Knowledge

Founded by Richard A. Proctor, 1881.

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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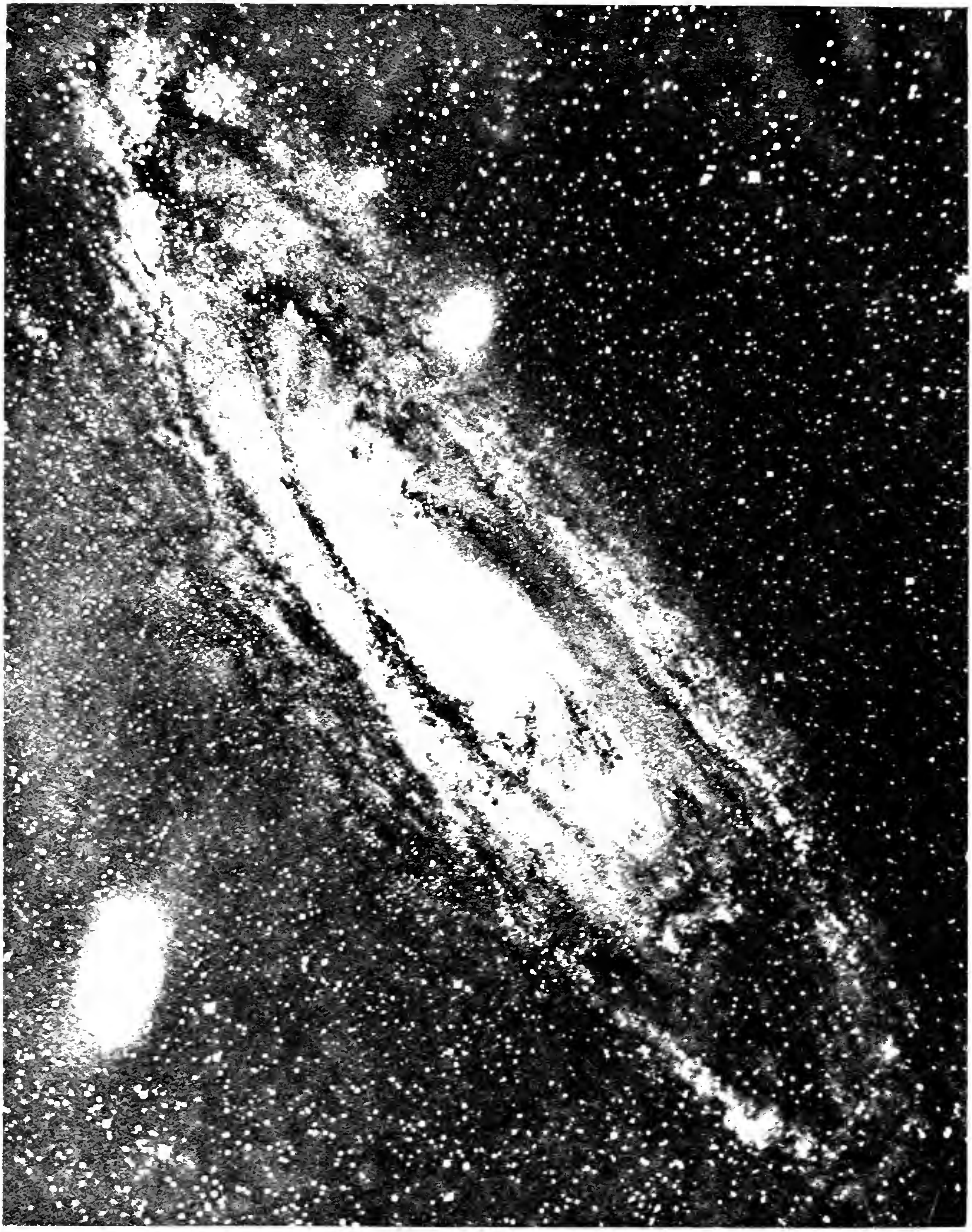

From a photograph taken at *Yerkes Observatory, September 15th, 1901.*

The Nebula in Andromeda.

Printed by the Photo-Printing Syndicate, with a Rotary Photogravure Machine, on ordinary paper.

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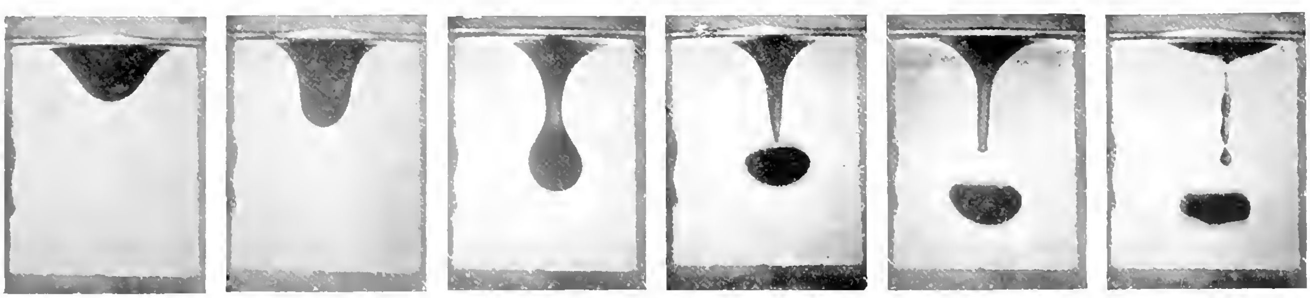
JANUARY, 1911.

A SIMPLE EXPERIMENT ON THE FORMATION OF DROPS OF LIQUID.

By CHARLES R. DARLING, A.R.C.Sc.I., F.I.C.

WHEN a suspended mass of liquid attains a definite size it becomes too heavy to be sustained by the adhesion of the liquid to the surface from which it hangs, and, consequently, a portion breaks away, resulting in the formation of a spherical drop. When the liquid hangs in air, as in the case of water on the end of a leaky tap, the drop breaks away too quickly to permit the process of separation to be observed by the unaided eye. In order to study the changes in outline undergone by the suspended liquid, instantaneous photography and rapidly intermittent light have been employed, and have succeeded in disclosing the beautiful transition shapes which accompany the detachment of the drop. Either of these methods of observation, however, demands the use of elaborate instruments, and it is here proposed to describe an experiment of the simplest description, which not only enables the process to be followed easily by the eye, but is unique in the respect that the formation of the drops is automatic and continuous. It was arrived at by the author as the result of a comparative study of the physical properties of water and other liquids of approximately equal density.

A glass beaker, about six inches high and four inches in diameter, is filled with water to the height of about four and a-half inches, and seventy or eighty cubic centimetres of commercial aniline are added, which will sink to the bottom of the vessel. The temperature of the beaker and its contents is now raised to 75° or 80° C. by means of a burner, when it will be observed that the aniline will rise to the surface of the water, from which it will hang in a mass of curved outline. Almost immediately the suspended aniline commences to alter in shape; and gradually a large drop, an inch or more in diameter, detaches itself from the mass and falls through the water. The formation of this drop takes place so slowly, owing to the aniline being buoyed up by the water beneath, that all the changes of shape associated with the process may be observed distinctly. The appearance presented is well shown in the accompanying photographs, taken by Mr. B. Abel, of the City and Guilds Technical College, Finsbury, with an ordinary hand camera. In No. 1 the formation is commencing; No. 2 represents the stage just preceding the formation of the neck; in No. 3 the neck has formed, and in No. 4 the drop has just broken away; No. 5 shows the flattening of the drop due to the shock of breakage,



1 2 3 4 5 6

The formation of a drop of aniline.

and also shows the neck to have taken a cylindrical form; whilst in No. 6 the distortion of the drop has proceeded further, and the cylindrical neck, being unstable, is seen to be breaking up into three separate portions, each of which forms a sphere. These photographs, however, do not give such a complete idea of the process as may be obtained by watching the experiment, as only six detached stages are represented. Variations occur, also, in the fate of the neck, which sometimes shrinks back into the mass remaining on the surface: sometimes breaks off and forms a single sphere, and often several spheres of varying sizes. The exact method of taking the photographs will be explained later.

And now, the detached drop having fallen to the bottom of the beaker, comes the surprising part of the experiment. The fallen drop is seen gradually to rise to the surface, where it joins the mass from which it previously broke away. At once another drop commences to form, and having become detached, falls and rises in the same manner as the previous drop. So long as the temperature of the water is maintained at 70° C or over, this procedure continues indefinitely. The forces at work on the drop perform a Sisyphean task.

Here it may be explained that the photographs shown do not represent one and the same drop, but that a snap-shot was taken at different phases in the formation of six separate drops. The uniformity with which the process is repeated is thus exhibited in a striking manner, as the photographs might easily be taken to represent six stages in the formation of a single drop. It may be added that the temperature should never exceed 85° C, nor fall below 70° C if photographs are being taken; and that the distorting effect of the glass beaker may be overcome by placing it in a rectangular vessel with glass sides, also containing hot water. This plan was followed by Mr. Abel in securing the photographs shown; it is also suitable for the optical projection of the experiment.

The explanation of the formation of the drops and their subsequent ascent to the surface is, in the main, simple. Aniline is a liquid which at low temperatures is denser than cold water, but at high temperatures lighter than hot water, owing to its higher degree of expansion. If dropped into water below 60° C, aniline will sink; but if the temperature of the water exceed 65° C, the aniline, after becoming warmed by its surroundings, will rise. Hence, in the experiment under notice, the aniline ascends to the surface of the water owing to its lesser density. By spreading out on the surface, however, the aniline is cooled more than the water beneath, and soon becomes denser than the water in consequence of this cooling. The aniline then tends to sink, and a drop breaks off as shown in the photographs. By passing through the hot water, however, the temperature of the detached drop rises, and if the temperature exceed 65° the drop will again become lighter than its surroundings and will ascend to the surface. The success of the experiment depends upon this remarkably delicate balance in the temperature-density relations of aniline and water. It must be stated, however, that aniline is partially soluble in water, and hence the drop is falling not through pure water, but a saturated solution of aniline in water. Questions with regard to the surface tensions of the liquids would also have to be entered into in giving a detailed explanation; and these apparently minor details probably furnish the reason why certain other liquids, which might be expected to behave in the same manner if substituted for aniline in the experiment, fail to do so. So far as investigations have been conducted, no other liquid has been made to operate automatically in producing and reproducing the drop.

One other feature of the experiment is deserving of notice. It may be made to represent the principle of elementary heat engines. The lower part of the water serves as the source of heat; the atmosphere above the surface acts as the refrigerator to which the rejected heat is given; and work could be done by the moving drop. It would not be difficult to construct an indicator diagram for this rudimentary heat-engine, based on Carnot's well-known cycle, for the drop passes through a regular and recurrent set of operations. A beaker of hot water and some aniline may thus be made to teach many useful lessons, and furnish a further example of how the profoundest scientific truths may frequently be deduced from the simplest experiments.

THE GREAT NEBULA IN ORION.

The photograph of the Great Nebula in Orion (reproduced on the opposite page) is made from a negative which we owe to the courtesy of Sir William Christie, F.R.S., the recent Astronomer Royal, and is one of the triumphs of celestial photography at the Royal Observatory, Greenwich. No finer photograph of the nebula is in existence. The reproduction is enlarged three diameters, from a negative taken by Mr. Melotte, on December 1st, 1899, with the thirty-inch reflector, the focal length eleven feet five inches, and the exposure two and a quarter hours. The nebula seen through a telescope glows like a vast filmy cloud of emerald light. Its brightest portions have edges sharp as in an engraving, and are side by side with regions of the most intense blackness.

The Great Nebula in Orion [illegible]

Focal length [illegible]

HOW AND WHY DO LEAVES FALL?

By G. S. BOULGER, F.L.S., F.G.S.

THERE is no element which contributes more to the difference of the landscape as we travel from the Equator northward than the prevalent character of the foliage of the trees. In the tropical jungle the bulk of the trees are dark green, thick-leaved evergreens, a characteristic which extends northward in the more insular moist climates of coast and island regions, notably exemplified by the flora of Japan. In the Cooler Temperate Zone the predominant trees are dicotyledonous angiosperms, the "broad-leaved trees" of our foresters, with smaller, thinner leaves than those of the jungle, lighter in tint, producing a less dense shade, and, for the most part, falling in autumn. Northward of these again the polar limit of arborescent vegetation is reached by the striking Sub-Arctic Zone of "needle-leaved" conifers, mostly evergreen.

FIGURE 1.
Longitudinal section of a stem and the base of a leaf stalk of horse chestnut shewing the light coloured cork layer that causes leaf-fall.

It must be noted, in passing, that this term "evergreen," though often true enough of a tree, does not apply to the individual leaf. A tree is evergreen when it retains the leaves of one year at least until after those of the next season are unfolded. We have numerous gradations, from our ordinary "deciduous" species, which are bare of leaves for five or six months in the year, through such cases as that of the privet, which retains its leaves through a mild winter, and that of the holm oak which is only stript by exceptional frost, to such evergreens as the holly, or the cedars and pines, that retain their needles for several successive years.

If we look at the question of leaf-fall no longer geographically, but from the point of view of the systematic botanist, we find that the lower and simpler types of leaves do not fall. The primitive leaves of mosses have no articulation at their base: the elaborately-divided fronds of most tree-ferns wither and hang their dead stalks downwards from the stem: the needles of conifers wither similarly, generally after being several years on the tree: and the simple sheathing leaves of most Monocotyledons have not so perfect a system of articulation as we find in the Dicotyledons, especially those with compound leaves.

A thoughtless, unobservant conclusion would be that the leaf dies and then, and consequently, falls off; but this is far from being the case. Preparations may begin for the fall of the leaf almost as soon as it is formed: and in many cases the leaf is moist and its cells fairly inflated when it falls. As far back as 1758, Duhamel ascribed the fall of the leaf to a layer of tissue between the stem and the leaf, which remained "herbaceous," *i.e.*, capable of growth, but could not stand winter cold: whilst Vrolik, in 1797, spoke of the absorption of a layer between the dead and living parts but belonging itself to the living. In 1848 a Dr. Inman, in a paper communicated to the Literary and Philosophical Society of Liverpool, described an inward extension of the cork of the bark and disruption taking place through cellular tissue external to this corky layer, from without inwards

"The provision for the separation," he writes, "being once complete, it requires little to effect it; a desiccation of one side of the leaf-stalk, by causing an effort of torsion, will readily break through the small remains of the fibro-vascular bundles; or the increased size of the coming leaf-bud will snap them; or, if these causes are not in operation, a gust of wind, a heavy shower, or even the simple weight of the lamina, will be enough to disrupt the small connections and send the suicidal member to its grave. Such is the history of the fall of the leaf. We have found that it is not an accidental occurrence, arising simply from the vicissitudes of temperature and the like, but a regular and vital process, which commences with the first formation of the organ, and is completed only when that is no longer useful; and we cannot help admiring the wonderful provision that heals the wound even before it is absolutely made, and affords a covering from atmospheric changes before the part can be subjected to them."

In 1859 Hugo von Mohl, the illustrious founder of the cell theory, chanced to spend his autumn vacation at home, so that he observed the successive fall of the leaflets and the leaf-stalk in the leguminous *Gymnocladus canadensis* with the conveniences of his laboratory at hand. He found that a layer of cork already extended through the cellular tissue at the base of the petiole in September. Immediately above this a layer of cells had become brown (suberised): and, separated from this by two or more rows of the ordinary colourless polyhedral cells of the leaf-stalk, what he termed the separating, or "absciss," layer originated. This only formed between the 4th and the 15th of October, extending across the stalk from the inner or axillary surface, and contained in its cells protoplasm and starch-grains. It is, in fact, what we now term "secondary meristem." Von Mohl only recognised two layers of cells in the absciss-layer, which he believed to split apart, while he thought that the fibro-vascular bundles were broken mechanically by the weight of the blade and the strain of wind and rain. He perceived, however, that the fall of the leaflets between the 10th and 20th of October, and the subsequent fall of the petioles was independent of the cork-layer formed at least a month before. This cork layer, in fact, is not formed in advance in those ferns which are deciduous, in beech, elm or most oaks. Von Mohl also noticed that when leaves fell suddenly, after an autumn frost, a thin layer of ice had formed in the delicate sappy cells of the absciss-layer, torn cell-walls evidencing the violence of the disruption.

In 1863, Julius Sachs traced the gradual removal of the contents of the leaf-cells. The protoplasm and nuclei are dissolved, the chlorophyll-granules become disintegrated, the starch disappears, leaving only the few yellow granules, or the reddened cell-sap, which produce our autumn tints; while starch, potash and phosphoric acid travel down the leaf-stalks to be stored up in the twigs, and only the waste or end-products of metabolism, calcium-oxalate crystals, resins and alkaloids remain to be thrown off with the falling leaves.

Figure 2.
A beech which has lost the leaves from the ends of the shoots.

Figure 3.
The terminal leaves still remaining on linden tree.

In 1882, M.M. Guignard and Van Tieghem returned to the study of *Gymnocladus*; but began their investigation in the middle of June. They found that no cork is formed at the base of the leaflets. It is not worth while to heal the wound on the leaf-stalk which is itself to fall in a day or so. The suberised layer was formed at the base of the main petiole by the middle of June: then a layer of meristem, the "phellogen" or cork-cambium, originates below it and the absciss-layer above it, before the end of June. This layer spreads inwards from the epidermis through the cellular tissue of the bast and wood-bundles. It consists not of two, but of three, layers of cells of which the middle row is absorbed. The two remaining rows, still living and turgid, swell outwards with rounded surfaces, and so create a strain which snaps the fibres and vessels. These observers also induced leaf-fall artificially at midsummer, by placing a cut-branch in a box filled with moist air, and they found that after the fall of the leaf the cellular tissue of the vascular bundles whose ends are exposed on the leaf-scar becomes "merismatic," *i.e.*, undergoes cell-division, forms cork, and penetrates and fills up the ends of the vessels.

It is well to bear in mind that prolonged drought will induce leaf-fall much as does a frost, and that a layer of cork is formed below the prickles on old stems of rose or bramble, and below twigs in some plants which shed these branches as others shed their leaves. On the other hand, if a branch be broken through early in summer, its leaves wither but do not fall, no absciss-layer being formed. Coppiced oaks or the clipped beeches and hornbeams in the hedges of nursery-gardens also retain their leaves, as if the energy and material used up in the formation of callus to heal the wounds caused by pruning-knife or shears left none for the formation of the usual absciss-layers. The pollard hornbeams of Epping Forest, which used to retain their withered foliage through the winter, have, since the Forest was taken over by the Corporation of London, and lopping has been stopped, been gradually regaining the deciduous character of "spear" trees.

Everyone must have noticed the successive fall of the leaflets and the leaf-stalks in the ash or horse-chestnut, the thick-ended petioles being aptly known by children as "bones," since they are by no means unlike the leg-bones of birds. There is, however, another interesting little point in connection with leaf-fall which is, perhaps, less familiar, and which is well illustrated in the photographs, by Mr. Johnson, of Tunbridge Wells, from which our blocks have been prepared. This is the order in which the leaves fall from the twig. In the beech this is *basipetal, i.e.*, the younger leaves at the apex of the twigs fall first. In the linden, the poplar, and apparently in the majority of trees the fall takes place *acropetally, i.e.*, the older leaves at the base of the twigs fall first.

It is well to notice that here again we have order and not chance: that Nature has, as we often find, two or more ways of bringing about the same result: and that even in such an apparently simple matter as the fall of the leaf there is room for a good deal more research.

SOLAR DISTURBANCES DURING NOVEMBER, 1910.

By FRANK C. DENNETT.

During November there has been a considerable falling off in solar energy, a complete absence of dark spots being recorded on sixteen days, and on five of these facular disturbances were also absent. It is a little peculiar that the majority of the disturbances have occurred in the northern zone, which for so long has been comparatively quiet. The longitude of the Central Meridian at noon on November the 1st was 18° 22'.

As No. 82 continued on the disc until November the 3rd it is shown on the accompanying chart.

No. 83.—A pore in the northern spot-zone, only seen on the 3rd.

No. 84.—Two pores only visible on the 7th, in the area formerly covered by No. 75.

No. 85.—A solitary pore also ephemeral, only being seen on the 14th.

No. 86.—First seen on the 16th, when it showed some of the characteristics of an elliptical outbreak. The leader, or western spot was 10,000 miles from north to south, and the group about 3° in length. The spectroscope showed the C line of hydrogen displaced both on the red and violet sides, and prominences were visible in projection over the group, whilst the D_3 line of helium was dark through the outbreak. On the 17th it was seen as a nearly straight group of small spots 40,000 miles in length. By the 18th it had assumed a lozenge shaped arrangement of pores, with the largest behind, or eastward, and when last seen on the 19th there were only two pores, 26,000 miles apart.

No. 86*a*.—A single, not very black, pore a little west and south of the group, only recorded on the 16th.

No. 86*b*.—A minute pair of pores 19,000 miles apart, in the former area of No. 78, only seen on the 18th.

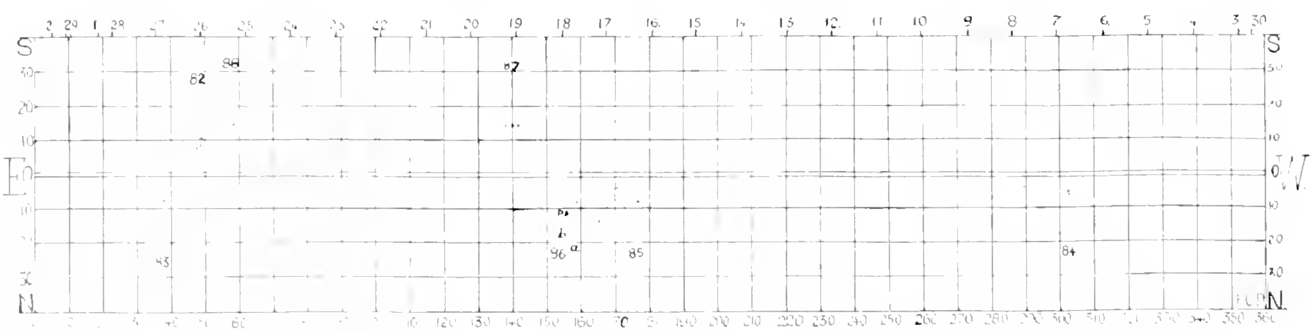
No. 87.—Three pores nearly in line, also seen on the 18th only, in the area of No. 79*c*.

No. 88.—A single spotlet seen from the 20th until the 22nd in a disturbed area, having apparently come round the limb.

On November the 12th a curved facular ridge of horseshoe form was seen in northern latitude in the position dotted upon the chart.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and F. C. Dennett, working in places so far apart as Lisburn, Chorlton-cum-Hardy, Bath, and Hackney, thus making the record almost complete.

DAY OF NOVEMBER.



EXPERIMENTAL MECHANICS.

By W. D. EGGAR, M.A.

Mechanics is the mother of two sciences, Engineering and Gravitational Astronomy. This statement is perhaps open to question. Both engineers and astronomers may wish to claim a more remote ancestry for their studies. But, without insisting on the precise relationship of the different groups, we may point out that Gravitational Astronomy is very much younger than mechanics, and it might almost be said that she made her entry into the world after the manner of Minerva, appearing full grown and fully equipped from the brain of the god-like Newton. The perfection of her equipment, and the unexceptionable propriety of her demeanour commended her to all mathematicians, with the result that Mechanics, her real mother, was received into their select circle, taking the name of Applied Mathematics, and not encouraged to see much of her other daughter, fond, it was feared, of low and irregular company.

Figure 1.
Apparatus for measuring time with a tuning fork.

Times have changed. Even the House of Lords must become more democratic, and engineering has become so very much of a great lady as to compel the respectful attitude of mathematics, and to make her connection with trade rather a recommendation than otherwise. In other words, the world must have engineers, and engineers must have mathematics, and, therefore, mathematics has become more practical. Moreover, in the engineering profession itself the problems which require solution become more and more of a kinetic nature. The strains and stresses in girders and embankments are as important as ever; but, in addition, the mechanics of movement is growing in importance. We move faster nowadays, not only on the railways, but on the roads, in the water, and even in the air. Hence it is that the practical teaching of mechanics, whic[illegible] to be limited to a few experiments with spring bala[illegible] and pulleys, has now spread into the region of kine[illegible]. The concepts of force and work are undoubtedl[illegible] approached by practical measurements of th[illegible]ficiency of simple or complex machines; and [illegible] has been found that velocity, acceleration, kine[illegible] energy, moment of momentum, and other concepts involving movement can best be realized in a practical manner.

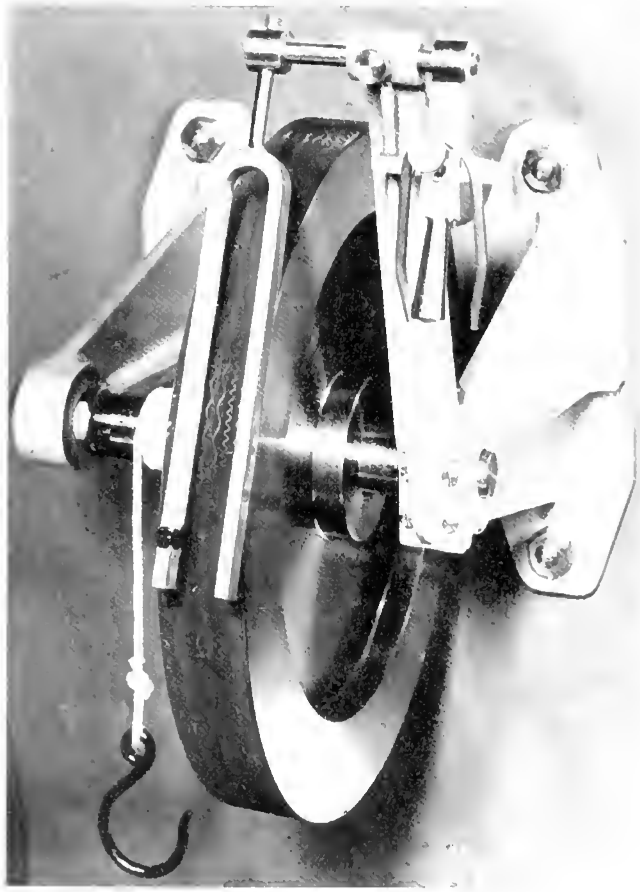


Figure 2.
Measuring the velocity of the rim of a wheel.

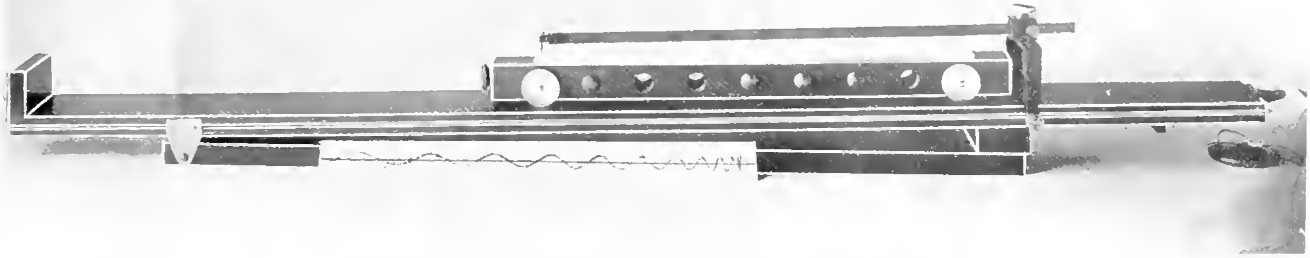


Figure 3. Fletcher's trolley for measuring acceleration.

The measurement of time has always been a difficulty in the way of those who have tried to teach kinetics by experiment. Electric chronographs are expensive, and, even where expense is no bar, they are frequently found wanting either in their working or in their power of elucidating the problems in which they are employed. A recent adaptation of the old tuning-fork method of measuring time has revolutionized schools of dynamics. The tuning-fork method will be best understood from a glance at Figure 1, which shows an arrangement for allowing a plate of glass to fall so as always to be in contact with a style attached to one prong of a tuning-fork vibrating with known frequency. A wavy-curve is traced on the glass by the vibrating point, and the space fallen in a given time can be determined by measuring the length of that portion of the wavy curve which contains a number of waves corresponding to the given time. Another apparatus for measuring the velocity of the rim of a flywheel by means of a tuning-fork is shown in Figure 2. Now a tuning-fork is not very easy to manipulate, and it goes rather too fast for beginners. Here it is that a great simplification has been made by Mr. W. C. Fletcher, of the Board of Education.* A strip of steel clamped at one end carries a paint brush at the other end. A long trolley carrying a strip of paper moves underneath this paint brush in the direction of the steel rod's length. Suppose the steel to vibrate ten times a second, then the paint brush will trace a wavy line on the paper, and ten waves will represent the distance travelled in one second. The lengths of the waves give the velocities, and the changes in the wave lengths give the accelerations. Figure 3 gives an example of the way in which Fletcher's trolley may be employed for measuring the acceleration when the trolley is allowed to run down an incline. One of the curve tracings made by the paint brush is shown resting by the side of the plane. As for the way in which the acceleration is determined from a curve of this kind, let us consider the curve shown in Figure 4. Placing a centimetre scale along its wave crests, we can read off the distances of these crests from the starting point of the curve to the nearest half millimetre, thus 0·1, 0·35, 0·8, 1·45, 2·25, 3·2, 4·35, 5·65, 7·1, 8·7, 10·5, 12·4, 14·5, 16·75. From this, by subtraction, we obtain the successive wave-lengths, viz.: 0·25, 0·45, 0·65, 0·8, 0·95, 1·15, 1·3, 1·45, 1·6, 1·8, 1·9, 2·1, 2·25. It is obvious from this that the wave length has been increasing fairly uniformly, the successive increments in wave-length being again obtained by subtraction. Thus they are 0·2, 0·2, 0·15, 0·15, 0·2, 0·15, 0·15, 0·15, 0·2, 0·1, 0·2, 0·15. The average of all these is 0·167. Now, since the wave-lengths correspond to periods of one-fifth second, it is plain that the average increase in the space travelled in each one-fifth second is increasing at the rate of 0·167 centimetre in every one-fifth second. Hence in each second the increase in the velocity is $5 \times 0{\cdot}167$ centimetre per one-fifth second, or $5 \times 5 \times 0{\cdot}167$ centimetres per second. The acceleration is therefore 4·17 centimetres per second per second.

FIGURE 4. Wavy Curve showing acceleration.

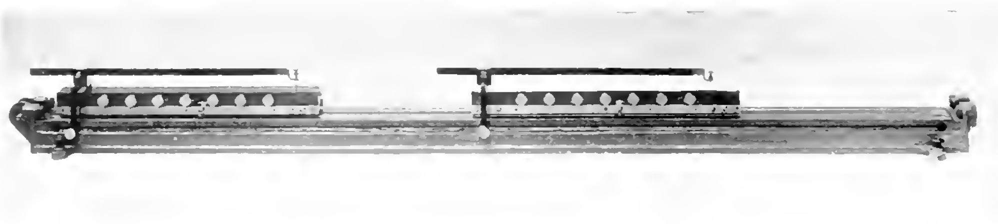


FIGURE 5. Two trolleys for verifying the laws of momentum and impact.

As an example of the way in which the apparatus may be employed we may take the verification of the law "Acceleration is proportional to the accelerating force." The variable force is obtained by varying the slope of the plane. To avoid having to consider the force of friction, the trolley is first connected by a string passing over a pulley, shown in the figure, to a scale pan of known mass, and weights are added just enough to prevent the trolley from accelerating when it is given a start down the plane. When the waves made by the paint brush are of equal length the total force down

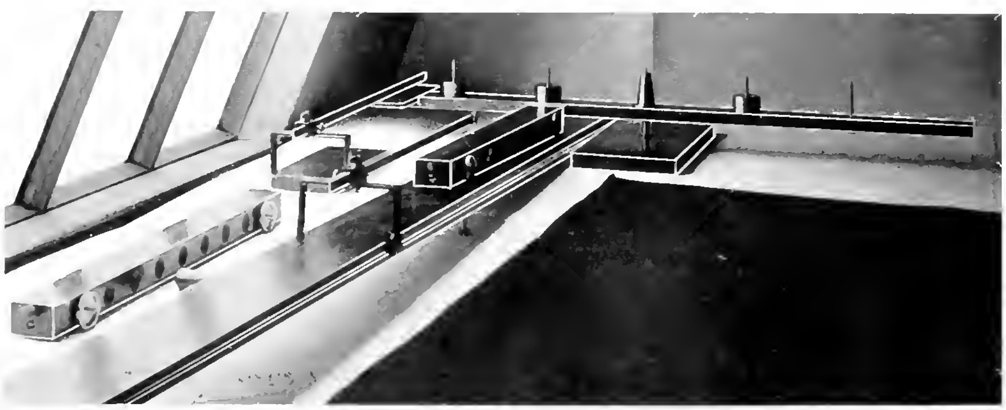


FIGURE 6. An inertia bar set in motion by a trolley.

* See *School World*, May, 1904.

the plane is exactly balanced by the scale pan and weights. Now if the string is removed the trolley will accelerate under a force which is equal and opposite to that which has been removed, viz., the weight of the scale pan and its contents. The acceleration can be measured as before. If the bullet embeds itself. After the shot the trolleys retire with equal momenta.

Figure 6 shows an inertia bar, which is set in rotation by the impact of a trolley. Vibrating springs are employed as before to measure the momentum of the trolley, and the angular momentum of the bar.

FIGURE 7.
A vibrator used for measuring the angular velocity of a fly wheel.

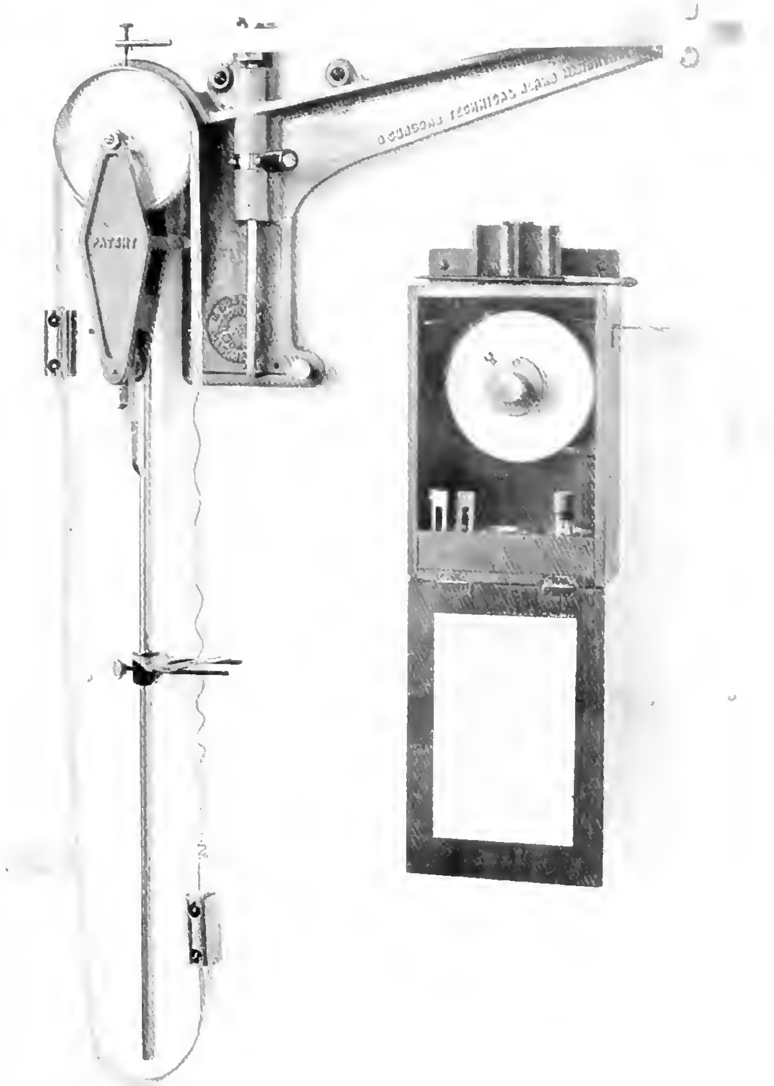


FIGURE 8.
The vibrator adapted to an Atwood's machine in which a paper ribbon replaces the string.

observations are now repeated with a different angle of slope the two accelerations will be found to be in the same ratio as the two accelerating forces.* An approximate verification of Newton's Second Law may seem unsatisfactory; but the method has the merit of making the notion of acceleration much more easy for the ordinary mind to grasp.

Figure 5 shows how, by means of two of these trolleys, laws of momentum and impact may be verified. In one form of the apparatus, employed by Mr. Ashford at Dartmouth Naval College, one trolley carries a pistol and the other a target in which the

Figure 7 shows the vibrator employed in measuring the angular velocity of a fly wheel. The notion of kinetic energy becomes clearer after a series of measurements taken with an apparatus of this kind.

Mr. G. Cussons, of Manchester, to whom we are indebted for the photographs used in illustrating this article, has adapted the vibrator to a form of Atwood's machine in which a paper ribbon replaces the usual string. The apparatus is shown in Figure 8. Excellent results are obtained from this instrument, and Figure 4 is a reproduction of one of the curves obtained from it.

* See Eggar's Mechanics, E. Arnold.

CARRIERS OF PLAGUE.

By E. S. GREW.

With illustrations from photographs by the courtesy of Dr. C. J. Martin, F.R.S.

TECHNICALLY any animal is a carrier of plague which has plague, and in the organs or blood of which the plague bacillus resides. In that sense the natives of India are plague carriers; the rats and bandicoots of India are still more emphatically plague carriers. But, in the last resort, seeing that the instances in which a rat suffering from plague could inoculate man with plague bacilli must be so rare as not to be worth considering, the true carriers of plague are the animals which convey the bacilli from rat to rat, or from rat to man, or, in rare instances, from man to rat. These animals are the fleas which infest rats.

FIGURE 1.
An old Bengalpura Street.
All the dwelling houses are above stables, and therefore, on the face of it, likely to be infested with rats.

FIGURE 2.
The interior of a Cooly's Room.
Pots and boxes containing articles of daily diet are lying all over the place and affording shelter and facility to rats.

This conclusion, apparently so simple, was, however, not reached without long continued investigations, undertaken, at the instance of the Indian Government, by a commission of bacteriologists (under the direction of Dr. C. J. Martin, F.R.S., and Col. David Bruce, F.R.S.), which has been at work since 1904. Among the investigations made by the Plague Commission's bacteriologists have been a number which dispose of the idea that plague can ordinarily be spread by plague bacilli which may be left on the earth—on the floor of infected houses, or on the soil. Nor can plague be transmitted usually by aërial infection. That is to say, it cannot be transported through the air, or with wind-swept dust. Nor, again, though this belief has had a long currency, can it usually be transmitted through food. *The Indian Plague Commission have discovered no fact which would support the suggestion that plague may effect an entrance into the human organism through the stomach or intestinal canal.* The probabilities of infection through swallowing any number of plague bacilli are extremely small; and it is justifiable to conclude that in nature, infection of rats by feeding rarely or never takes place, *and that rats do not become infected by eating the carcases of their comrades.* The repetition of these facts has a certain interest at a time when the appearance of plague among rats in Suffolk has created a very distinct prejudice against the use of game, of hares, and even of imported rabbits as food. Everyone would, of course, prefer not to eat any animal which could possibly have died from plague, but no one would be in the least likely to contract plague by doing so.

In view, however, of the fact which is now declared by the highest authority to be well established, that there have occurred two cases of plague pneumonia in Suffolk, and that there have been a number of cases of plague among rats in that neighbourhood, it becomes important to inquire what the probabilities are of any considerable spread of the infection in England.

In any outbreak of plague in a new locality the factors which determine the extent and severity of the epidemic are much more numerous than are generally supposed, and the margin between danger and safety is dependent on factors which are in themselves apparently slight. For example, it has already been said that plague is spread entirely by plague fleas. This may naturally lead to the inquiry

FIGURE 3.

The house (at Parel) with the plant pot in front, produced a very large number of rats.

whether the last Great Plague of London, which proved so devastating, was spread by fleas? If it

FIGURE 5.

Taking a systematic flea count.

were so would not this argue that the habits and dwellings of London in the late seventeenth century were much more dirty than we have any evidence to show that they were? Moreover, would not the supposition be in confli[illegible] the recorded facts that whole families wer[illegible]ith the plague, apparently taking it fro[illegible]ther? That is certainly true; and the ans[illegible]se questions is

FIGURE 4.

An examination of plague infected rats at one of the Indian Government Laboratories.

to be sought in the fact that plague has more than one development. It may develop into plague

FIGURE 6.

Picking off fleas from live rats for experiments.

pneumonia, which, of all forms of plague, is the most dangerous and the most infectious. The mortality in plague pneumonia approaches one hundred per cent.; hardly anyone recovers from it. Moreover, while suffering from it the patients are delirious, they are with difficulty restrained from walking about, and they cough and spit incessantly. Their sputum is full of plague germs, and is highly infectious to anyone on whom it may be discharged. Rats, also, may have plague pneumonia; and there is one instance at any rate in which a bacteriologist is believed to have contracted plague from the sputum of a plague infected rat. The Great Plague of London took place in winter, and a large number of victims no doubt had plague pneumonia; hence the virulence and rapidity of the contagion.

FIGURE 7.
Pulex felis ♂, the cat flea.

What then is the genesis and progress of an outbreak of plague? Plague, in the first instance, appears to arise in certain foci in Asia and Africa, where it always exists. In a locality such as Bombay, an outbreak among human beings is preceded by an outbreak among rats, and if a curve be drawn showing the rise, culmination and decline of the plague among rats, it is found that a rise, culmination and fall of plague among human beings takes place in a curve almost parallel to that of the plague among rats, but occurring about a fortnight later. The reason is quite plain. In the native dwellings of India generally, and in the native villages of the Punjab, man and the rat live together like friends. There are two kinds of rats in India, as there are two kinds of rats in England, though the numerical proportions of the two kinds are usually reversed. In England the commonest rat is the so-called grey rat, *Mus decumanus*, or Hanoverian rat, which usually inhabits sewers, and is a fierce, strong animal, shy of human beings. In India the commonest rat is the black rat, *Mus rattus*, which is not at all shy, and which, being allowed to do so, lives on terms of intimacy with the Indian native. But the black rat is found in England, in the Thames and Mersey warehouses; and the grey rat is found in Indian ports. The reason why the black rat spreads plague in India is that it dwells unmolested in the native villages, and in the ramshackle native quarters of towns: and that, consequently, if it has any epizoötic disease which can be transmitted to man, there is an initial probability of its transmission. In short the Indian rat is a reservoir of plague, which is constantly being tapped by the fleas which live on it, and which carry it on to the human being in the rat's neighbourhood. On a rat infected with plague thirty fleas are by no means an excessive number. In one native house in Parel, an Indian village, no fewer than three hundred rats were trapped. Multiply the number of fleas by the number of rats, and the number of possible plague inoculators thus arrived at will give an indication of the risk which Indian natives run of contracting plague when there is an outbreak of it among rats.

FIGURE 10.
Ctenopsylla musculi ♂, the mouse flea.

FIGURE 8.
Sarcopsylla gallinacea ♂, the chicken flea.

FIGURE 9.
Micro-photograph of a ♂ *Pulex cheopis*, the Indian rat flea.

It will be seen, therefore, that even if there were an outbreak of plague among the rats of Suffolk, the chances of the development of a corresponding outbreak are not very large. But they are further narrowed by the kind of fleas which live on rats in this country and in these latitudes. There are six kinds of fleas which have been found on rats. The human flea (*Pulex irritans*) is found on it sometimes, but not very often. The dog flea (*Pulex canis*) is found more often but still seldom. The mouse flea (*Ctenopsylla musculi*) (see Figure 10) is also found.

There are, however, three kinds of fleas which are found commonly on rats, and the consideration of which is more particularly relevant to the question of the contagiousness of plague. The first is a rat flea, *Typhlopsylla musculi* (not unlike the mouse flea), which is common on rats in some parts of Europe; but which will not bite man. The second is the most common European rat flea, *Ceratopsyllus fasciatus* (see Figure 11). But this flea will not feed on man, except when starving. The last, and most important, flea is *Pulex cheopis* (see Figure 9), the Indian rat flea, which, unlike the European rat flea, readily feeds on a number of

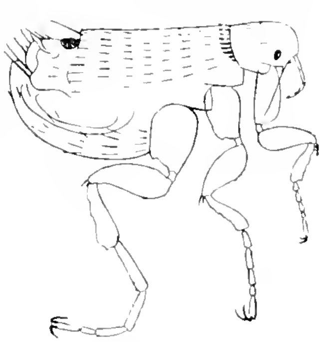


FIGURE 11.
Ceratopsyllus fasciatus ♂, the European rat flea.

animals. In the absence of rats it will readily bite man.

It will be seen at once how important this factor is. The varying appetite of the different kinds of fleas modifies to a great extent the probability of the transmission of plague to man. If it were possible, or probable, that the European rat flea should alter its habits an[illegible]t man as a host, the probability of human pl[illegible] Europe would be of an entirely different [illegible] At present northern Europe, and, to a less [illegible], Europe in the temperate zone, seems immune [illegible] an out-break of plague on account of the [illegible]bits both of the grey rat and of the flea which [illegible] on it.

CORRESPONDENCE.

PODURA SCALES.

*To the Editors of "*KNOWLEDGE."

SIRS.—While fully appreciating Mr. Plaskitt's kind reference to my article, for which I thank him, there are yet certain points in his letter to yourselves with which I, for one, cannot agree. I cannot admit, for instance, that in the Podura scale mounted dry we are "left with the only alternative (that is, in being mounted in a medium) between the normal of air and the scale itself"; or, that for that reason, "we make no advance upon the earliest methods." As I understand it, with a scale mounted dry, and tight against the cover glass, there is no normal of air, but perfect optical contact with glass throughout, also with the cedar oil of the same refractive index between that and the objective. Mr. Plaskitt speaks of the scale, not being flat, giving rise to distortion. That has not been my experience, though it may be said of other kinds of scales, such as those belonging to the Moth and Butterfly.

Assuming that the widest apertured oil immersion objective is employed upon this scale, the best way to discover whether it is working at its maximum is to look down the tube of the microscope after removing the eye-piece. If the back lens is seen then to be filled as to three-quarters of its diameter with white light, this condition may be said to be fulfilled. Under no circumstances could this be obtained with an objective of 1·40 N.A. were there a stratum of air between the object and the cover glass.

These conditions were fulfilled in all my work upon this scale. For myself I never required other proof of optical contact, than the flashing out of the object in brilliant light, as if the scale were self-luminous. Apart from this, however, my friend, Mr. E. M. Nelson, with whom, at that time, I spent many delightful days at his house over the microscope, tested it for his own satisfaction with the Vertical Illuminator, when the test was always justified.

As to the three-quarter cone of white light at the back lens of a wide apertured objective; this for a long time now has been looked upon as the ideal illumination, where the greatest resolving power is combined with perfect definition. Mr. Nelson, in his Presidential Address to the Quekett Club in the early part of 1895, went fully into this question. The address will be found in Vol. 6 of the Journal of that Club, beginning at page 14, but as some readers may not have access to it, I beg to be allowed to make the following extract for their benefit:—

"It is common knowledge that when a full cone is employed, the resolving power falls off, and it has been customary to account for this falling off in the resolving power by the outstanding spherical aberration in the objective. To test the accuracy of this current notion a critical image was set up, and matters arranged so that access could be obtained to the back lens of the objective without disturbing any of the adjustments. When a full cone of light was used (that is, the back lens entirely filled with light—T.F.S.) the resolving power fell off, and when a three-quarter cone was employed it was as usual restored again; a stop was then placed at the back lens, cutting off the peripheral unilluminated annulus. We had, therefore, an objective of less aperture, but illuminated by a full cone. Under these circumstances one would have expected to see a critical image, but not so, and this is the crucial point. In order to obtain the maximum resolving power for that reduced aperture the illuminating cone had to be reduced until three-quarters of the back lens was illuminated."

It follows, then, that given the three-quarter-cone as the most ideal illuminant, such a cone of an oil immersion objective of 1·40 N.A. must have a much greater resolving power than the similar cone of a dry objective whose maximum aperture is only 1·0. Up to a certain period dry glasses were the only ones available. All my photographs of the scale were taken under the first conditions; hence, unless I blundered greatly, they must have made an "advance upon the very earliest methods."

We now come to the question of oblique light as helping towards the further elucidation of structure in the Podura scale. Mr. Plaskitt says, that when central light is used, "there is insufficient contrast to bring out several of the finer phases of detail. It is much the same as if one placed a piece of plain glass in the midst of a lamp flame and were asked to observe its uneven surface, or to direct a telescope boldly towards the full moon and be expected to trace its finest details."

The illustrations on the face of them are apt enough, yet, I fear for all that, a little misleading. The conditions of producing an image in the microscope differ from those concerned with unaided vision upon natural objects. In the microscope it is of a two-fold character; one geometrically, as in ordinary vision, taking up the centre of the back lens of the objective; the other, by diffraction, occupying the outer unilluminated ring. Both images reach the eye as one, that produced by diffraction strengthening the image produced in the ordinary way of vision. Neither with regard to the telescope and the moon do I think the cases are exactly upon all fours with each other. In one, the microscope, the light is tilted to the object; in the other the telescope remains the same—the moon it is that revolves. Mr. Plaskitt's photographs do not exhibit shadows such as when details in the moon are seen in profile, proving, to my mind, that the conditions of production are not the same.

Like Mr. Plaskitt I have been unable to discover any difference between the two sides of the scale, though I have had them mounted between two thin cover glasses, to enable me to get at each side. It is, indeed, altogether a puzzle, this secondary structure, and such for the present, I fear, it must remain. One thing, however, I would say in conclusion. If my own experience with minute structure is any guide, and with all deference I say this, it is that oblique light will not guide us further, but will only make confusion worse confounded.

Yours faithfully,

T. F. SMITH.

ON THE OCCURRENCE OF SOME SMALL FINELY WORKED FLINTS IN PALEOLITHIC GRAVELS.

By LIEUT.-COL. UNDERWOOD.

At various times during the past two years I have been carefully searching two gravel pits in which paleoliths are found one within a mile of Ipswich, the other at Upper Dovercourt, near Harwich.

The gravels of these two pits are of entirely different ages—that at Dovercourt being a terrace gravel of the River Stour, and situated eighty-seven feet immediately above it; while the gravel at Ipswich is not apparently connected with any river system, and as it rests on London clay (the base bed) and is surmounted with glacial boulder clay and interlocated with fine sand containing quartz pebbles,

From Gant's Pit, Dovercourt.

rounded diorites, sarsen stones and other erratics, it may be assigned to Middle Glacial age, and is undoubtedly much older than the Dovercourt deposit. In this latter pit no regular Acheullien *haches* are found, as at Dovercourt, and no large implements of war, until we come to the lowest bed of red sand, with large blocks of flint, and a few other stones, similar to what Rutot calls the "*gravier du fond*," found by him at Greville, which lies directly on the base bed, or London clay, where we get very large parallel-flaked, rough-pointed "*Coups du poing*" rubbers, and so on, but no small side-worked tools.

The Dovercourt pit, on the other hand, consists of a mass of gravels and sands resting on the London clay to an average depth of twelve feet. These are divided by a band of clay about half way down, of a few inches in thickness, which separates the bones and implements into two distinct zones. In the upper beds are found the remains of deer of four species: Reindeer, Red Deer, and Fallow, this species of a large kind which has also been found at Clacton. Boar, Wolf and Arctic Fox bones, occur with implements mostly unpatinated, or only slightly so, of Mousterian type, consisting of small tools, from three to five inches long, assegais, side knives or choppers, dressed flakes, rubbers, scrapers (round and hollow) and dressed bones, and a fish hook made from a halibut's clavicle.

In the bed below the clay band are found the bones of Mammoth, two kinds of Rhinoceros, *Bison briscus*, *Bos primigenus*, and the Horse, while the implements are of late Acheullien type, large and beautifully worked haches, together with small tetragonal and hexagonal borders, dressed flakes, rubbers of a peculiar kind, and a series of very small side-worked flints of almost pigmy appearance, consisting of delicate hollow and round scrapers, saws, and very small pointed tools like arrow or dart heads. These latter are so finely chipped that it is necessary to go to specimens of late Neolithic culture to find their equals, and though this is so, their deep patination and scratched surfaces point to an antiquity far greater than the Acheullien *haches*, which are lying *in situ*, un-water worn, while these small types, with some large and rude forms, have evidently been washed in from an older gravel. In the gravel at Ipswich exactly similar diminutive

From Bolton and Laughlin's Pit, Ipswich.

implements occur at depths ranging from ten to thirty feet from the surface, but are considerably more numerous.

The large number of these small well-worked implements which my friend, Mr. Moir, and myself have collected is very remarkable, and brings into prominence some questions which have not hitherto been discussed. Firstly: How is it that in our Museums, many of which contain large collections of magnificent weapons of War and the Chase from the principal river gravels, these paleoliths are seldom shewn? It is almost a certainty that they occur everywhere, but owing to the fact that workmen are only paid and encouraged to look for the larger specimens, presumably they are generally overlooked.

Secondly: These small fabrications are not to be found in the later gravels, as in the case of Dovercourt, above the clay band, nor are they found associated with large early Neolithic implements of Cisbury and Eastbourne. This seems to point to one of two conclusions, either that side-pressure flaking or "nicking" became a lost art at one early period and was not resuscitated till later Neolithic times: or that the workers (possibly a special race) of so-called "pigmy" [illegible] and small side work generally were driv[illegible] districts where their ancestors made these [illegible] tools," as Rutot so aptly describes them, [illegible] not again migrate to the same places for many [illegible] later.

Thirdly: I would suggest more [illegible] could be thrown on the present mystery of pa[illegible]n, if a general system were adopted of classing [illegible] implements in all the gravels of England a[illegible] to their forms and respective ages; and the ga[illegible] in the evolution of man's handiwork and arts would [illegible] more filled up by such a system than at present.

In the accompanying illustrations the finds of the two pits respectively are shown in types, and with the name of the pit in which each was found.

THE MYSTERY OF THE FLORAL PIGMENTS

By P. Q. KEEGAN, LL.D.

THE literature on the subject of the colours of flowers has been very voluminous as respects the final cause of the phenomena, but a truly scientific explanation thereof has seldom been attempted. We do not want to discover the purpose which these lovely pigments fulfil in the economy of the plant, so much as the chemical and physiological efficient causes of their appearance. The chemistry of plants requires to be studied, and the products of the physiological processes going on in their interior need careful detection and distinguishment. In this way only can the laws which govern the vital activity be discovered, and thereby also a true scientific understanding of the phenomena be attained. The corolla is the organ wherein the yellow, blue, and red colouring matters are chiefly produced, and hence its physiology has to be carefully studied and determined, not only in itself, but also in its relationship with that of its neighbouring organs, viz., the stamens and pistils. We know that the corolla grows very rapidly, that it is the seat of energetic oxidation and at times considerable transpiration; its assimilatory power is generally feeble, and it has a poor development of the vascular system, *i.e.*, of the conducting apparatus. Hence the appearance of the pigments in the corolla has been explained in a general and rather vague way by simple modifications in the phenomena of cellular nutrition and of cellular chemistry (Curtel*). Chlorophyll is not produced or regenerated in the corolla owing to insufficient nutrition, and hence carotin (the pigment of the orange and deep yellow flowers) is allowed to appear, while the blue and red pigments are due to the energetic oxidation of which this organ is the special seat. This explanation seems to account fairly well for the production of the yellow pigment (carotin), but it fails to throw light on the fact that the red and blue pigments (anthocyan) are evidently evolved by a very special physiological process, which does not generally take place in any other part of the plant with a strength and completion at all comparable with that proceeding in the tissues of the corolla. The mere oxidation of an organ is not sufficient, unless something is produced there independently, whereon the oxidation may operate. If the corolla possesses a very feeble or annulled assimilatory power, its protoplasm exhibits a very energetic deassimilatory power, and this latter fact is proved to demonstration when the chemical constituents of the floral parts are compared with those of the other organs of the same plant.

A series of chemical analyses of common plants performed by myself (see *The Naturalist*, 1902-10), revealed the important fact that, while the flowers of certain species are habitually tinted purely and vividly, the quantity of tannic chromogen contained in the other organs (stem, leaf, root) is or may be, extremely small. Hence, the conclusion was readily suggested that the formation and development of the blue and red pigments in these cases were strictly local, and absolutely confined to the floral envelopes, *i.e.*, they were not necessarily dependent on the particular amount of tannin produced by the organism in its entirety. Now, as tannin is a product of deassimilation of a high grade, it seemed certain that this particular physiological process was carried on in the corolla very energetically; it was pushed further there, as it were, than in the other organs of the plant. The question then to be decided was in what manner did it act, and what also were the real causes of its specific energy and completeness.

It became clear that it was not (as M. Curtel opined) merely because the corolla possessed feeble powers of assimilation, that, therefore, its powers of deassimilation should be raised correspondingly. The law of plant physiology applicable to this case is that processes of special deassimilation are brought about in certain cells to the profit and benefit of other neighbouring cells. The albuminoids of the corolla cells minister to the pressing needs of the stamens and pistils. The vital activity incident to the process of fecundation, the formation and differentiation of the stamens, ovules and seeds, etc., induces a powerful drain on the albuminoids of the corolla, whose molecules consequently break up; the nitrogenous nuclei thereof are separated and pass over as much as is required to the cells of the stamen and pistil, while the aromatic nuclei remain behind as tannic chromogen, the precursor of the brilliant blue and red pigments. Numerous experiments performed by myself (see *Nature*, lxi., 105) render it certain that the conversion of tannin into visible pigment varies in intensity and completeness very considerably, according to the particular petal examined. In cranesbill, tufted vetch, peony, and sweet pea the conversion is complete; in foxglove, carnation, and some roses it is nearly so; in clover, sea pink, and flowering currant it is not complete; while poppy, burnet and cineraria are still further remote from perfect development of tincture. And, inasmuch as different species of plants belonging to the same genus evolve habitually either blue or red flowers, while the chromogen of all is exactly the same substance, there can be no doubt that these differences can only be explained by a diversity in the development of the pigment. As already suggested, the most developed in this respect are those plants which habitually evolve blue or purplish-blue petals, and it is these very plants which exhibit the most intense and energetic reproductive capacity.

* *Annales des Sciences Naturelles.*—Bot. Ser. 8, t. 6, page 221.

ON THE STUDY OF DOUBLE STARS BY AMATEUR OBSERVERS. V.

By G. F. CHAMBERS, F.R.A.S.

PRACTICAL HINTS ON OBSERVING DOUBLE STARS.*

DIMENSIONS of telescopes in inches of aperture must not be regarded as conclusive as to the possibilities or impossibilities of dividing close Double Stars. There are several factors of importance involved in the matter: *e.g.*, the quality of the object-glass: the steadiness of the mounting: the power of the observer's eye: its training to detect small points of light: his skill and experience generally. How important such points as these are is well illustrated by a remark by Burnham, made many many years ago, when he presented one of his early catalogues of new Double Stars to the Royal Astronomical Society.[1] Speaking of some measures which had been placed at his disposal by Baron Dembowski he says:—"Few observers would be able to measure such stars, and those habitually observed by him, with an aperture of only 7 inches. It is another illustration of the truth that much more depends upon the observer than the size of the instrument. I may add that nothing has been more gratifying and flattering to me than to find my measures of a difficult pair with 18½ inches aperture agreeing closely with the measures of Baron Dembowski with 7 inches."

Another illustration of the proof of Burnham's general statement here is to be found in the Double Star work done many years ago micrometrically by Dawes, and in another aspect (the literary one) by Webb. The form of micrometer best adapted for general use is that known as the Bifilar micrometer mounted in conjunction with a position circle. For the benefit of beginners in the use of such an instrument it is suggested that after bringing a Double Star into the field of view the milled head which moves the position circle be turned until the position wires are approximately parallel to an imaginary line joining the stars. The stars are then by means of the slow motion on the telescope to be brought between the position wires, and then a final adjustment of the wires to parallelism with the aforesaid imaginary line is to be made. The distance wires are then to be approximately adjusted to the distance of the stars, and then by means of the slow motion of the telescope the stars are to be brought on these wires at a place clear of the position wires, and the final rectification made. It will be found most convenient to make these measures thus at places on the wires where they do not cross the position wires. Two readings, one of position and one of distance, are then to be taken and entered on a printed blank form of which a specimen will be given presently. It is advisable to take at least four measures of each sort, and treat the mean of the four as the result to be placed on record as the measures of the star observed.

In measuring Double Stars it is important that the observer should so hold his head that the line joining his eyes should either be coincident in position with the line joining the stars or directly at right angles to it. Carrying out this suggestion may sometimes involve a strain on the muscles of the neck which must be guarded against, and this will best be done by using a diagonal reflecting prism on the eye-end of the micrometer. The angle of position required is that obtained by measuring round the circumference of a circle (with the principal star of the pair in the centre) from the N. point round to 360°, backwards contrary to the motion of the hands of a clock. The reading of the micrometer wires should be 0° and 360° when the wires are vertical. There is no test of the verticality of the wires which can be quickly applied, and when the instrument is attached to the telescope for use the position of the zero will be found to be slightly different from night to night. It is not worth while, therefore, to attempt to have the zero in the correct place. And after the micrometer is attached to the telescope preparatory to starting work, or during the observations, the angular error of the zero point out of place is obtained in the following manner and applied as a correction to the mean reading of the position angle of the star. The wires are brought approximately to point East and West and a star of any sort is brought into the field. The slow R.A. motion of the Equatorial is then used, and by trial the star is caused to travel along one of the position wires, the observer adjusting the position of the wires until the motion is along the wire. This done the wires then lie along a parallel of declination and are therefore displaced 90° from the N. point. Subtract 90° from this reading and we have the zero error. On the position circle there are usually two verniers 180° apart, so the observer has a choice of readings 180° apart: and, moreover, the wires will be in the same position on two stars really differing in angle by 180° so that it may be necessary to add 180° to the resulting measure. Whether or not this

* In the preparation of this section I have been materially helped by Mr. G. M. Seabroke, F.R.A.S.

[1] *Memoirs R.A.S.*, vol. xliv, page 147.

must be done must be settled by the estimated position of the star, or by consulting other previous measures.

Thus far we have spoken of taking measures of distance by adjusting the wires on the stars; and if the micrometer screw-head reads zero when the wires were over each other we should only have to convert the divisions of the reading on the stars into seconds of arc, and the angular distance would be had. It is not without risk of error that we can adjust the screw so as to read 0° when the wires are coincident, and the difference in the expansion of the steel screw and the brass in which it is mounted would soon cause an error in the value of the zero which might, however, be allowed for when ascertained. But it is better to avoid this complication of error by taking measures of the star with the moveable wire first on one side of the fixed wire and then on the other. The distance through which the wire is moved will then be double the interval between the stars, and dividing this by two will give the actual interval; which process also has the good effect of halving the error of observation. Thus, it is advisable that the reading of the screw-head should only be approximately zero when the wires coincide. If the readings are taken when they *increase* with the increase of the distance of the wires they are called "*direct*"; and when the moveable wire is on the other side and they *decrease* with the increase of the distance of the wires, they are called "*indirect*." Since the numbers decrease from 100 (or from whatever may be the reading of the screw-head) on the indirect side we have to subtract the indirect reading from 100 and add this to the direct reading.

To avoid risk of error and for convenience' sake, it is well to adopt the fiction of calling the reading 1000 when the wires coincide, that being the usual number of divisions for 10 revolutions of the micrometer screw. It follows, therefore, that all readings within this distance of the wires are *positive*, and we have only to subtract the smaller reading from the larger to get the double distance of the interval measured.

For instance: suppose that a direct reading embraces one revolution (= 100 divisions) and 15 more, making a total of 115 divisions. Add to this 1000, and write down the result = 1115. The indirect reading of the same stars after crossing the wires will also be one revolution (100 divisions) and about 15 divisions over, but as we are reading backwards from 100 the reading actually is about 85, say 80. (For it is not likely that the wires coincided exactly at 0). On the assumption that coincidence takes place at 1000, we write down 880 as the indirect measure: then $\frac{1115-880}{2}$ is the distance of the stars in divisions of the instrument.

To find the value of the divisions in arc, separate the wires by a known number of revolutions, and note the time that a star on or near the equator takes in passing transit-fashion from one wire to the other. Then, since 15" of arc [illegible] 1ˢ of time the number of divisions ([illegible] number of revolutions) divided by 15 tim[illegible] [illegible]ne of passage in seconds will give the num[illegible] [illegible]isions which correspond to 1" of arc.*

Seeing that it often happens tha[illegible] [illegible]res have to be reduced under circumstances [illegible] [illegible]rable to accurate mathematical thought, it is w[illegible] [illegible] resort when possible to mechanical labour-saving [illegible]nts.

One of these available for Double Star [illegible] is a "Barlow lens," the usefulness of which [illegible] now-a-days to be very little understood. It is [illegible] achromatic plano-concave lens which has a powerful magnifying effect, and by inserting such a lens between the object-glass and the micrometer a few inches inwards from the latter an image is altered in size so that the distance between the two stars can be made to accommodate a certain number of micrometer divisions without fractions. For instance, the magnification of a pair of stars may be so adjusted that 10 divisions correspond to 1" of arc. After finding the value in divisions of a measure we have only to move the decimal point, and then a value recorded in seconds of arc presents itself. Should this value not be absolutely correct we learn at any rate the percentage of the error and apply it in writing down the definitive distance.

The following forms are recommended for use. No. 1 shows the method of entering observations as they are taken, and No. 2 the method of recording the final results for permanent reference:—

No. 1. TEMPLE OBSERVATORY.

DOUBLE STARS.

Date: *Sept. 6, 1909·67.*

Σ *2218*

R. A. *17 39.* Dec. *+63 11.* Mag.

POSITION.		DISTANCE.	
		Direct.	Indirect.
Wires E. & W.	*166·2*	*1017*	*982*
	90	*1018*	*981*
Zero error	*76·2*	*1017·5*	*981·5*
Readings.		*981·5*	
	58·5	2) *36·0*	
	57·0	*18·0*	
	57·0		
	58·7		
	4) *230·8*		
	57·7		
	76·2		
	161·5		

Pos. A.B. *341·5*
A.C.

Dis. A.B. *1·80*
A.C.

* A more exact method of obtaining this result is to measure the distance of two stars whose positi[illegible] [illegible]tly known such as certain stars in Pleiades. As to this see Gledhill's "Double Stars."

No. 2. TEMPLE OBSERVATORY.

	h. m. s.			
1880 Approx. R.A.	*17 39 35*		*1880* Approx. Decl.	*63° 13'*
Cor. for *1900*	*17 39 12*	Name...........................	Cor. for *1900*	*63 11'*

Mag^s. A. *6·5* B. *7·7* C.

Struve's number *2218*

h „ *7137*

Position.	No. of Obs.	Dist."	No. of Obs.	Date 180 +	Observer's Name	Remarks on Observation.	Notes on previous measures, &c.
318·2	*5*	*2·29*	*2*	*83·70*	*S*		*1832·7 2"·50 356·7 Σ*
319·8	*5*	*2·03*	*2*	*·70*	*S*		
319·2	*1*	*2·11*	*2*	*·72*	*S*		
311·5	*1*	*1·80*	*2*	*09·67*	*S*		

Gledhill has made the following suggestions as to Double Star observing which he says embody the recorded experience of Struve, Sir J. Herschel, Dawes, Dembowski, and Secchi:—

(1) At the outset it must be remarked that the Observatory (doors, windows, slit, and ventilators) should be thrown open at least an hour before observation begins, in order to reduce the temperature of the room to that of the external air.

(2) If the definition be bad and the motion great, it is useless to attempt the measurement of Double Stars. In short, if a power of at least 300 cannot be used, the results cannot generally be of any value.

(3) Very bright stars should be measured in daylight or twilight.

(4) The observations should be made near the meridian if possible.

(5) The observer should be in an easy position—the prism effectually secures this; and the driving clock ought to go smoothly.

(6) The bright-field should be used almost exclusively—red and blue colours are most in use.

(7) Use the highest powers possible, and always the *same* powers.

(8) A moderate number of measures of an object on each of two nights is better than a large number on one night.

(9) Use printed forms.

(10) Enter date, hour, weather, and distance from meridian, before observation begins.

(11) Notes on definition, general impression as to the value of each measure or set, etc., cannot well be too copious.

(12) In all doubtful cases make a sketch, and add full description.

A few more miscellaneous hints applicable to telescopic work on Double Stars will now be given.

Use a dew-cap of a length equal to two or even three diameters of the object-glass; and it is well to have the dust-cap fit the end of the dew-cap as this saves moving the latter every time that work is begun.

Remove and carefully cap the micrometer every night to keep dust and spiders from getting on to the wires.

See that the Right Ascension and Declination of the stars which you are going to measure are for an epoch sufficiently recent that you can make sure of finding the star you want, or you may find yourself measuring the wrong star. The epoch of 1900 is sufficiently recent, and the principal star of every pair given in these articles is sufficiently bright that there should be no difficulty in dropping upon any star wanted; but in all cases of doubt the places may be brought up for Precession for any epoch later than 1900 by means of the Table of Precessions.

Examine by daylight the telescope and accessories and see that everything is ready for use in its place and in working order; or, come night and the right star brought into the field, and you may find some of the moving parts of the telescope or micrometer out of order and not be able to rectify matters by lamplight.

For reading a micrometer small electric lamps with a *pinch* contact are the best for use; but whatever lamp is employed, take care that the light is to such an extent shaded as not to endanger the sensitiveness of the eyes.

Take as many readings as you can remember before writing down any of them, but be sure you do remember them. It is a great advantage to have an assistant to write down the figures whilst the observer is calling them out. In this way the observer is able to keep his eyes unimpaired by too much contact with light. Small electric lamps of three candle power with switches fixed to the verniers of the setting circles are valuable accessories.

Have a movable slide with red, yellow and blue glasses fitted in front of the lamp which illuminates the field, and also a stop† to control the amount of the incoming light. In this way the illumination of the field can be readily adjusted. It is always well to use sufficient light to illuminate the wires even

* Handbook of Double Stars, page 83.

† A slide of smoky glass shaded off by gradations of tint answers well for this purpose.

though the stars under observation (or one of them) are too faint to permit of continuous vision. Bright wire illumination on a dark field is very useful in such cases, but this may be beyond the reach of many amateurs.

A second pair of distance "wires" of thicker web will often be found very useful when faint stars have to be measured, and the illumination of the field has to be kept down so low as to render the ordinary webs invisible. For these thicker "wires" the guy lines supporting a web may be used. They are of about the thickness of a fibre of silk and consist of many ordinary lines of web made by the spider into what may be called a cable.

It will occasionally happen that the "wires" (spider webs) of a micrometer break, as the result, it may be, of lack of care in handling the instrument, or even owing to the weather. This may be a source of inconvenience of a serious character to an observer if he is living at a place remote from an optician. A thick metal wire is renewable without much difficulty by anybody possessed of a moderate amount of mechanical skill, but to replace a genuine spider line may be a matter of some difficulty, first of all to obtain such a thing, and then to fix it.

In order to obtain a supply of spider line take a piece of moderately stout iron or copper wire about 9 inches in length and of such thickness (say 22 Birmingham wire-gauge) as to be fairly rigid when so bent into the form of a 2-pronged fork that the ends may be about three inches apart. Next, hunt up a spider and persuade him to attach his web to the wire fork near one end and then cause him to drop a few inches and catch the web on the other prong of the fork; then by turning the fork round one can wind up as many turns of the web as one cares to have, taking care to keep each new turn separate from, that is, not in contact with, the previous one. If this part of the business has been satisfactorily accomplished a stock of spider line will have been laid up for use.

The next thing is to render the lines secure on the fork before selecting and removing one preparatory to transferring it to the m[illegible]. This is done by touching both ends of each [illegible] of the coil where it passes round the fork with [illegible] shellac varnish or other sticky stuff. When th[illegible] set and is dry, the removal of any one web m[illegible] accomplished without affecting the others.

When it is desired to take a web [illegible] of stock in order to use it, make a second stout w[illegible]k, rather less in breadth between the prongs th[illegible] the first one. Put some sticky stuff on the tip of each prong and lift off a length of line from the storage fork. Remove the cover of the micrometer; clean off any old ends of broken web; touch with varnish each spot where the ends of the new web are wanted to go, and drop the new web into its proper place; let the varnish dry; and when the web is found to be in the right place and secure, cut off any overplus with a small pair of scissors. This final action in the work of renewal is more easily described than carried out, but with a little patience and the spoiling of a few webs, a final good result may reasonably be expected.

If you cannot secure the coöperation of a living spider to provide a new web, and have none in stock, search must be made for an old web *in situ*, and a suitable portion picked out and removed with a forked wire (such as already described) and baited, as it were, with some sticky stuff. A web thus casually obtained may probably be dusty, and may perhaps consist of more than one single strand, in which case certain obvious precautions must be taken and things done.

It will seldom happen that marks cannot be detected on the sliding fork of the micrometer to indicate where old webs have been attached, and therefore, where new ones must be applied so that they may be parallel to one another. Use a screw-driver which fits properly the small screws of the micrometer when it has to be taken apart. A sharp bradawl is a good substitute. Nothing looks worse than the head of a screw damaged by a tool unfit for work. While the screws are out, put them in a little box for safe keeping, for small micrometer (and other) screws have great straying power.

SPECULATIONS.

In the volume of which I have made so much use, Innes has entered upon some reflections and speculations which, as they are not of the wild and irresponsible character so common now-a-days, I gladly quote by way of conclusion to this preliminary dissertation because of their present interest and prospective usefulness. He says:—

"The study of Double Stars will always be interesting from the Newtonian point of view, and in the case of the brighter pairs, the spectroscopic determination of motion in the line of sight will lead to a knowledge of the true position in space as well as of the absolute dimensions of their orbits, and hence their parallaxes. The irregularities of their orbital motions (already ascertained in a few cases, which will multiply as observations grow more precise) indicate the presence of disturbing bodies. For these reasons even the Binaries with the best-determined orbits deserve careful and regular observation. From the astro-physical point of view, it is hoped that much may be learned from their study. A contracting and rotating mass of gas may eventually reach an epoch when it will become unstable, and separate into two or more portions forming a Binary system. It is evident that this critical period will depend on the constitution of the body, its speed of rotation, mass and temperature. Systematic observations, micrometric and spectroscopic, should in time enlighten us on these, at present, obscure subjects. When we are able to arrange the elements of the orbits of say one thousand Binary pairs in tabular form, with their spectroscopic history, both of constitution and of radial speed, including for each the proper motion and its solar component, we shall be in a position to attack questions relating to the constitution of the

"It is true that of these α Crucis is not a Binary. It is perhaps all the more remarkable for that reason, being one of the brightest stars in the sky, and shown by photography to be surrounded by a cluster, or rather

Σ 2703 Delphini.

Mags. 7½, 7½, 7½: Distances 25″, 71″, 59″.

γ Delphini.

Mags. 4½, 5½: Distance 11″.

β Cephei.

Mags. 3½, 8: Distance 13″.

Cephei.

Mags. 5½, 8½, 8½, 10: Distances 1¾″, 12″, 20″.

sidereal heavens, which are to-day beyond the realms of reasonable speculation. In this respect the stars of the Southern hemisphere offer at least as attractive a field of investigation as those North of the equator. In spite of neglect, the Southern systems already exceed in importance those of the North. Among them may be quoted:—

Sirius	ω^2 Eridani
α Centauri	α Crucis
γ Virginis	β Muscae
γ Lupi	4 Aquarii
γ Centauri	ξ Scorpii
γ Circini	τ Lupi
γ Sextantis	β Phoenicis
ζ Aquarii	ζ Sagittarii

by rings, of very faint stars, in the centre of which the two large stars are, as far as can be ascertained, absolutely stationary. Are these gloriously brilliant stars devoid of mass, or, if they shine with an intrinsic brilliancy of surface equal to that of Sirius, at what distance must they be apart that gravitational motion becomes too small to be detected even in a century? Speculation and analogy alike fail us, and a systematic study of all Double Stars is alone likely to solve these and many other allied questions. The high eccentricity of the orbits of some Double Stars, including α Centauri, subjects the internal constitution of the components to different pressures at the times of peri-astron and ap-astron. Does this affect their spectra in a measurable degree?"[1]

[1] Reference Catalogue of Southern Double Stars, page xiii a.

NERVES AND NERVOUSNESS

By DAVID FRASER HARRIS, M.D., B.Sc. (Lond.)

(Lecturer on Physiology, University of Birmingham.)

Possibly no terms are so loosely used as "nerves," and "nervousness." Owing to the prevailing ignorance about the nervous system they have become of much profit to the quack and the charlatan. Before we attempt to understand in what "nervousness" consists, and why some people are "nervous" and others not, we should find out what a nervous system does, what the possession of it means, and what would be the result of our not having one. The central nervous system is a mass of very highly specialised living matter (nerve-cells) contained inside the skull and spinal column in order to be protected from injury from outside. Into and out of this mass of nerve-cells run certain nerves from and to the "periphery," by which we mean all the body exclusive of the central nervous system itself. Most of the nerves going in, carry impulses which arouse sensations, most of the nerves going out, carry out impulses which arouse movement: by the former the environment acts on us, by the latter we act on the environment. The nervous system as a whole is *the* great means of communication between one part of the body and another: without it we should be totally unaware of what was going on around us. We should have no sensations and no pain: although possessing eyes we should not see, though having ears we should not hear: and, not having any sensations, we should have no emotions and no ideas, since these are higher mental states compounded of the more fundamental states of sensation and perception. Of course we should have no memory, as there would be nothing to remember. Again, if we had no nervous system, we should not be able to move a muscle when we wished: no matter in what danger we found ourselves we should be powerless to escape from it. One part of the body would not have the least idea where the other part was, what it was doing, or what it wanted: we should have no knowledge of the world around us or of our relationship to it. We could initiate no bodily activity, and so would be powerless to make any change whatever in the relations between the environment and ourselves. But by means of the afferent nerves the centres do receive information regarding both the body and the outside world, and, in consequence, the individual, through his centres and efferent nerves, can constantly adjust his body to the changing conditions of the environment.

The management of an army is a good analogy with the working of the nervous system. The army council—a few men—we may liken to the highest parts of the brain, the intelligence department and signallers to the afferent nerves, the rank and file of the soldiers to the muscles—the ultimate executants of the orders issued by the council. [illegible] the soldiers, left to themselves, would never of themselves engage in any plan of concerted action. They must be drilled, made to execute first independent and then corporate movements in accordance with definite orders, the meaning of which they have previously learned. The men must be arranged in squads, companies, regiments and battalions, and must go through manoeuvres from time to time to practise what would be required of them in actual warfare. But in order that the army council issue appropriate commands, it must be kept informed as to the condition, number and distribution of all the units constituting the army. The soldiers are the muscles: if left to themselves, that is not attended to by the central nervous system, they might act spontaneously from time to time, but not always in a manner calculated to promote the well-being of the organism as a whole of which they form the constituent parts. The men must be drilled by sergeants who take orders from junior officers, who obey superior officers, who in turn obey orders ultimately emanating from the council at the War Office. Indirectly, then, this council issues orders to each individual soldier in the army. Similarly the brain is in touch with each muscle, which it also drills and exercises and keeps in readiness for future activity, a state we call "tone." The muscles, if not in constant functional connection with the nerve centres through the efferent nerves, would become toneless, slack, unready to contract when a motor impulse (command to action) arrived. But the very opposite is what we find: muscles duly innervated have a certain degree of tension, are ready to shorten after only an exceedingly brief time from the instant of receiving the message. Muscles not thus innervated, even though well supplied with blood would not be in a perfect state of health, would become "a law unto themselves," and therefore be unrelated to their neighbours' needs. This unfailing outflow of impulses from the cells of the central nervous system to the periphery—to muscles, blood-vessels, glands and possibly other tissues—is known as *innervation*. Innervation really means being attended to by the central nervous system: it is not being given strength to do work, but it is being kept in readiness to do work—a very different thing. It is being neurally supervised. Innervation is not the commissariat: the blood supplies the food: the blood is the canteen; each muscle must absorb its own nourishment, but by means of innervation it will be constantly kept "up to the mark," drilled, made tonic and ready for action. Innervation is each soldier's knowing that those in authority over him have not forgotten about him, that messages have been duly sent out to order his food to be brought into camp, that orders have been received as to how each minute of his day is to be occupied, and so on. A command to action imparts no strength to act, but it constitutes a necessary antecedent condition for an attentive, well drilled soldier to obey on the shortest notice in the best possible manner. This is what tone does for muscles: it keeps them ready. This outflow of what we may conveniently call tonic impulses has nothing to do with our consciousness: although diminished in intensity, for instance, during sleep, it is not abolished. We do not therefore consciously or voluntarily innervate our muscles: they are innervated subconsciously. When the nervous system dies the muscles take on the flaccidity of death before they enter upon *rigor mortis*, the rigidity of death.

Now we have a good deal of evidence that the outflow of these tonic impulses is rhythmic or intermittent, in other words at a certain regular rate per second. Physiologists are not agreed as to the exact rate of arrival of these at the muscle, but efforts are being made to determine it. In what we call a voluntary muscular contraction it is extremely probable that, although the intensity of these impulses is very greatly increased, their number per second, or periodicity, remains the same. The will, then, only exaggerates the existing state of tone; this exaggerated tone is a voluntary contraction, and hence it is sometimes said that "tone is incipient contraction"—a very good description. We know that heat is given out in voluntary contraction, but heat is also produced by a muscle in tone; and in proportion as the tone dies down so is the output of heat diminished.

This unconsciously exerted tonic influence of the nervous centres on the muscles is, like many other things, best realised when it is temporarily diminished or done away with. Thus, when a man gets a blow on the head, is "stunned," or suffers a severe and especially sudden injury, or has his central nervous system badly poisoned by alcohol or chloroform, he is quite unable to remain in a standing posture. This shock, or collapse, is due to his muscles having become more or less toneless, not so much because they are poisoned as because their innervation is reduced or abolished through the mechanical or chemical damage to the centres emitting the tone-maintaining impulses. The nerve-cells responsible for sending out these tone-preserving impulses are sometimes called "trophic centres," or centres related to trophism, a Greek word meaning "growth" but now taken as synonymous with tissue-health. Trophic nerves for muscles are none other than the efferent nerves conveying impulses inducing tone in the muscles. Trophic impulses in any other sense, in so far as muscles are concerned, do not exist.

All tissues, even such an apparently lifeless one as bone (which, however, is very much alive), when from any cause deprived of their nerve-supply suffer in health, become atrophic, or atrophy. It is equally correct to speak of blood-vessels and glands as being kept in tone or in a good trophic state by reason of their innervation. Thus, if the efferent nerve to any tissue is cut, the tone of that tissue is diminished or abolished for the time being, muscles become flabby, blood-vessels paralysed or dilated, and glands quite unhealthy. It will be convenient to have a term for the nerve-cell in the centre and its outgrowth, the efferent nerve-fibre, which passes all the way from the central nervous centre to the periphery: it is "the efferent neurone." Neurone means nerve-cell and all its processes including the long conducting process to the tissue or organ innervated. The nerve-fibres which stretch from nerve-cells to tissues have at least the property of conductivity, the power of conducting nerve-impulses. Toneless muscles are a sign of deficient innervation, a condition seen for instance typically in melancholia. It is, of course, a mental condition, but its outward and visible sign is deficiency of tone of all tissues not only muscles but blood-vessels, glands, and skin as well. Deficient innervation leads to deficient tone, whether that deficient innervation is due to mechanical injury to the nerve or to a depression of the emitting centre itself. In neurasthenia, again, innervation is deficient: not only are the muscles lacking in tone, but the glands, for instance the gastric glands, are deficient in chemical tone, and as they do not secrete sufficient hydrochloric acid there results the consequent nervous dyspepsia. Popularly a neurasthenic is "a nervous person"; strictly speaking such a person is suffering from weakness of the nerve-centres, probably due to their being poisoned or not sufficiently nourished at some previous time. Nerve-centres themselves, then, can be in good health, full of vigour and nerve-energy, or they can be less vigorous, putting forth less energy, be definitely weak. Neurasthenia is only Greek for *not-strength* of nerves; but in this case "nerves" means nerve-centres, since nerve-trunks are not sources of energy and merely conduct impulses. Nerve-energy or nervous energy are terms one reads about a great deal, sees very often used in advertisements of quack medicines, and so on; but it is a thing of which the man of science has very little knowledge. There must, of course, be such a thing as nerve-energy; else nerve-centres could effect nothing and affect nobody, for "*ex nihilo nihil fit*." The English physiological psychologist, Dr. MacDougal of Oxford, has coined the word "neurine" as a convenient term for nerve-force. Although we know almost nothing about nerve-force we know a little of what it can do, just as, although we do not know much about electricity, we know something of what it can do: both electricity and neurine pass from places of high to places of lower pressure. Returning to the centres in the spinal cord, we see that they are the sources of the nerve-energy sent out to the tissues everywhere; but we might at this point ask ourselves: do we know anything of the material basis of this nerve-energy?

(To be continued).

NOTES.

ASTRONOMY.

By F. A. Bellamy, M.A., F.R.A.S.

FAYE'S COMET (or 1910 *e* Cerulli).—The comet announced as a discovery by Cerulli at Teramo Observatory, on November 8th, by means of photography, proves to be a re-discovery of the unexpected, or forgotten, return of the comet discovered by Faye in 1843. This comet is interesting as having a short periodic orbit of seven and a half years, or slightly less; so that, since 1843, this is the ninth return, and it happens to be a favourable one: it is not always so, as at some returns it could not be observed, notably in 1903. When discovered on November 8th it was of the 9·5 magnitude. After a few observations had been made, it was ascertained by W. F. Meyer and Miss S. H. Levy, of the Berkeley Astronomical Department, U.S.A., that the elements of the orbit which they computed resembled those of Faye's Comet, and they afterwards computed elliptic elements from observations of November 9th, 11th, and 13th; they give the date of perihelion passage as 1910, November 12·413, G.M.T., but M. Ebell (*Ast. Nach.* 4456), deducing the time from Professor Stromgren's elements for 1903, finds the date to be October 23·747 Berlin M.T. In *Ast. Nach.* 4461, G. Fayet has discussed the question both with new observations and old elements, and he obtains November 2·283 Paris M.T. as the date of passage, and the other elements are very close to those which he deduces from Strömgren's work. Fayet's elements are:—

T	=	1910 Nov. 2·28269. Paris M.T.
ω		199° 51′ 6″·74
☊		206° 7′ 0″·31
i		10 30′ 24″·79
e		0·560806
log. *a*		0·575109
		486″·792

They should, however, be regarded only as provisional. Plenty of observations are being obtained and they will prove of use in the computation of a definitive orbit.

Fayet has also deduced an ephemeris for Paris mean midnight: from a portion given here it can be seen that the comet is now moving northwards and eastwards: it reached its most southerly declination on December 19th and 20th, and at the end of this month it is about the same right ascension as the Pleiades and twenty degrees south, and its magnitude will be equal to half that at the time of re-discovery.

1910–1911.			R.A.				Dec.	
Dec. 17	...	3	39	13	...	−3°	0′·5
„ 20	...		40	23	...	−3	8′·5
„ 25	...		42	51	...	−3°	13′·9
„ 30	...		45	58	...	−3	27′·2
Jan. 4	...		49	45	...	−3	47′·2
„ 9	...		54	11	...	−4	12′·6
„ 14	...	3	59	10	...	−4	42′·3
„ 19	...	4	4	43	...	−5	15′·3
„ 24	...	4	10	43	...	−5°	50′·7
„ 29	...	4	17	12	...	−6°	27′·6

HALLEY'S COMET.—It is still possible for observations to be obtained of this much-discussed comet. Those who wish to see it again before 1985, should not lose the opportunity during the next few weeks; it is best situated for observation about 5 a.m., and will be at a similar position about two and a half hours earlier each month; being at rather a low altitude it may be seen more readily at places south of England. This ephemeris is that given by F. E. Seagrave, in the *Astronomical Journal*, No. 620.

Midnight G.M.T.

1910.							
Jan. [illegible]	...	11	51	27	...	[illegible]	
„ 11	...		44	53	...	[illegible]	
„ 19	...		36	57	...	[illegible]	
„ 27	...		27	51	...	[illegible] 8	1[illegible]
Feb. 4	...		17	44	...	[illegible]7	4[illegible]
„ 12	...	11	6	56	...	−17	8′·1
„ 20	...	10	55	49	...	−16	19′·2
„ 28	...		44	44	...	−15	20′·5
Mar. 8	...		34	6	...	−14°	14′·3
„ 16	...		24	15	...	−13°	3′·7
„ 24	...		15	25	...	−11°	51′·6
April 1	...	10	7	40	...	−10	40′·7

ASTRONOMER ROYAL FOR SCOTLAND.—We offer our congratulations to Professor R. A. Sampson upon his appointment to the position of Astronomer Royal for Scotland. His works upon J. C. Adams and Jupiter's Satellites have hitherto absorbed nearly all his time given to astronomical work; both these memoirs are of great and lasting importance. Now that he has charge of an observatory worthy of the name and one with an excellent and efficient all-round equipment, we look forward to a continuance and development of that practical side of astronomy so ably inaugurated at Edinburgh by the newly-appointed Astronomer Royal for England, Mr. F. W. Dyson.

THE PRESENT STATE OF VARIABLE STAR WORK. Introduction.—Exclusivism seems to be the worst policy in scientific research. As observational science is now highly developed in practically all the countries of the world, and all the workers are exploring almost the same borderland of discovery, accurate and ever-renewed knowledge of what others have done and are doing, is an absolute requirement if unnecessary duplication is to be avoided, as well as the waste of energy, time and money. This knowledge, however, is not always as perfect as it ought to be, especially in great countries such as Britain, France, and the United States, where scientific men, less inclined to internationalism and to the study of foreign languages, are sometimes tempted to consider the scientific activity of their countrymen as representing science. Small countries are better able to avoid this drawback, for, lacking elaborate sources of scientific information, forced to be polyglots and naturally exempted from any undue chauvinism, their men of science are in a better position to consider from an unbiassed point of view the efforts of the whole of the scientific world. And this, perhaps, is one of the reasons why countries, small in their area and economic possibilities, maintain a high standard of research among their powerful rivals.

In the peculiar field of astronomy in which I have been engaged for many years—the study of those interesting objects, variable stars—much correspondence with British amateurs has shown me how often their views on this subject are confined to English references. I therefore think that a comprehensive statement of what is actually done in this branch, in the whole world, may be welcomed by all interested in the matter including those possessing a telescope, whatever its size may be. It will not only give them an idea of the work of astronomers in this direction in different countries, but will also show them how the observation of changing stars is carried out with zeal and success by isolated workers.

Statistics of Discovery.—Many complaints have been made recently with regard to the great disproportion which exists between the great number of variable stars known at the present day and the attention shown to them. A mere glance at a catalogue of such objects will make this perfectly clear and illustrate how many, and even essential facts, remain unknown; especially as to long period variables, which should all be followed in a permanent manner in view of a better knowledge of their light-curves.

In order to bring this out more clearly, I have drawn up a table of the discovery of variable stars during recent years. For this, I deduced from a manuscript catalogue of such objects, for each year during the last decade (1900–1909), the number of variables announced as being variable, and to which a "provisional number" has been affixed, together with the number of the same stars that have received up to the present a "final name"—a combination of two letters—as explained hereafter, and the proportion between these two series of figures.

Variables in clusters have not been included in the lists, but *novae* or temporary stars have been, since they are in the A.G. lists they were considered as lettered. The discovery at Harvard and at Heidelberg of a large number of very faint variables accounts for such great totals as that of 1904, for example, and I intended at first to exclude them from the statistics; but, as the variability of several of these objects has been confirmed and as they thus received final names, I ultimately included them.

In dealing with the total number of "provisional variables" care must be taken to exclude some "apparent" variables. For instance 19.1900 Puppis is a rediscovery of Z Puppis; 67.1901 and 74.1901 are ρ Cassiopeiae and κ Persei respectively, and as they possess Bayer (Greek) letters, they will never receive final names in the usual nomenclature, and have been excluded; 2.1902 is a rediscovery of U Lacertae; 9.1902 and 43.1909 are the result of mistakes and never had a real existence.

In the following table, the first column contains the total (apparent) number of provisional numbers of variables as shown by the *Astronomische Nachrichten*; the second the true or real number of discoveries; the third, the number of variables which have been lettered up to the present (including the latest list of the A.G. Committee in A.N. 4364); the fourth, the number of variables still unlettered and of which, therefore, little or nothing is known; the fifth and final column, the proportion between the real number of discoveries and the lettered variables. The small number of lettered variables in 1909 is of course partly due to the fact that they had only been known a short time.

Year.	(1) Apparent Number.	(2) Real Number.	(3) Lettered.	(4) Non-Lettered.	(5) Proportion.
1900	29	28	28	0	100·0%
1901	99	97	61	36	62·9
1902	23	21	21	0	100·0
1903	86	86	43	43	50·0
1904	283	283	60	223	21·2
1905	171	171	38	133	22·2
1906	194	194	47	147	24·2
1907	223	223	101	122	45·3
1908	175	175	35	140	20·0
1909	46	45	10	35	22·2
1900–09	1329	1323	444	879	33·6%

It will be seen that in recent years the proportion between new variables and those that are more or less "settled" is a little more than 20%, and that 66% of all the variable stars discovered during the last decade still awaits confirmation. This fact will appear more strikingly still on the inspection of Figure 1, where they have been graphically represented.

If British amateurs will consider that their own country offers them, through the medium of the "Variable Star Section" of the "British Astronomical Association," so ably conducted by Mr. C. L. Brook, F.R.A.S., an amateur himself, a splendid and almost unique opportunity to achieve, with the most simple appliances, a mass of useful work, and to contribute

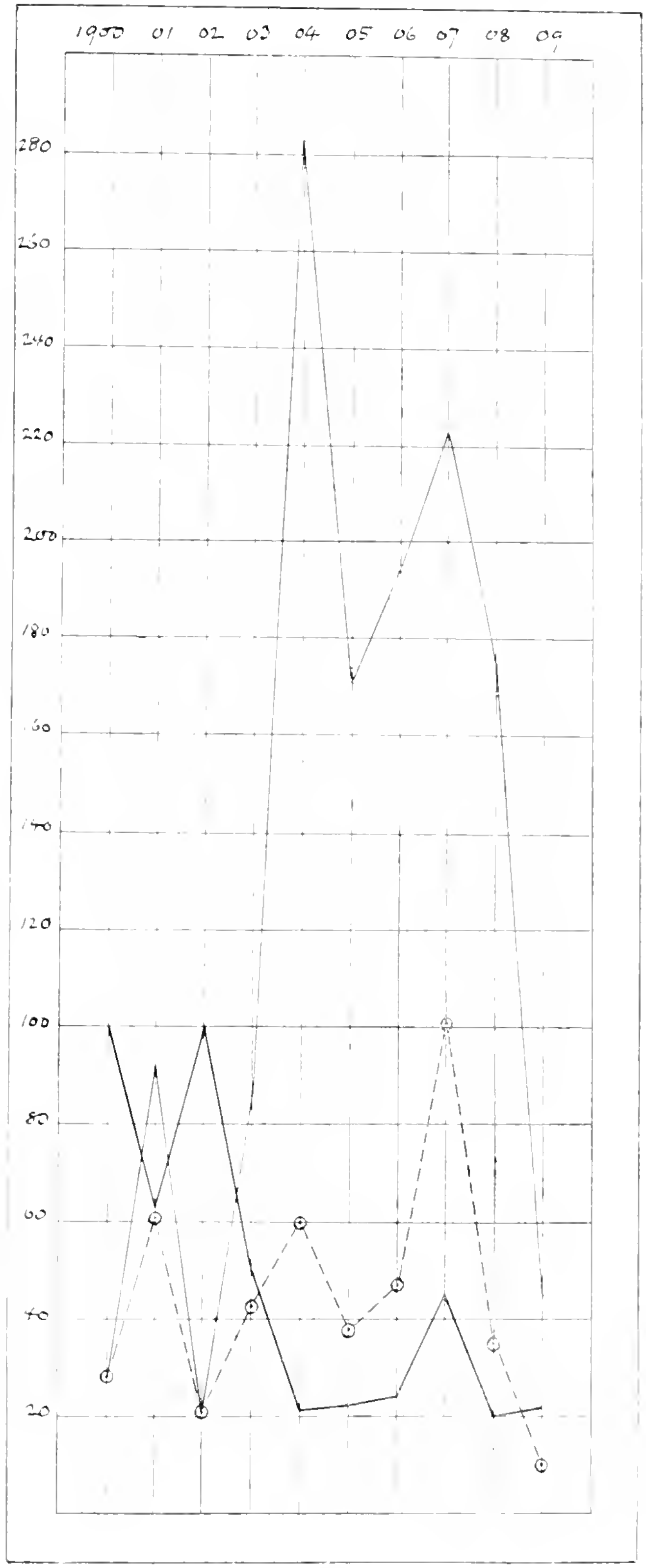


Figure 1.

The Discovery of Variable Stars.

The upper line represents the number of variable stars discovered each year; the broken and interrupted line the number of the same stars whose variability has been confirmed; and the heavy line at the base, the proportion between both.

to our knowledge of the mysterious laws which govern the sidereal universe, I hope that some of them at least will seize this opportunity at once, and join the small band of observers, to which I am proud to belong, whose scientific activity is greatly appreciated; if not very fully in the British Isles, at least elsewhere.

Félix de Roy,

Honorary Secretary "Société d'Astronomie d'Anvers."

(*To be continued.*)

BOTANY.

By Professor F. Cavers, D.Sc.

SUSPENSOR IN FERN EMBRYOS.—It was recently shown by Lyon that the embryo of *Botrychium obliquum* has a suspensor, while Campbell recorded a similar structure in the case of *Danaea*. The interest of these discoveries lies in the fact that hitherto a suspensor has only been known to occur in the embryo of *Lycopodium* and *Selaginella* among the Fern Alliance, or Pteridophyta. Lang (*Ann. Bot.*, 1910) has just discovered that *Helminthostachys*, which is closely allied to *Botrychium*, has a massive suspensor like that of the latter genus.

THE ECOLOGY OF CONIFERS.—The ecological features of the Coniferae are discussed by Groom (*Ann. Bot.*, 1910), who sets out various problems relating to this interesting subject. The main questions are: (1) the cause of the xerophytic foliage and tracheidal wood; (2) the cause of the survival of Conifers in competition with Dicotyledonous trees; (3) the cause of the suppression of various Conifers in past ages. Stress is laid on the fact that all Conifers are not xerophytic, in spite of their xerophytic leaf structure. Höhnel showed that the Larch has a rapid transpiration current, while Groom's experiments show that Coniferous wood, in spite of its tracheidal structure, may conduct water with a rapidity equal to that of a rapidly transpiring Dicotyledonous tree. Another point is noted in this connection—the aggregate leaf surface of a Coniferous tree may exceed that of a Dicotyledonous tree, because of the immense number of the leaves. This leads to the view that the xerophytic structure of the Conifer leaf is actually necessary because of the great amount of exposed surface, and the term "architectural xerophytism" is suggested for xerophytism that is dependent, as in this case, upon the organization of the plant rather than upon the direct influence of external factors on the organs in question. The extinction of many of the ancient Conifers is attributed to their imperfect acclimatization, to the fact that they have a large number of insect and fungus enemies, and to their relatively slight power to react advantageously to new conditions. At the same time, their "architectural" xerophytism enables them to thrive in nearly all situations, from those that are physically or physiologically dry to those that are sufficiently humid to permit the development of luxuriant non-xerophytic forests.

"GERMANOL."—A Berlin syndicate has placed on the market a product called "Germanol," consisting of an earthy mixture containing about eighteen per cent. of calcinated soda. The virtue of this mixture, which is intended for agricultural use, is attributed by the manufacturers to an increased porosity of the soil following an increase in the proportion of carbon dioxide, the latter being supposed to act as a "fertiliser." Mitscherlich (*Landwirtsch. Jahrb.*, 1910) has made extensive experiments, however, which appear to show that if this mixture has any value at all it must be attributed to the action of the carbon dioxide in increasing the solubility of difficultly soluble substances in the soil. He concludes, moreover, that increasing the carbon dioxide content of the soil does *not* result in an increase of plant product; that there is always sufficient carbon dioxide in the soil already to render mineral food available; and that any increase in the solubility of soil constituents due to increase on carbon dioxide content is absolutely superfluous so far as [illegible] advantage to the plant is concerned. It would seem, there[illegible] that "Germanol" will prove a failure in practice, just as [illegible] other nostrums, like "Nitragin" and "Nitro-bacterine," hav[illegible] in the past.

BOTANY IN CALIFORNIA.—Some [illegible] publications on Botany issued by the University of [illegible]fornia are of general interest. They include a beautifully [illegible] paper by Hall on ornamental trees, especially the [illegible] brush" genera of the Eucalyptus order (Myrtace[illegible] [illegible]ardner describes a new genus of Flagellates (*Leuvenia*) w[illegible] is of special interest in view of the importance attached to these lowly organisms lying at the common base of the animal and vegetable series. This new genus presents a remarkable combination of characters which make it difficult "at present to classify it, even to naming the family to which it belongs or in which it has its nearest affinities." The nuclei and pigment-bodies (chromatophores) are inconstant in number, while in the motile phases contractile vacuoles occur at both the anterior and posterior ends, while pyrenoids, gullet, and eye-spot are absent. The same author also describes two new genera of Green Algae which grow in association with other marine algae of California. *Endophyton* grows inside the frond of Red Algae of various kinds, and apparently forms a link between the families Chroolepideae and Chaetophoreae, differing from the latter in the absence of hairs. *Pseudodictyon*, referred to Chroolepideae, grows among the cells of the cortex in species of tangle (*Laminaria*).

CHEMISTRY.

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

ACTION OF POISONOUS ALKALOIDS ON PLANTS.—An instructive series of experiments has been carried out by Messrs. Otto and Kooper (*Landw. Jahrb.*, 1910, xxxix, 397) to ascertain the effect of adding dilute solutions of poisonous alkaloids to the soil in which plants are grown. It was found that when a relatively small area of soil was treated daily with a solution of strychnine sulphate, the liquid first filtering through the soil contained the acid constituent of the salt, but not the alkaloid, though this, too, eventually passed through the soil unchanged. This phenomenon of temporary absorption of the alkaloid was also observed in the case of perfectly sterilised soil, and was thus not due to bacterial action. The presence of solutions of salts of alkaloids, such as strychnine, in the soil had a pronounced effect upon plants growing therein, checking both germination and growth, and causing the fruit to be abnormal. Nicotine added in the form of a three per cent. solution was retained by the soil, apparently through the formation of a loose "addition compound," for the alkaloid was not altered chemically by the absorption. Eventually a portion of the nicotine was decomposed and volatilised, this being apparently brought about largely by the influence of heat and moisture in the soil. The growth of the tobacco plant was greatly stimulated by the addition of nicotine solution to the soil, and the proportion of nicotine in the plant showed an increase. The alkaloid had a similar, though less pronounced, effect upon the growth of the potato, and did not appear to affect the composition of the plant. Treatment of the soil with a solution of sodium nitrate had a similar stimulative action upon the growth of the tobacco plant.

THE GLAZING OF ANCIENT GREEK VASES.—The nature of the black glaze upon a Greek vase excavated at the Heraeum has been examined by Mr. W. Foster (*Journ. Amer. Chem. Soc.*, 1910, xxxii, 1259), who has found that it does not contain manganese, but consists of an iron compound, probably ferrous silicate. The red glaze upon a Mycenian vase has also been examined, the surface of the vase being scraped with a diamond, and an analysis made of the resulting powder. The conclusion drawn from the results is that the colour of the glazing is due to the presence of a ferric compound.

Analyses of the body of Mycenian vases showed that they contained from approximately 41 to 48 per cent. of silica, 17 to 20 per cent. of alumina, 7 to 9 per cent. of iron oxide, 14 to 20 per cent. of lime, 4·5 per cent. of magnesia, about 3 per cent. of potassium oxide and about 5·5 per cent. of carbonate. From these analyses it appears that Mycenian pottery differs from Attic and Campanian pottery in containing much less silica but much more lime, and in the relatively large proportion of carbonate present. Owing to its low proportion in silica the pottery can be readily melted at a relatively low temperature.

THE DIGESTIBILITY OF BLEACHED FLOUR.—Of the numerous methods that have been proposed for bleaching flour, only those in which nitrogen peroxide is employed as the bleaching agent have proved successful upon a commercial scale. Flour bleached in this manner is now largely sold, and on more than one occasion has been the subject of actions in the law courts. Hence the experiments of Mr. E. W. Rockwood upon the effect of bleaching upon the digestibility of flour (*Journ. Biol. Chem.*, 1910, viii, 327) have a special interest at the present time. In these experiments the tests were applied simultaneously to bleached and unbleached samples of the same flour, the conditions in each case being strictly parallel. It was found that uncooked gluten separated from the flours was digested by pepsin with equal rapidity in each instance, while the product from the bleached flour was digested more readily by pancreatin than that from the unbleached specimen. The cooked gluten from the bleached flour was more easily digested both by pepsin and pancreatin than that from unbleached flour, while bread made from the two kinds of flour did not differ in its digestibility, the nitrous compound having been expelled during the baking. The bleaching process was also found to have had no appreciable influence upon the digestibility of the starch in the flour.

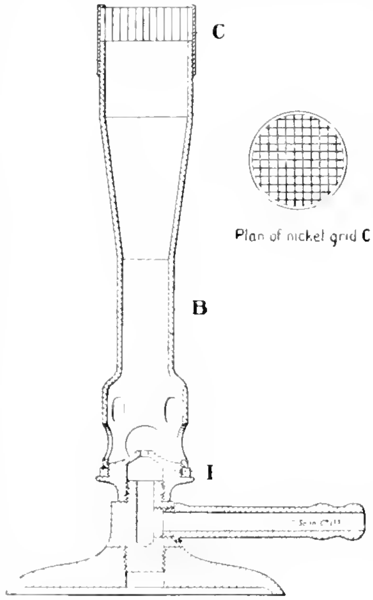


FIGURE 1.
The Méker Burner.

THE MÉKER BURNER.—A new gas burner, presenting many advantages over the ordinary Bunsen burner, has been put upon the market by the Cambridge Scientific Instrument Company, under the name of the Méker burner. The construction of this is shown in the accompanying figure, from which it will be seen that the holes for the admission of air are much larger than in the Bunsen burner, so that the mixture of air and gas in the chimney is of the right proportion for complete combustion. A deep grid of nickel is screwed to the top of the burner to prevent the flame "striking back." The flame of this burner is homogeneous, and does not show the inner and outer cone of the Bunsen flame. Its temperature is much higher than that of the latter, and is nearly uniform throughout. In fact, the coolest part of a Meker flame is hotter than the hottest portion of a Bunsen flame. A burner of modified form has been made for use with compressed air, thus enabling a yet higher temperature to be reached.

ECONOMIC BIOLOGY.

By WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.

HOUSE FLIES AND DISEASE.—I promised last month to deal with some of the correspondence I have received with reference to house flies as transmitters of disease. A renewed interest, I am pleased to say, has been awakened in the subject, and, as I recently stated, I trust the public will ultimately educate the authorities in order that our different public bodies will realize the seriousness of the matter. No one wishes to create a scare, or to indulge in wild unguarded statements, but to calmly and judicially consider the facts as brought out by recent investigations.

FLIES IN WINTER.—One correspondent inquires what becomes of the flies in winter,—do they die, leaving eggs to hatch later, or do they hibernate? Mr. F. P. Jepson has shown (*Journ. Econ. Biol.*, 1909, vol. iv.) by marking flies in the summer of 1908, for purposes of identification, that nearly all of them were captured in a bakehouse, the supply continuing up to nearly the middle of November, when a sudden sharp frost seemingly caused their sudden disappearance; they reappeared, however, on February 15th, 1909. From these and other experiments he concludes that during the winter flies may be found where the conditions—temperature and so on—are favourable, and that they will breed in the winter. Many undoubtedly persist throughout the winter as adults, and appear to be more hardy and longer lived than those taken in the summer.

THE SPREAD OF INFECTIVE DISEASES.—The belief that flies may carry the germs of different diseases dates back to the sixteenth century, but actual experiments proving this are of much more recent date. Experiment has now actually demonstrated that the following diseases can be disseminated by the agency of house-flies:—Anthrax, cholera, ophthalmia, tuberculosis and typhoid fever. In addition to these there are a number of diseases which are probably carried by flies, but the evidence, as yet, is inconclusive.

There is now evidence sufficiently clear to show that, apart from disseminating the germs of the above diseases, flies also carry the eggs of parasitic worms and various species of fungi.

Professor Nuttall very pertinently remarks (Local Government Board Report, No. 16, 1909): "It should be remembered that a fly may cause relatively gross infection of any food upon which it alights after having fed upon infective substances, be they typhoid, cholera or diarrhoea stools. Not only is its exterior contaminated, but its intestine is charged with infective material in concentrated form which may be discharged undigested upon fresh food which it seeks. Consequently, the excrement voided by a single fly may contain a greater quantity of the infective agents than, for instance, a sample of infected water. In potential possibilities the droppings of one fly may, in certain circumstances, weigh in the balance as against buckets of water or of milk."

PROGRESS OF THE WORK.—Our grand-parents would have laughed at the idea of attempting to control such ubiquitous pests as house-flies; indeed, there are still people who are unconvinced as to the seriousness of the part these insects play in every-day life, as is instanced by many of the letters I have received during the past two months; but, thanks to the excellent work that is being carried out at Cambridge and elsewhere, it will not be long before the public are not only convinced, but they will make themselves heard for drastic alterations that will tend to minimise the danger.

Dr. Monckton Copeman has recently scheduled (Local Government Board Report, No. 40, 1910) the work that is being done at Cambridge, which includes special attention to the elucidation of the question as to the range of flight of flies, both in horizontal and vertical directions; and under varying conditions, meteorological and otherwise. Trials are to be made of the respective value of various baits for attracting and killing flies. The so-called lesser house-fly, *Homalomyia canicularis*, is to be studied. Dr. Graham-Smith will continue his work on the experimental infection of flies with pathogenic micro-organisms, whilst Dr. Nicoll will inquire into the possible agency of flies as carriers of the eggs of parasitic worms, and so on.

These are a few of the lines of research and experimentation, all of which will increase our knowledge and place us in a more able position to effectively deal with a pest we can well afford to be without, and one in dealing with which the general public can materially assist.

GEOLOGY.

By Russell F. Gwinnell, B.Sc., A.R.C.S., F.G.S.

WIND AND WATER.—Quite a number of papers published within the last few months deal with such subjects as the movements of wind and water, and the resulting aeolian and aqueous deposits.

In "The Origin and Growth of Ripple Marks" (*Proc. Roy. Soc. A.*, Vol. lxxxiv), Mrs. Ayrton describes experiments leading to the conclusion that there are three ways of originating sand ripples under water. Two of these methods are capable of originating and then extending regular ripple-marks wherever water is oscillating over sand, whether its surface be smooth or uneven to start with. These are:—

(1) The "Differential Motion" Method, by which single ridges arise at the loops of stationary waves.

(2) The "Brush" method, whereby the brushing action of the vortex in the lee of any existing dune or obstacle sweeps up a new ridge beside it, leaving a hollow along the neutral line of the vortex.

The third method, depending on an initial uneven surface, could, unaided, give rise to *irregular* ripple-mark only, since it consists in piling up sand in places where the surface chances to be uneven.

Summarily the processes by which mounds of sand are built up under the action of stationary waves are:—

(1) Ripples always first form at places of maximum longitudinal motion of the water, *i.e.*, at places of constant level.

(2) Smooth spaces are left at and near the places where the water has no longitudinal motion, *i.e.*, where the change of level is greatest.

(3) Each set of ripples grows into a mound having its centre plane at the place of maximum longitudinal velocity and its lowest parts close to places where the longitudinal motion is zero.

(4) There are therefore two of these mounds to each water wave.

Mr. A. Wade, B.Sc., F.G.S., in the *Geological Magazine* September, 1910, deals with "The Formation of Dreikante in Desert Regions." These curious three-edged stones, so characteristic and abundant in most desert regions, are shaped somewhat like a Brazil nut. The old explanation of their fluviatile origin has long been discarded in favour of an aeolian origin, which supposes that the wind (laden with sand and thus a powerful eroding agent) strikes the point of the pebble, glancing off on either side so that the "keel" on the upper surface of the pebble is in the direction of the wind. If this is the true explanation, it is difficult to make it tally with observations recently carried out by the author in the Egyptian Desert.

Thus he finds that the Dreikante are equally pointed at both ends; collecting over three hundred specimens in an area of about three hundred acres, he finds 78% set with the "keel" approximately at *right angles* to the wind; the keel instead of being a simple straight one is often curved or even bifurcating at both ends, giving a five-faced solid instead of a three-faced one; the faces are parabolic curves; finally, actual experiment proved that these three-edged stones could not remain with their pointed ends facing a strong current of wind.

The author, therefore, shows that the travelling sand-grains hit not edgewise but broadside on a face; and being projected off again in an upward direction, the parabolic curve is produced. The cutting-away [illegible] until the pebble stands on a very narrow base, and th[illegible]s over; thus the erosion commences again on a fresh [illegible]." Sometimes at night the rattling of the pebbles moving [illegible] the action of a high wind is very considerable."

In the November issue of the same maga[illegible] printed a summary of the views of the Russian geologist, [illegible], as to aeolian deposits. He classifies the various types [illegible] tifica-tion in aeolian deposits (such as ripple-mark, [illegible]onal stratification with opposed dips, horizontal, vertical, and [illegible]), and their modes of origin. In addition to ordinary wind, the action of whirlwinds can often be distinguished by the spiral or circular arrangement of the dust particles. The dimensions of particles of desert dust transported by the wind diminish from the centre towards the margins of the desert. The grains of sand have special characters in aeolian and in aquatic deposits; in the former they are characteristically triangular.

Finally, we may note two papers by Mr. A. R. Horwood, of Leicester Museum, on "The Origin of the British Trias." One paper was read before the British Association in September last, the other before the Geological Society on November 23rd. The general view of conditions in Triassic times is that the deposits appear, on the whole, to have been laid down under conditions similar to those which now prevail in the dry interior of continents. The lower-lying country between the mountain ranges was covered by wind-blown sand and alluvial deposits washed down from the hills during occasional floods, and gradually the mountain-chains were more or less completely buried. In hollows in the nearly level plains that were thus produced, the water collected and was evaporated, forming lakes of brine. (See Lake and Rastall: "Text Book of Geology," 1910).

Mr. Horwood, however, considers the British Trias to be a delta deposit, in which desert conditions did nothing more than locally act upon the rock. *They had no part whatever in the work of deposition.* Among many other points, he notes that ripple-mark affects only the sandstones, and not the marls; also that, whereas *all* varieties of desert sand agree in possessing the texture of miniature pebbles with a highly polished surface, all Trias sediments exhibit an eroded surface.

He maintains that there is positive, direct and accumulative evidence to prove that the Trias as a whole (and not the Bunter only) was the work of rivers which had continued to bring sediment in one form or another from the north-west of Britain more or less continuously from the close of the marine phase of Lower Carboniferous times.

THE ORIGIN OF CORAL ISLANDS.—Reef-building corals can only thrive in seawater which does not exceed about thirty fathoms in depth, and the temperature of which never falls below 20° C. (68° F). The latter limitation almost restricts coral islands to tropical seas; the former implies a shallow submarine foundation in every case. The explanation of the occurrence of such shallow foundations or submarine plateaux, far from continental land, has been more or less of a mystery right down to the present day. The fact of the existence of the plateaux is established, and also that the material is frequently volcanic; in other cases the living coral is founded on an enormous thickness of dead coral rock (as at Funafuti, where a boring of over a thousand feet encountered nothing but coral limestone).

The curious atoll-structure, where a ring of coral islets more or less encloses a central lagoon, renders the explanation more difficult. The main theories are those of Darwin, Dana, and others, on the one hand, and of Murray, Agassiz, on the other. Darwin's hypothesis necessitates subsidence of innumerable islands, the corals growing upwards on a talus-slope of their own debris as fast as the islands sink. This implies wide-spread crustal subsidence. In Murray's eyes the submarine platforms are volcanic islands denuded to a "plain of marine erosion," and the conditions are those of general elevation or long-continued crustal repose.

R. A. Daly, writing in the *American Journal of Science* (November, 1910) on Pleistocene Glaciation and the Coral

Reef Problem, explains the phenomena of coral islands as being due neither to crustal subsidence nor to elevation of volcanic islands, but to *changes in the sea-level itself.* These changes, broadly treated, consisted in a lowering of the water-level, followed by a return to normal conditions as the great ice-caps first grew to enormous dimensions, and then retreated during the Great Ice Age. Estimating the Polar ice-caps during the glacial epoch at an area of six million square miles, with an average thickness of three thousand to five thousand feet, the author points out that the removal of this water would of itself lower the general sea-level by one hundred and twenty-five to two hundred and eight feet (say twenty to thirty-five fathoms). Besides this, however, the gravitational attraction of this great mass of ice would heap up the ocean water nearest it to such an extent as to lower the equatorial sea-level another five to eight fathoms. Thus the total lowering of sea-level in the tropics would be quite thirty fathoms. Conversely, the deglaciation of the whole ice-cap would *raise* it to this extent.

Now, the submarine plateaux on which coral reefs are found do not, as a rule, depart very much from an average of about thirty-five fathoms below present sea-level. Allowing for a "veneer" of coral detritus, etc., of ten to fifteen fathoms in thickness, the "solid rock" is about forty-five to fifty fathoms under water. The *uniformity* of the plateau level is explained by neither Darwin's nor Murray's hypothesis: the present author explains it as being due to marine abrasion during the Glacial Period. Allowing for the thirty fathom lowering of sea-level produced by the Polar accumulation of ice, this platform would then be within fifteen to twenty fathoms of the surface, a depth in which the *growth of the coral organism is possible.*

If the whole earth were chilled during the Glacial epoch (as supposed by some) reef-building corals would be vastly restricted in areal distribution. A fall of six degrees only would enormously diminish the area where the marine isotherms never fall below 20° C., the temperature necessary to coral life. This would mean that most of the present areas of coral seas were then free from such life. As the retreating waters caused low Pleistocene islands to emerge from the sea and no coral fringes protected the loose volcanic or calcareous material, denudation would be very rapid. Exposed on all sides to abrasion by the open sea, these islands would lose substance at least as fast as the chalk cliffs at Dover are doing (about three and a half feet per annum). At this rate the Chagos Bank, now a huge plateau, sixty miles broad by ninety miles long, could have been reduced to the Pleistocene sea-level in about fifty thousand years; and the whole duration of maximum glaciation in Pleistocene times was much longer than that. Moreover, in the case of many areas this Pleistocene denudation was only the "finishing touch" to subaerial denudation, which might have been continuously going on previously. Some of the volcanoes, indeed, may have been not merely pre-Tertiary, but even pre-Cambrian.

Amelioration of climate followed, allowing coral life in the waters where shallow platforms were now prepared for them.

At the same time deglaciation caused a gradual deepening of the sea. The coral growth would easily be fast enough to keep the living zone of coral within twenty fathoms of the surface during this deepening. The mechanism of growth, with the resulting development of atoll, barrier and fringing reef forms would be analogous to that imagined by Darwin on the subsidence hypothesis.

The theory of a general lowering of sea-level in inter-tropical seas—counteracted in higher latitudes by the glacial attraction—in no sense excludes complications due to local warpings of the earth's crust. Other processes invoked by previous writers have been so far neglected in the argument because of the high probability that neither basin-foundering, nor sedimentation, nor absorption of water by weathering rocks seem to have been important enough since Tertiary times to effect, by more than a fathom or two, the changes of level assumed.

METEOROLOGY.

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

THE week ended November 19th, opened with extremely unsettled weather in all districts, with heavy rain, snow and sleet. Thunderstorms and hail were reported on several days. In the South, however, there was a decided improvement in the second half of the week. Temperature was below the average everywhere, by as much as 7° in places, while sunshine was, on the whole, in excess. In Ireland and in Scotland W., the amount of rainfall for the week was below the average, though the number of rainy days were in excess there as elsewhere. The mean temperature of the sea water was higher than that of the air on all our coasts, the excess at Plymouth being 10°. The highest temperature reported was 58° at Geldeston on the 15th, the lowest 18° at Marlborough on the 17th.

The week ended November 26th, was cold generally, but the weather was finer in the Southern and Eastern districts than in the Northern and Western. The defect in temperature exceeded 9° at several stations, and at Prestwich it reached 10°. At three stations in Ireland there was a slight excess. The highest temperature reported for the week, 59°, was in Ireland on the 23rd. The lowest minimum was 10° at Balmoral on the same day. In Westminster the highest reading was 43°, and the lowest 25°. The amount of rainfall varied much. In the English Channel it was three times the average, and in Ireland S. nearly twice as much, while in Scotland N. it was not quite half as much as usual. In the Eastern districts generally the rainfall was in defect, and at Spurn Head the week was rainless. Sunshine was in excess except in the Southern districts. Balruddery reported the highest aggregate, 22·7 hours or 43 %. The mean temperature of the sea water ranged from 53°·0 at Teelin to 40°·0 at Penman Bay.

The week ended December 3rd, was, as a rule, dull and unsettled, with frequent and long-continued rains. In the extreme North, however, and in Ireland, the weather was bright and cold. Aurora was seen in Scotland on November 29th and 30th. Temperature was low everywhere, the defect exceeding 7° in places; the highest reported reading was 56° at Jersey on the 27th, the lowest 19°, at West Linton and Markree Castle on the 30th. Rainfall again varied greatly, it being only one-fifth of the average in Scotland N., while in the Midland Counties it was five times the average. Falls of 1-in. and upwards in twenty-four hours were frequent, and at Raunds in the four days, December 1–4, the total precipitation was 4·23-ins. Sunshine was in excess of the average in Scotland N., and in Ireland N., but in no other district. At Jersey the total duration for the week was only 5·8 hours (10 %), while at Castlebay it was 33·4 hours (67 %). In London the week was sunless. The mean temperature of the sea water was greater than that of the air on all our coasts. The individual readings varied from 53° at Plymouth, to 40° at Cromarty.

The week ended December 10th, was dull, mild and wet, with a good deal of strong wind. Temperature was high everywhere, the excess exceeding 6° at several places. The highest readings reported were 57° at Cirencester on the 7th, and at Llandudno on the 9th, the lowest, 29°, at Balmoral and at Arlington. Over a large part of the kingdom the temperature of the air did not fall below the freezing-point, and on the ground the minimum was only 25°, at Balmoral. The rainy days were in excess of the average, and at many stations rain was measured each day. The amount of rainfall was, however, not excessive, except in England S.W., where it was nearly twice as much as usual. In some districts, indeed, the rainfall amount was in defect, and in Scotland N. it was but little more than one-third of the average. Sunshine was scanty in all districts. At Westminster the total duration was only 1·3 hours (2 %) while the highest amount reported was only 13·5 hours (25 %) at Felixstowe. The temperature of the sea water varied from 52° at Plymouth to 39° at Cromarty.

THE AUTUMN OF 1910.—For Meteorological purposes the Autumn is taken as the three months, September, October, November, and of the thirteen weeks, September 4th to December 3rd, 1910, in England S.E., four weeks have been unusually warm, eight weeks unusually cold and only one week about normal. During the same period five weeks have been classed as weeks of heavy rainfall, four as weeks of light rainfall and four weeks as normal. The sunshine in five weeks has been abundant, in six weeks scanty, and in two weeks normal.

THE S.E. TRADES AND RAINFALL.—Some years ago Dr. W. N. Shaw called attention to a remarkable apparent relation between the strength of the S.E. Trades, as recorded at St. Helena, and the rainfall in England, and the suggestion then made has stimulated research in various directions. In a paper just published in the *Quarterly Journal of the Royal Meteorological Society*, Mr. J. I. Craig, of the Egyptian Weather Service, expresses the opinion that a distinct connexion has been traced between the winds at St. Helena and the Rainfall in Northern Africa. If this opinion is confirmed on further investigation, it will be of great practical importance; for the Nile flood depends on the rainfall in Abyssinia and the adjacent regions, and any reliable prognostication of the probable Nile flood should be of immense advantage to Egypt.

SNOW IN JOHANNESBURG.—Mr. H. E. Wood, in a paper in the *South African Journal of Science* for September, says: "On the morning of August 17th, 1910, the town of Johannesburg, for the first time in its history, was covered with snow to a depth of several inches. To many of its inhabitants, particularly the younger generation, the sight of snow was quite new. The result was that the unusual event was celebrated by a general holiday in the town."

MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD.	ARTHUR EARLAND, F.R.M.S.
JAMES BURTON.	RICHARD T. LEWIS, F.R.M.S.
THE REV. E. W. BOWELL, M.A.	CHAS. F. ROUSSELET, F.R.M.S.
CHARLES H. CAFFYN.	D. J. SCOURFIELD, F.Z.S., F.R.M.S.

C. D. SOAR, F.R.M.S.

A MYRMECOPHILOUS SPIDER (*Thyreosthenius biovatus*).—A good deal of interest always attaches to the heterogeneous assemblage of creatures which for some reason or other are permitted to spend their existence, or part of their existence, in company with various species of ants, and a few remarks, therefore, concerning a small spider somewhat notorious in this respect, may not be altogether out of place here.

Many species of spider have been, at one time or another, recorded as having been found in ants' nests, but, upon careful investigation of their claims, only three of our British spiders can be considered to be really myrmecophilous, namely, *Tetrilus arietinus*, *Evansia merens*, and *Thyreosthenius biovatus*. It is easy to comprehend how mistakes are liable to arise in this matter. Many [illegible] be found under stones, or amongst the vegetati[illegible] st the sides of pieces of rock; and when the prote[illegible] is turned over it is the simplest thing in the world t[illegible] to drop into a nest of ants should there be one und[illegible] spiders, too, are often captured apparently wandering up[illegible] urface of the nest of the wood-ant (*Formica rufa*[illegible] will be noticed that it is usually in the case where [illegible] t has been disturbed, and the surviving ants have [illegible] d a comparatively small nest upon the summit of the d[illegible], leaving a bulk of uninhabited material upon which [illegible] creatures may venture with some amount of safety. In [illegible] such instances in a wood in the N[illegible] of London I have found large number[illegible] of a small spider (*Tiso vagans*) actually living amongst the debris of the nest, but in no case were the spiders found in the central portion where the much-persecuted ants still held their own. It would, however, have been extremely easy to have fallen into error, especially as the nests were of a lighter and more friable character than is usually the case, and it was consequently by no means easy to decide where the inhabited portion ended and the debris commenced.

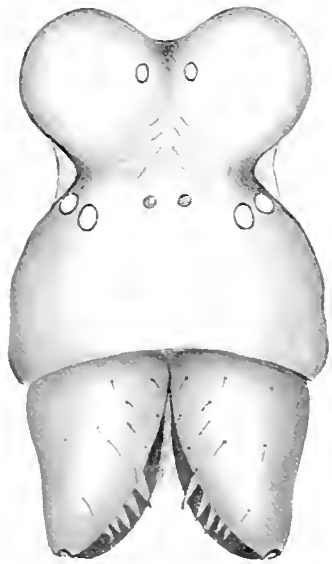


FIGURE 1.

Thyreosthenius biovatus, male. Front view of head showing cephalic prominences and extraordinary arrangement of eyes.

Thyreosthenius biovatus is, in the male sex, a most grotesque and striking creature; but, on account of its small size, its peculiarities are hardly visible even to highly trained eyes, unless a lens be employed. The female, on the other hand, is a most ordinary looking creature, and indistinguishable, except by careful microscopical examination, from quite a number of allied spiders. Both sexes, even when fully developed, are of a somewhat pale colour, and convey the impression of immaturity.

The only species of ant with which they associate appears to be the wood-ant (*Formica rufa*). So far as I am aware the reason for their presence in the nest is quite a mystery. It seems pretty clear that they do not feed upon the ants, which are in size and fighting capabilities vastly superior to them; and it seems unreasonable to suppose that they destroy the various small creatures which the ants harbour as scavengers or pets. Still, the so-called intelligence of the ant has been enormously exaggerated, and it is not beyond the range of possibility that the spider may be fooling its hosts, and perchance making meals at the expense of their offspring when the nurse's back is turned. When the nest is disturbed the spiders do not feign death, but generally extricate themselves from the débris and are quite easily seen. Isolated specimens are occasionally found wandering at some considerable distance from any nest, but, so far as I have been able to ascertain, not in any district where the wood-ant does not occur. As a rule the males appear to be considerably rarer than the females, but it is quite possible that, as in the case of many other spiders, the life of the adult male is a short one.

In some of the very restricted pine areas of south-east Sussex, during the early part of October, specimens of *Thyreosthenius* are sometimes to be found in the small newly-formed nests which are plentiful where larger nests have been destroyed by the gatherers of "ants' eggs." [illegible] nests vary considerably in character, some bein[illegible] pupae and others being almost devoid of any for[illegible] ants. It is a curious fact that I have never found [illegible] spider in a nest where pupae were very numerous. A[illegible] season mentioned, namely, early October, the ma[illegible] of the captures were males, and almost all of these, a[illegible] the females.

had only just attained maturity. I am unable to report on the contents of these small nests early in the summer as they were not then in existence. Large nests, however, examined in May, contained, on the testimony of local collectors, a comparatively large number of females, the males being stated to be very rare in the adult state.

Dr. Randell Jackson, who has kindly forwarded me a northern specimen of this species, also reports a great preponderance of females amongst his captures. A detailed description of the spider would be out of place here, but the following characters will suffice to distinguish it from its allies:—Eyes small and very widely separated; front row straight by their bases in female, by their centres in male. Posterior eyes strongly procurved (in the male this row of eyes is distorted by the exaggeration of the caput). Legs fairly long. Femora each with two rows of bristles on the underside. Tibial spine very small, close to base of joint. Metatarsi I, II and III with sensory bristle; in III it is just beyond the middle; in I it is about two-thirds from the base. Tarsi not much shorter than metatarsi: somewhat fusiform, especially in the male.

The species most likely to be confounded with *Thyreosthenius biovatus* is *Peponocranium ludicrum*, which agrees with it pretty closely in size and general appearance, and which possesses, in the male sex, a somewhat similar cephalic protuberance. It occurs also in pine and heath districts, and is not uncommon in many parts of the South of England. The specimen purporting to be a male *Thyreosthenius*, presented to the British Museum by Mr. Donisthorpe, is, in reality, nothing but *Peponocranium ludicrum*.

F. P. SMITH.

QUEKETT MICROSCOPICAL CLUB.—November 22nd, 1910, Mr. E. J. Spitta, L.R.C.P., Vice-President, in the chair. A paper on "A Water Mite new to Britain (*Neumania triangularis*, Piersig)" contributed by Mr. Geo. Plant Deeley. This genus was formerly called Cochleophorus, and several species are described under this generic name by Mr. C. D. Soar, in *Science Gossip*, June, 1900. The locality from which Mr. Deeley obtained his specimens was Parkhill, Stourbridge. Both sexes were taken.—Mr. T. B. Rosseter, F.R.M.S., on "A new species of Avian Tape-worm (*Hymenolepis upsilon*)." He found it in January, 1910, parasitic, amongst the faeces of the intestine of a Wild Duck (*Anas boschas*). The author gave an account of its affinities, references being made to the work of Schilling (1823), Creplin (1829), Dujardin, Pagenstecher (1858), Pfaff and Olrix, and Krabbe (1867). A full description of the specific characters of the new species was given, and from the similarity of the uterine sac to the Greek small υ, the name upsilon was bestowed on it.—Mr. James Burton on *Botrydium granulatum*. "The plant consists of small green balloon-shaped vesicles about three millimetres in diameter. Below the surface of the mud an extensive root system is produced; the roots branch dichotomously and extend to a considerable distance, often reaching a length of six millimetres. As the plants very often grow thickly side by side, the roots are entangled and interlaced in the mud, and, the whole plant being of somewhat tender consistency, it is difficult to extricate perfect specimens. The upper part, when young, is filled with protoplasm and is bright green in colour. Later the centre becomes more watery and the green is seen to be due to finely granular chlorophyll. The colourless roots are filled with watery protoplasm. As to its classification, Professor West classes it with the group *Heterokontae*. All the older books put it among the *Siphoneae*, and it seems, for several reasons, to be very appropriately placed there. One of the interesting facts connected with *Botrydium* is that, although it is of such considerable size, it is unicellular. In thinking of a unicellular organism—plant or animal—we usually consider it as something very small, or even microscopic, in size; but that is not necessarily the case. The *Siphoneae* are a class grouped together because of the noticeable characteristic that they are all unicellular, notwithstanding which, most of them are of considerable size. The best-known member of the group is the exceedingly common *Vaucheria*. There are many species—some terrestrial, and found on the damp earth of flower-pots and on damp garden-paths; others occur in ponds. In these plants, though they reach a length of several inches, and sometimes nearly a foot, no dividing-walls appear in the filaments under normal vegetative conditions. Most of the family are marine and one genus—*Caulerpa*, occurring in the Mediterranean—reaches a length of several metres, and yet is only one cell.

Mr. Herbert F. Angus, of the firm of H. F. Angus & Co., exhibited and described a number of Microscopes by R. Winkel, of Göttingen, who, he said, enjoyed a high reputation in Germany, although almost unknown in England. He pointed out that the model was of the more or less stereotyped Continental pattern, inclining more to the Zeiss model than any other, but differing in several important details, as was only to be expected in the productions of an old-established firm who had given proof of their originality in the past by first employing fluorite in the construction of objectives, and producing an objective with a hyper-hemispherical front lens.

A ROCK GRINDING MACHINE FOR AMATEURS.—Nearly every amateur microscopist who has taken up the study of petrology has at some time felt desirous of preparing thin sections of rocks for himself instead of purchasing them, but has in a good many cases been deterred by the labour involved in grinding them by hand. This method will answer the purpose if only a few slides are required, but when he takes up the matter seriously and wishes to make large numbers of sections the student finds the necessity of having some mechanical means to minimize the work.

The professional lapidaries' lathes, and also the special rock slicing and grinding machines placed on the market for petrologists, are generally speaking far more expensive than the average amateur can afford, and I therefore wish to describe a home-made apparatus which has been found to give good results, and to be fully capable of doing the work for which it was devised.

Figure 2 gives a general view of the entire machine, and Figure 1 shows the top of the table and the way in which the various parts are disposed.

The cost of this machine complete is, roughly speaking, 17s., and it can be made by anybody capable of using ordinary tools.

The apparatus is erected on an ordinary sewing machine table, which can be procured very easily. For the slitting disc, which is shown on the right hand side of Figures 1 and 2, it is necessary to get an ordinary polisher's lathe head. This is threaded at one end to take a circular saw or emery wheel, and upon this thread is run the cutting disc, which is then bolted on in the same way as a circular saw. I use a plain disc of soft iron six inches in diameter, and about one-fiftieth of an inch thick.

The rock-holder is the most elaborate part of the arrangement, but is quite simple to manufacture. Figure 3 is a near view of this on a larger scale. It consists of a spindle six inches long, an upright to carry the same, and the jaws to hold the rock. Four and a half inches of this spindle are three-eighths of an inch in diameter threaded sixteen to the inch, and the remaining one and a half inches are a quarter of an inch in diameter, and threaded to take the cones of an ordinary bicycle pedal. This spindle was made for me by a working cycle maker. It is carried on an upright cut out of oak three-quarters of an inch thick. This has a threaded plate screwed on each side of it, through which the spindle moves. There is a lock nut on the spindle behind the upright to hold it rigid. To the end of the spindle are attached the jaws for holding the rock. This portion consists of a piece of oak three quarters of an inch thick, three and a half inches long by three inches wide. To the bottom of this is screwed a piece of oak a quarter of an inch thick, and on top of this is a moveable piece which is clamped on the rock by the butterfly nuts of the two three-inch bolts.

The upright portion of the jaws is fastened to the spindle by the ball bearings of an old bicycle pedal. When the machine was first made this bearing was plain, and consisted of a nut and washer behind the upright of the jaws and another nut and washer in front, and these were simply screwed together. This worked fairly satisfactorily, but stuck somewhat when tightened sufficiently to prevent shake, and the bicycle pedal bearing was substituted. It will be seen that the jaws, if properly adjusted, swing on the ball bearings parallel to the cutting disc, and the rock can be moved forward for cutting another slice by turning the spindle toward the operator.

A disc of brass one and three-quarter inches in diameter is fixed to the left hand end of the spindle as a handle for turning it by, and this is graduated into four equal divisions for reference.

In order to get the rock-holder to swing strictly parallel with the cutting disc, some adjustment is necessary, and this is arranged by bolting the upright carrying the spindle to the table. The bolt in front is a fixture, but the one in the rear goes through an elongated hole in the table, so that the upright can be swung on the front bolt as a pivot until the jaws are parallel, and then the back bolt is clamped up tight.

The rock is kept against the cutting edge of the disc by the chain and weight attached to the rock holder at the bottom corner. This can be seen in the illustrations.

The grinding lap is a cast iron disc eight inches in diameter, half an inch thick in the centre, with the top surface bevelled off to three-eighths of an inch at the edge. A lead or copper lap can be used instead of the cast iron one, but I find the latter is quite satisfactory and is cheaper to purchase.

The spindle for this lap is made from an ordinary half-inch bolt, six inches long, procurable from any ironmonger. This requires cutting down until it is about four inches long, then it has to be centred, and made with a cone at the bottom end and a cup at the top. A pulley wheel is fixed at the bottom of this spindle to take the driving band. Two nuts are wanted for the top of this spindle, one of which is screwed up tight for the lap to rest on, and the other to fasten it by. The bearing for this spindle under the table is a screw with a cup in the end, which is fixed with a couple of nuts through a threaded plate. This plate is attached to a piece of wood affixed to the underside of the table. The top bearing is a screw with a cone point which passes through a threaded plate into the top of the spindle. This

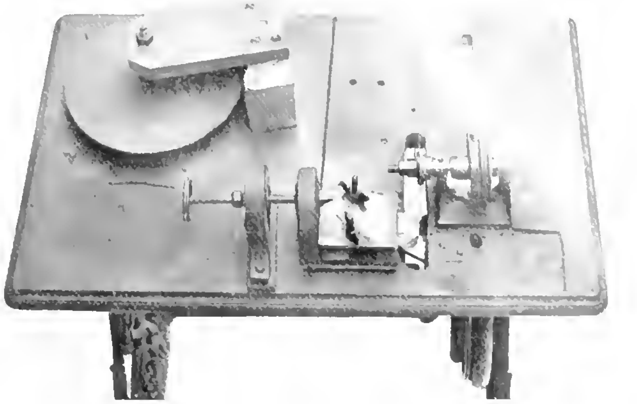


Figure 1.

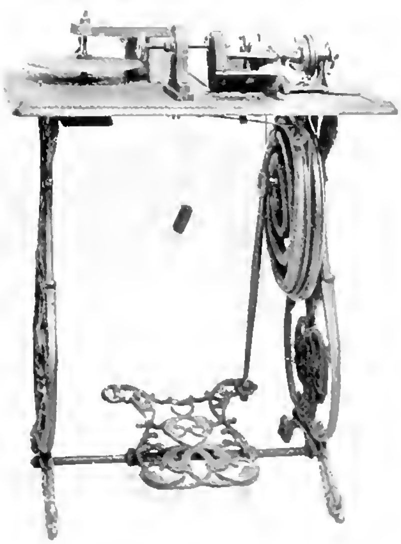


Figure 2.

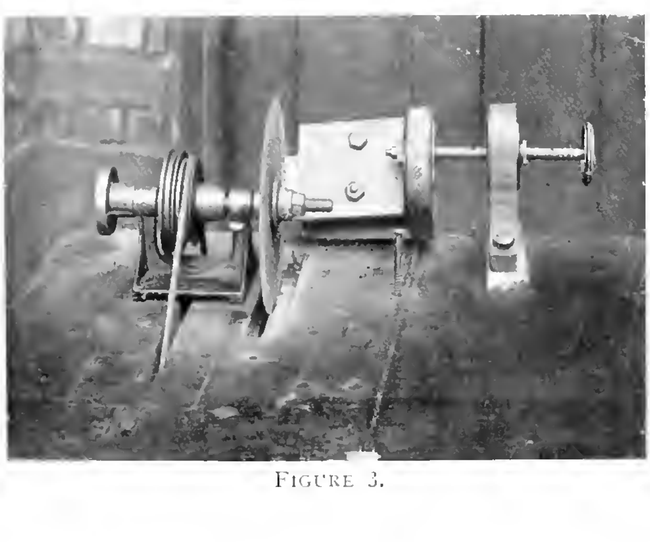


Figure 3.

screw is adjustable for taking up wear and is securely fixed by the lock nut. All this can be procured from a small cycle maker at a very reasonable price.

The carrier for this top bearing consists of a block of wood seven inches long by three inches high by two and a half inches wide, and this is securely screwed to the table from underneath.

Upon this is a piece of oak three quarters of an inch thick, seven inches long by three inches wide, to which is screwed the threaded plate for the coned screw of the bearing.

This method of fixing has been found quite satisfactory. It is perfectly rigid, and there is no shaking or jumping of the lap, even when driven at the highest speed obtainable.

It will be seen that the drive for the slitting disc is taken direct from the driving wheel, but that for the grinding lap goes over two jockey pulleys so as to get the horizontal movement. These jockey pulleys are ordinary iron pulley wheels with screw ends, such as are used for carrying blind cords.

It is necessary to have two leather or gut bands, and these have to be changed when altering from the slitting disc to the grinding lap.

A piece of tin, shaped like a bicycle mud guard, is fixed to the table behind the slitting disc to stop the splashes. A tin tray is also placed below the table under the disc to catch the waste carborundum and water, which can be used over again. Round the grinding lap I use a cake tin, which has had a large hole made in the bottom for the spindle and pulley wheel to pass through. A ledge of tin is soldered all round this hole to keep the water, and so forth, from the bottom bearing. These mud guards are not shown in the photographs.

This apparatus has been in use now for about three years, and has ground between four hundred and four hundred and fifty slides during that time. It has given the greatest satisfaction to me, and although, no doubt, it is not so good as a professionally made machine (with which, of course, it is not intended to compete), it will be found a very useful article for the amateur petrologist, who usually has far more enthusiasm than he has money.

C. H. Caffyn.

ROYAL MICROSCOPICAL SOCIETY.—November 16th, 1910, Professor J. Arthur Thomson, M.A., F.R.S.E., President, in the chair. In connection with the gift of two slides of *Pleurosigma*, the Hon. T. Kirkman, the donor, asks whether fresh-water Pleurosigmae with oblique striae are rare.

Mr. M. J. Allan, of Geelong, sent a slide of spicules of a species of *Gorgonia* unknown to him concerning the identification of which he sought information. He also sent some slides mounted in fluid by a method of his own. He likewise mentioned in a letter that four years ago he had devised a variable eye-piece giving three magnifying powers, which he offered to send for inspection. Mr. Merlin sent, for exhibition, three photomicrographs of Grayson's Rulings, which Mr. Grayson had sent him. They showed the 100,000, 110,000, and 120,000 bands of Grayson's twelve-band plate. Previously no photograph had ever been exhibited of anything over 112,595 lines to the inch. Dr. Butcher exhibited a number of photomicrographs of diatoms, *Coscinodiscus asteromphalus* and *C. omphalanthus*, *Navicula Smithii*, *Pinnularia cardinalis* and *Triceratium favus*. The photographs were taken in series and represented successive focal planes of each object. The conditions under which they were taken were given.

Mr. A. E. Hilton exhibited a number of mounted specimens of British Mycetozoa. In reference to his exhibit he said that at the present time the disposition was to classify the Mycetozoa among the Rhizopoda, but their metamorphoses marked them off as an entirely distinct group. Their life-history presented three principal phases—aquatic, amoeboid, and aerial. The question of the sexuality of the Mycetozoa was a very obscure one. In all three phases there were nuclear divisions.

The President made a communication on Japanese Pennatulids, and exhibited some typical specimens of great beauty. He said that he had been entrusted by Professor Ijima, of Tokyo University, with a collection of Pennatulids, on the study of which he was at present engaged. His report was not yet ready for publication, but he had thought that it would be of interest to the Fellows of the Society to see a representative sample of these beautiful Sea-Pens. They would understand, when they looked at the dimensions of the specimens, why it was necessary on a long railway journey to be content with a sample of the collection.

The Pennatulacea, or Stelechotokea, include some of the most beautiful of fixed marine animals—long graceful colonies, often plume-like, as their name suggests, with rich colouring, and with strong luminescence. They live fixed on the floor of the sea, and many of them show a familiar adaptation to life on the bottom—long stalks raising the polyp-bearing portion off the substratum. In deep-water forms, such as the beautiful Umbellulas, the proportion of sterile stalk to polyp-bearing rachis reaches an extreme.

The Pennatulids were related to Alcyonarians, such as Dead Men's Fingers, Precious Coral, Organ-Pipe Coral, the Gorgonids and the Gorgonellids, like *Hicksonella*, which Mr. Simpson had established as a new genus at the last meeting of the Society. They differed markedly, however, in several respects. In a very remarkable way the primary polyp, which developed from the fertilized egg, was sacrificed to forming the main axis on which the secondary polyps were borne, which in turn might give off (always through the intermediation of stolons or solenia) tertiary polyps and so on. A central rod, which was present in the majority as the skeletal support of the colony, ran up the middle of the gastric cavity of the primary polyp, and some authorities regarded it, therefore, as endodermic in origin, whereas the skeletal support of all related forms is ectodermic. Thirdly, the Pennatulids almost always showed a pronounced dimorphism—along with the ordinary polyps or antozoöids there were dwarf polyps without tentacles, the siphonozoöids, whose office it was to keep currents of water going in the canals of the colony. It should also be noted that there was in Pennatulacea a marked tendency to bilateral arrangement of the polyps, similar to the arrangement of barbs on a feather.

The President also read two papers by Dr. Jas. F. Gemmill, (1) "Aerator for small Aquaria," (2) "Adaptation of Ordinary Paraffin Baths for Vacuum Embedding." Mr. J. E. Barnard read papers "On the Use of a Metallic Electric Arc in Photomicrography," and on "A Simple Method of obtaining Instantaneous Photomicrographs."

THE EFFECT OF GRAVITY ON *EUGLENA VIRIDIS* EHRB.—At the Meeting of the Royal Society held on November 17th, Harold Wager, F.R.S., gave the results of some experiments on the movements of micro-organisms. *Euglena viridis*, when placed in the dark in shallow vessels or narrow tubes, becomes aggregated into network-like patterns or more or less well-defined circular groups. If a narrow tube filled with water containing sufficient Euglenae to give it a pronounced green colour be placed horizontally in the dark or in a weak light, the aggregation takes the form of a series of nearly equally spaced groups like green bands crossing the tube from one side to the other. Each group shows clearly two distinct regions, a central denser one consisting of cells moving downwards, and a lighter peripheral area consisting of cells moving upwards. There is, in fact, a constant cyclic movement, which is kept up so long as the aggregation persists. Examination with a pocket lens shows that, as the organisms reach the bottom of the stream, they gradually separate from one another, and begin to move upwards. As they reach the upper surface, they are seen to be drawn towards the central denser region of the group, and again enter the downward stream. This aggregation, with its regular cyclic movements, may persist for several days, provided the Euglenae are kept in the dark or under red glass.

The downward movement appears to be a purely mechanical one, dependent upon the specific gravity of the organism, and is not due to a stimulus which evokes a physiological response as in geotropism or geotaxis. The upward movement is, on the other hand, due partly to the activity of the organisms themselves, partly, no doubt, to the currents set up in the liquid by the friction of the downward moving stream. The upward movement of *Euglena* appears to be controlled, so far as the orientation of its elongate body is concerned, by the action of gravity.

The network-like aggregations and groupings resemble very closely the cohesion figures which are formed, under certain conditions, when fine sediment is allowed to settle slowly in a fluid, and the conclusion has been arrived at that the aggregations are probably of the nature of cohesion figures, due to the action of gravity upon organisms massed together, combined with the vortices set up by the streaming movements.

The movements of certain micro-organisms are therefore controlled in a purely mechanical fashion, and the advantage to those species which, like *Euglena*, are often found in a confined space in large numbers, must be very great, as by its means a constant circulation is maintained, and they are prevented from accumulating in such dense masses as would be detrimental to their existence by interfering with their assimilatory or respiratory functions.

PHOTOGRAPHY.

By C. E. Kenneth Mees, D.Sc.

INFRA-RED PHOTOGRAPHS.—A recent holiday trip to Portugal gave me an opportunity of trying some landscape photographs taken by infra-red light after the manner suggested by Professor R. W. Wood.

A filter was prepared which passed only light above 7,250 A.U., and through which, therefore, only a very faint amount of deep red light could be seen by screening the eye thoroughly.

The plates which were used had a sensitiveness extending with long exposures to 7,600, so that the region used with the plates and screen was situated between the *a* and *A* lines, from 7,250 to 7,600.

The multiplying factor of the screen on these plates was found to be about three thousand, so that, as a normal exposure at F. 8 in sunlight would have been about one-tenth of a second, the infra-red photographs required an exposure of five minutes.

Unfortunately the peculiarities of the Portuguese small boy, and the very limited time at my disposal, tended to cut exposures too short; but some of the results obtained proved of considerable interest.

Two typical examples are reproduced herewith. The first is taken from the great bridge over the Douro, in Oporto, and shows well one of the most striking features of all these photographs—the intense blackness of the blue sky. (See Figure 1.) Even the faintest trace of cloud stands out at once against the blue sky when observed by infra-red light, so that it would seem possible that the method might be of considerable use to the meteorologist. The shadows in infra-red light are extraordinarily deep, showing no detail at all if the sky be clear, because the blue skylight contains so little light of long wave length.

The second photograph, which is taken in the Avenue Liberdad, in Lisbon, shows the extraordinary appearance of foliage under this infra-red light. The chlorophyll has but the slightest absorption for it, so that the foliage on the trees appears white, while in the left-hand bottom corner we have the curious phenomenon of a white palm! (See Figure 2.)

Incidentally, it is interesting to remember how few coloured substances do absorb infra-red light between seven thousand and eight thousand A.U. The only two dyes which I know to absorb completely in this region are Naphthol Green and the new Hoechst dye, Filter Blue-Green. The new Badische Anthraquinone dyes absorb to seven thousand five hundred but transmit light of greater wave length; nearly all other blue and green dyes transmit red light of wave length seven thousand or under.

From an Infra-red photograph [illegible] E. Kenneth Mees.

FIGURE 1.

A view from the great Bridge over the Douro in Oporto.

AN "EXPLOSION" THEORY OF THE LATENT IMAGE.—In a letter to *The British Journal of Photography*, Mr. F. F. Renwick makes a suggestion for a new theory of the latent image, though various facts pointing in the same direction have been published at intervals. This theory is based on the observation of Dr. W. Scheffer, that a silver bromide grain on exposure, violently throws off a part of its substance, rupturing the surrounding gelatine in its passage.

Mr. Renwick suggests that, in an emulsion, the silver bromide grains are wrapped round by a tangled meshwork of gelatine, and can only be attacked either through the extremely minute channels left, or by diffusion through the substance of the gelatine skeleton. Now, if Dr. Scheffer's observations be accepted, then in the neighbourhood of an exposed grain the densely tangled network is broken through, and channels of relatively large size, giving far readier access for the developer to the silve[illegible] grains, are formed.

In some respects this theory se[illegible] more satisfactory than any hitherto held. It has ge[illegible]en assumed that the commen[illegible]t of development depended upo[illegible] provision of a nucleus, upon w[illegible] the silver produced by the in[illegible]on of silver bromide with the [illegible]per could precipitate. This re[illegible] probable, but a difficulty was that, [illegible]is case, once fogging from an [illegible]posed developer had commenced, it should have proceeded at the normal rate. This does not seem to be the case; if measurements be taken of the increase of fog with time of development for an unexposed plate, it is found that the function obtained is similar to that given by an exposed plate, but with a much lower velocity constant.

This is accounted for at once if the exposed grains have literally become "exposed" to the attack of the developer, by blasting passages through their surrounding network.

This explosion theory is also valuable in that it enables one to give a meaning to the "ripening" of an emulsion. A "ripened" grain would be one which was in the most explosive state; that is, in which the crystallisation occurring during cooking had reached the limit of stable equilibrium, so that any further access of energy would result in its disintegration.

The theory is certainly fascinating in its possibilities, though it will have to face much criticism, especially from a consideration of the destruction of the latent image by oxidisers, and of the desensitising action of some metallic salts, when added to the emulsion.

From an Infra-red photograph [illegible] by C. E. Kenneth Mees.

FIGURE 2.

The Avenue Liberdad in Lisbon.

PHYSICS.

By W. D. EGGAR, M.A.

THE CAVENDISH LABORATORY.—On Saturday, November 12th, a large and distinguished company assembled at "the Cavendish" to do honour to Sir J. J. Thomson, whose twenty-five years of office as Professor of Experimental Physics have been signalized by the publication of the "History of the Cavendish Laboratory." The Vice-Chancellor presided, and Dr. Glazebrook, of the National Physical Laboratory, presented a specially bound copy to his old friend and former chief. Few institutions possess a more distinguished record than this Cambridge Laboratory, young as it is. James Clerk Maxwell was appointed as first professor to the newly constituted chair in 1871. The Laboratory, built under his directions, was opened in 1874. When Maxwell died, in 1879, Lord Rayleigh succeeded to the post, which he held until 1885. J. J. Thomson, then a very young man, was the third professor, and under him the Cavendish has, to quote Lord Rayleigh, assumed the first place among physical laboratories. Not only the professor's own researches, but the spirit with which he has animated the band of students who have thronged to him at Cambridge, have spread the fame of the laboratory throughout the civilized world.

SCIENCE AND ENGINEERING.—Sir J. J. Thomson, in a presidential address to the Junior Institution of Engineers, pointed out that the distinction between Physics and Engineering is one of aim, and not of method. It is the Engineer's business to turn to practical account the advances made by the Physicist. But the latter must by no means concern himself with utility. No man can foresee the significance of a new discovery; and it would be disastrous to the progress of Engineering if men of science were to confine their researches to matters of obvious utility. At the same time England is still behind Germany in the way in which new discoveries are seized upon and applied industrially. For example Professor Dewar invented a flask for holding liquid air. A form of this is now sold in large quantities as the "Thermos" flask, and used for keeping tea and other forms of refreshment hot (or cold). But none of these flasks are made in England. A well-known example of the German faith in pure scientific research exists in the Jena glass industry, which owes its foundation to the patient and thorough investigations of Abbé and Schott.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A.

HABITS OF THE WOMBAT.—J. A. Kershaw got two living wombats (*Phascolomys ursinus*) from Flinders Island in Bass Strait, and kept them alive in the National Museum, Melbourne. They took fresh grass and thistles readily, and allowed themselves to be handled. One of them had a young one in the pouch, which emerged in fifteen days. But it did not survive long. "In habits these animals remind one of the Rodents, their manner of feeding and quick side-to-side movement of the jaws being very similar. They are very quick in their movements when excited or alarmed, and run with greater speed than one would expect from such an apparently awkward animal. When touched, especially near the hind quarters, they have a peculiar habit of kicking violently backward with both hind feet. This, it was noticed, occurred even when approached by its companion. If annoyed, they do not hesitate to use both teeth and claws." A peculiarity not before noticed is their habit of closing their claws on the rough under surface of the paw so as to grasp pieces of grass and the like. They spent most of the day sleeping, partly buried in their bedding.

SPERMACETI ORGAN.—E. Danois has studied this curious organ in the whale, called *Kogia breviceps*, and finds that it closely resembles that of the cachalot. He finds corroboration of the view of Pouchet and Beauregard that the spermaceti organ is a dependence of the right nostril, and equivalent to a mucous gland in other toothed Cetaceans, such as the dolphin. If so, we have another illustration of a frequent evolutionary method—making an apparently new organ by a transformation of a very old one.

WASHING OYSTERS.—Fabre-Domergne has made an interesting series of observations at Concarneau, which should serve to justify scientific methods in the eyes of the world, for they concern the oyster. He has shown that oysters may be kept for eight days (or even for a fortnight) in filtered water, frequently changed, without losing any of their virtues, but gaining rather. The micro-organisms which are apt to linger in the mantle cavity, with deleterious results to the oyster-eater, can be thoroughly washed away by the filtered water, and the oysters do not lose in weight, nor in their power of "vital resistance," nor in "embonpoint." Their market value is unaffected, and we can swallow them with a lighter heart.

COLOUR SENSE OF HIVE-BEES.—John H. Lovell has made an experimental contribution to a much discussed question:—"Do Hive-bees distinguish colour as such?" The results of his experiments strongly support the conclusion that bees distinguish colours. They are more strongly influenced by a coloured slide than by one without colour, and when they get accustomed to visit a certain colour they tend to return to it habitually. They stick to their colours. But "this habit does not become obsessional."

ARE THERE BLACK CORALS IN THE NORTH SEA?—Messrs. Freeland, Fish Merchants, Aberdeen, recently presented to the Aberdeen University Museum a beautiful Antipatharian, or Black Coral, with two thick irregular branches over a yard in length, and with a basal diameter of nearly an inch! They got this from a trawler, which reported finding it some fifty miles off Aberdeen. Such records must be taken *cum grano salis*, for the sense of accuracy varies greatly in its degree of development, and mistakes may arise without any intention to play a trick on the innocent naturalist. Many of the trawlers make long voyages nowadays, a specimen may be passed from hand to hand, and invention may be called upon to supply what memory has lost. On the other hand, the specimen is rather an awkward one to carry about, and a secure record in 1908 of a large Antipatharian (*Parantipathes larix*) from the north-east of the Faeroes makes one more inclined to admit that the locality reported may be accurate. Unfortunately, the beautiful ebony black axis is polished from end to end, and there is not a trace of a spine, far less of a polyp! Secure specific identification is almost impossible.

COLOUR IN DEEP WATER.—Frederick Chapman has called attention to the occurrence of deeply coloured tests of the Foraminifer (*Polytrema miniaceum*), at a depth of five hundred and seven fathoms. The species inhabits relatively shallow water; the specimens from five hundred and seven fathoms showed the characteristic rose-pink colour. It may be recalled that one of the results of Sir John Murray's 1910 Expedition is to extend the light limit. Distinct traces of light were detected at five hundred fathoms.

REVIEWS.

ASTRONOMY.

The Romance of Modern Astronomy.—By Hector Macpherson, Junr. 334 pages. 39 illustrations and diagrams. $7\frac{3}{4}$-in. × $5\frac{1}{4}$-in.

(Seeley & Co. Price 5/-.)

This volume is one of the series published by this firm under the title of "The Library of Romance." We do not welcome works of romance in astronomy, preferring books dealing more with hard facts and less with romance and supposition, leaving such as these to be supplied by the readers. However, in the present instance, we do not find fault with the book, only with the title, for the author has written an entertaining book, and we like his way in which he records, in a pleasant and accurate manner, most of the great and well-known astronomical discoveries of the past four hundred years, as well as some of the Grecian discoveries. We would scarcely consider it as a text-book or book of reference for an observatory library, though a copy should be in all observatories; but few astronomers, and none of the general folks who love to read about astronomy, should fail to read, better still, acquire, this book. It is a book well suited for municipal and lending libraries, which mainly exist for exciting and stimulating a reader's interest in a subject.

The printing is clear and on light, thick non-surfaced paper; there are thirty-three chapters, and more than a dozen excellent plates, reproduced from photographs by Max Wolf, Puiseux, Janssen, and Lowell; there is also a good index.

B.

Ball's Popular Guide to the Heavens.—Third and Revised Edition. 96+xii. pages. 84 maps.

(George Philip & Son. Price 15/- net.)

We are glad to see this indispensable volume kept to the fore, by a third edition five years after the second edition.

In 1892 Sir Robert Ball, greatly aided by the present Radcliffe Observer (Dr. A. A. Rambaut), who formed two-thirds of the seventy-two plates, besides a large portion of the seventy-two pages of letter-press and index, wrote the first edition of this guide, then called *An Atlas of Astronomy*: that work consisted of seven chapters of text, which preceded the seventy-two plates. In the second and third editions a small number of these maps, chiefly of planets and comets, have been omitted or superseded by later work, and we find such names as Barnard, Ritchey, Hale, Campbell, Keeler, and so on, supplementing or replacing work by Common, Green, Roberts, Henry, Proctor, and others; astronomical progress demanded these changes. So that the changes result in a volume of eighty-four maps and ninety-six pages of letter-press in nine chapters.

The maps which were not included in the first edition, are chiefly those of the nebulae, comets, and sun. An important change, and an improvement upon the first edition, is in printing the maps of the tracks of the planets and the star maps upon a blue ground.

The maps are for the most part so excellently reproduced and cover the ground of astronomy so well that it is difficult to know where to find fault. But there are a few faults to which, in view of a fourth edition, we draw attention, as they have already been reprinted from the second edition. On page 13, Saturn's rings "are now (1903)." This is incorrect; the sentence required re-writing; page 17, a misprint for shadow-patch, also wrong in second edition; page 60 and other pages, deceased astronomers are sometimes referred to as "late," sometimes not; page 62, we think the number of stars in the Astrographic Survey Catalogues will be nearer four millions of stars than two millions, and the year (1903) is wrong. We also notice on page 54 that the maximum magnitude of Nova Geminorum is given as seven; it should be five, or even brighter, and an important omission occurs in the list of new stars, Janson's discovery in Cygnus in 1600; again on page 6, referring to Halley's comet, the author says "and its next return in 1910 will be awaited with very great interest." This was correct for the second edition of 1905; it is rather unfortunate that this should not have been corrected in the present edition, knowing that Halley's comet had come and gone five months ago, and that a frontispiece of this comet is given. Considering the many beautiful photographs of the comet which have been taken by Curtis (Lick Observatory), at the Cordoba and other favoured observatories, it is also to be regretted that this comet's beauty should be so depreciated and so unfavourably compared with the January comet by the drawing given. In future editions we would like to see reproduced the binary star information as in the first edition, but in a popular guide possibly that would be out of place; also a photograph of Halley's comet and some of Hale's beautiful solar work. The distribution of the text among the plates is a step in the right direction, and more appropriate to such works. May this volume reach many more editions and maintain its high character as a book which is needed in the observatory and in the astronomer's library.

F. A. B.

BOT[illegible]

A Text Book of Botany.—By [illegible] [illegible]son, M.A., B.Sc. Fifth Edition, Revised and E[illegible] 607+vii. pages. Illustrated. 7-in.

(W. B. Clive. Price

Although written specially to meet t[illegible] [illegible]irements of students reading for certain examination[illegible] work has decided merits, which have led to its being [illegible] [illegible]tensively by botanical students. As a handy and concise [illegible]pilation, published at a moderate price, it can be recommen[illegible] to all who wish for a single book to serve for reference, a[illegible] [illegible]ll as an introduction to more detailed works dealing wit[illegible] the different branches of the subject.

The present edition differs from its predecessors mainly in containing a large amount of matter which has been taken from the works of Professor Cavers, published by the same firm.

Plant Life in Alpine Switzerland.—By E. A. Newell Arber, M.A., F.L.S., F.G.S. 355 pages. 48 plates. 30 figures. $8\frac{1}{2}$-in. × 6-in.

(John Murray. Price 7/6 net.)

The wild flowers of the Alps, so numerous and so brightly coloured, cannot fail to attract the summer visitor. He gathers them, and finding them very different from the flowers of his own country, seeks to know their names. To aid him in this, there are a thousand books with gaudily coloured pictures, but should he desire to go a step further and find out something of the life histories of these flowers, and why they differ so markedly from the flowers with which he is familiar, there are very few popular books to which he can turn for guidance.

The volume now before us is in no way a flora, and very little is said as to the identification of the plants described. The introductory chapter deals with points in the structure of two of the best known of Alpine plants, the Alpenrose and the Edelweiss. Typical flowers of the meadows, pastures, rocks, marshes and forests are next discussed, and their special adaptations to the regions in which they are found, and to one another, are explained. The last chapter is given up to a discussion on the affinities and origin of the Alpine flora. A glossary of botanical terms, some notes on the structure of the flower and a bibliography form an appendix.

It has clearly been the object of the author to make the whole book abundantly intelligible, even to those without the slightest botanical knowledge, and in this he has succeeded well. If we must criticise we would almost suggest that in the first chapter the intelligence of the reader is perhaps a little insulted, that even too much water is added to the milk. The book is well illustrated by some excellent diagrams and there are some forty-eight plates, reproduced from photographs, some of which are exceedingly good. There was clearly a definite need for a book of this sort, and we feel that the present volume is admirably adapted to meet it.

GEOLOGY.

Smithsonian Miscellaneous Collections. Vol. 56. No. 5. *A Preliminary Study of Chemical Denudation.*—By F. W. Clarke, Chief Chemist, U.S. Geological Survey. 19 pages. No. 6. *The Age of the Earth.*—By G. F. Becker. 28 pages.

(Smithsonian Institution).

Dr. Clarke's paper is occupied with a revision of those geochemical data which are used in the discussion of some of the larger theoretical problems of geology. On the basis of the vast amount of material accumulated by the Hydrographical Department of the U.S. Geological Survey, a new estimate is made of the amount of matter carried down by North American rivers in solution to the sea. For the United States the revised *denudation factor* is seventy-nine metric tons of dissolved matter per square mile of drainage basin per year. Revised estimates are made as far as possible for South American, European African, and Asian rivers, but the data for most of these are still very defective. The composition of the matter thus carried to the ocean is discussed, and a special study is made of the factors used in Professor Joly's method of estimating the age of the ocean by means of the sodium content. Using Dr. Clarke's new figures, G. F. Becker attacks the problem of the age of the earth by Joly's well-known method. The chief new point introduced by Becker is that the increment of sodium in the sea during geological time has not been uniform but asymtotic. He conceives that the Archaean and massive igneous rocks which supply the great mass of the sodium originally occupied a far larger area, and were thus more exposed to denudation than they are now. Consequently the supply of sodium to the sea tends to suffer an asymtotic diminution with the lapse of time. With the new considerations and the revised data, the age of the ocean is now estimated at between 46·0 and 74·4 millions of years. The data for Lord Kelvin's method are similarly revised, and a final estimate of fifty-five to seventy millions of years for the age of the earth (starting from the *consistentior status*) is arrived at, limits not differing greatly from those found by Joly's method.

PHYSICS.

The Principles and Methods of Geometrical Optics.—By JAMES P. C. SOUTHALL. 626 pages. 170 illustrations. 9¾-in. × 6-in.

(Macmillan & Co. Price 25/- net.)

The Germans have taken possession of the great province of Applied Optics. The remarkable theoretical work of Petzval, Seidel, and Abbe, together with the systematic investigation, undertaken and carried through by Abbe and Schott, of the "optical properties of all known substances which undergo vitreous fusion and solidify in non-crystalline transparent masses," has led to the establishment of the Jena "Glastechnisches Laboratorium." Not only so, but until quite recently there has been no English treatise on Optics in which any reference to the later German theoretical work could be found. This book is a very successful attempt to supply the deficiency, and it is likely to be found indispensable as a book of reference. After a chapter on the fundamental laws of Optics, the characteristic properties of rays of light are considered, such as the principle of the shortest route, with an account of Sturm's theory of astigmatism. Then follow Reflexion and Refraction at plane surfaces, with a thorough discussion of prisms and prism-systems. After chapters on the reflexion and refraction of paraxial rays at spherical surfaces, comes a full account of Abbe's theory of Optical Imagery, by means of which it is possible to separate theoretical from mechanical impossibilities. The theory of Spherical Aberrations and Colour-phenomena also receive full treatment. A pleasing feature of the book is the fulness with which the history of Optics is treated. The author's affection for his subject is evident, and amid large arrays of determinants and pages of symbols the human element is never lost sight of. Full references to original sources are given, and in particular the author acknowledges his indebtedness to Czapski's great work. The book forms an excellent general introduction to the special theory of optical instruments, and another book dealing fully with the different types of instruments may possibly follow in time.

The Young Electrician.—By HAMMOND HALL. 306 pages. 93 illustrations. 8-in. × 4-in.

(Methuen & Co. Price 5/-.)

A thoroughly practical book and one from which, if a boy conscientiously worked (with a little sympathetic assistance) the series of experiments so subtly set forth in the succeeding pages, he would gain an excellent knowledge of the fascinating subject of electricity. Quite unlike the majority of "young" books it is practically written and yet is understandable by the uninitiated; and the final chapter, which deals with Wireless Telegraphy, leaves one like Oliver Twist.

One would suggest, just for boys' books, that the necessaries for the experiments and the construction of the models be tabulated, and the illustrations and diagrams should also be on the opposite page.

PHYSIOLOGY.

The Physiology and Hygiene of Sleep.—By DAVID FRASER HARRIS, M.D., C.M., F.R.S.E. 19 pages. 7-in. × 5-in.

(Cornish Bros. Price 3d.)

The Annual Public Lectures on "The Laws of Health" of the Midland Institute, Birmingham, are always interesting and instructive, and this year's lecture, delivered in September, 1910, and here reproduced in the form of a small booklet is certainly one of the best. Dr. Fraser Harris divides the causes that normally lead to and produce sleep into four classes:—The action of fatigue toxins from muscular and mental work; the diminution of the cerebral blood flow; the regular recurrence or, better, absence of sensations from the external world; and lastly the purely psychic causes, the absence of ideas, worries, emotions and the like. He gives us numerous examples of each of these types of sleep and shows how the opposite conditions may give rise to insomnia. Particularly would we agree with him, when he points out the general inconvenience that results from the action of those who go about our streets late at night, singing and shouting, and asks for legislation to stop this practice. Lastly, working along these same lines, some simple but excellent advice is given for the recall of "Sleep, O gentle Sleep, Nature's soft nurse!" by those who have lost her companionship. The booklet contains one of the best descriptions in popular language of the Physiology of Sleep that we have yet seen.

ZOOLOGY.

The Book of the Animal Kingdom.—By W. PERCIVAL WESTELL. 379 pages. 274 illustrations. 7-in. × 9-in.

(J. M. Dent & Co. Price 10/6 net.)

Mammals are not classified in this book on any systematic plan, for it is not intended to be a scientific treatise, but, as the writer hopes, will appeal not only to young folks in the homeland and in other places where English is spoken, but also to adults who have a general interest in the subject. The creatures, therefore, are grouped together according to their exceptional size, their means of protection, and their ways of obtaining their prey. The large number of photographic illustrations, by Mr. W. S. Berridge, adds greatly to the attractiveness of the book, and Mr. Westell has gone to some of the best authorities for information that is not within his own experience. We learn that if this book has the reception that it deserves it will be followed by another dealing with birds.

NOTICES.

THE SCIENTIST'S REFERENCE BOOK AND DIARY.—The present form of this useful annual consists of two books joined together but opening different ways. The first of these contains a diary with useful hints with regard to First Aid, and a Daily Wants dictionary, which gives much valuable information that is often required at a moment's notice. The other book consists of tables and various facts, under the headings of the different sciences, which are likely to be wanted by scientific people. A certain number of leaves are also left blank for memoranda.

Messrs. James Woolley, Sons and Company are to be congratulated on the publication. Some of the information with regard to the Scientific Societies is not quite up to date; for the Royal Anthropological Institute, the Zoölogical Society, and the Selborne Society, among others, have changed their addresses recently.

THE FACE OF THE SKY FOR JANUARY.

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

THE SUN.—On the 1st the Sun rises at 8.8 and sets at 3.59; on the 31st he rises at 7.43 and sets at 4.44. The Earth is nearest the Sun on the 3rd, when the Sun attains his maximum apparent diameter of 32′ 35″. Sunspots and faculae may usually be observed on the solar disc; of late the spots have been small. The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given below:—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc
Jan. 1	2 16′E	3 7′	204 30′
,, 6	0 11′W	3 41′	228 30′
,, 11	2 36′W	4 13′	162 49′
,, 21	7 18′W	5 11′	31 8′
,, 31	11 40′W	6 1′	259 28′
Feb. 5	13 41′W	6 20′	193 38′
,, 10	15 36′W	6 38′	127 48′

THE MOON:—

Date.		Phases.	H. M.
Jan. 8		First Quarter	6 20 a.m.
,, 14		Full Moon	10 20 p.m.
,, 22		Last Quarter	6 21 a.m.
,, 30	●	New Moon	9 15 a.m.
Feb. 6		First Quarter	3 28 p.m.
Jan. 13		Perigee ...	6 18 a.m.
,, 24		Apogee ..	7 42 p.m.

OCCULTATIONS.—The following are the principal occultations visible before midnight:—

Date.	Star's Name	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N point. E.	Mean Time.	Angle from N point. E.
			p.m.		p.m.	
Jan. 11	c^1 Tauri	4.2	6.11	76	7.17	237
,, 11	c^2 Tauri	5.4	6.43	62	7.52	255
,, 12	125 Tauri	5.1	10.21	107	11.27	241
Feb. 7	A^1 Tauri	4.5	5.26	8	6.4	304

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
Jan. 1 ...	19 53	S 20° 30′
,, 16 ...	18 52	19 31′
,, 31 ...	19 6	21 23′
Feb. 15 .	20 23	S 20 27′

Mercury is in Inferior Conjunction with the Sun on the 10th January and is thus unobservable for the greater part of the month. Towards the end of the month the planet is a morning star in Sagittarius, and rises on the [illegible] 28 a.m. or 1^h 16^m before the Sun. The planet is at gr[illegible]sterly elongation of 25° 17′ on February 2nd.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
Jan. 1	19 21	S 23° 11
,, 16	20 41	19° 45′
,, 31	21 50	14° 12′
Feb. 15	23 7	S 7 13′

Venus is an evening star in Capricorn, but practically unobservable throughout the month. On the 31st January the planet sets at 6.8 p.m. or 1^h 21^m after the Sun.

MARS:—

Date	Right Ascension.	Declination.
	h. m.	
Jan. 1	16 27	S 21° 43′
,, 16	17 12	23° 10
,, 31	17 59	23° 49′
Feb. 15	18 46	S 23° 35

Mars rises about 5.30 a.m. throughout the month, and is visible in the S.E. portion of the sky for a short time before sunrise. The diameter of the planet's disc is only 4″; thus, under present conditions, useful telescopic observations are practically impossible.

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
Jan. 1	14 30	S 13° 37′
,, 21	14 41	14° 24′
Feb. 10 .	14 48	S 14° 52′

Jupiter is a conspicuous object in the morning sky looking S.E.; he rises about 3 a.m. on the 1st January and at 1.20 a.m. on the 31st.

He is in quadrature on the 3rd February. The equatorial diameter of the planet is 34″, whilst the polar diameter is 2″·2 smaller. This polar flattening is readily observed in telescopes powerful enough to see the belts, but the satellites may be seen in small telescopes such as deer-stalkers of about 1¼ inches aperture, or even in a good pair of prismatic binoculars magnifying 8 times. The Moon appears near the planet on the 23rd.

SATURN:—

Date.	Right Ascension.	Declination.
	h. m.	
Jan. 1	1 54	N 9° 6′
,, 21 .	1 55	9° 12′
Feb. 10	1 59	N 9 49′

Saturn is due South on the 1st January at 7.13 p.m. and at 5.18 p.m. on the 31st. The planet appears as a bright star looking South and about 30° above the horizon; he is very conveniently situated for making telescopic observation, and with his rings he forms one of the finest sights in the sky.

The ring may be seen quite well in telescopes of about 1½ inches aperture with a magnifying power of 40, if the instrument is sufficiently steady and the object glass good; but larger telescopes are required to see the division in the ring and the belts on the disc. The planet is in quadrature on the 21st, and sets at 11.24 p.m. on the 31st.

As seen in the telescope the ring appears fairly open, since we are looking on the Southern surface at an angle of 16°. The apparent diameters of the outer major and minor axes of the ring are respectively 42″ and 12″, whilst the diameter of the ball is 17″.

The Moon appears near the planet on the 8th.

URANUS:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Jan. 1 ...	19 45 48	S 21° 43′ 40″
Feb. 1 ...	19 53 20	S 21° 24′ 3″

Uranus is in conjunction with the Sun on the 16th January; hence the planet will be unobservable throughout January and February.

NEPTUNE:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Jan. 1 ...	7 28 6	N 21° 15′ 5″
Feb. 1 ...	7 24 28	N 21° 23′ 1″

Neptune is in opposition to the Sun on the 11th, hence about this date he is on the meridian at midnight. The planet is situated in Gemini, about three and a half degrees South-East of the star δ Geminorum, but he is difficult to identify except in large telescopes. He may, however, be detected by his relative motion if successive observations are made at intervals of some days.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Name.
	h. m.		
Jan. 2-3 ...	XV. 20	+53	Quadrantids.
" 17 ...	XIX. 40	+53	θ Cygnids.

Minima of Algol occur on the 4th at 11.35 p.m., 7th at 8.24 p.m., 10th at 5.13 p.m., 27th at 10.7 p.m., and the 30th at 6.56 p.m. The period is $2^d\ 20^h\ 49^m$ from which data other minima may be calculated.

TELESCOPIC OBJECTS:—

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

CRAB NEBULA (M 1), in Taurus, situated about 1½° North-West of ζ Tauri, in R.A. $5^h\ 29^m$, Dec. 21° 58′ N.

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

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

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

ζ Orionis, triple, mags. 3, 6, and 10, separation 2″·5 and 56″; rather difficult in a three-inch telescope.

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

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

NOTICES.

YEAR BOOKS.—From Messrs. Adam and Charles Black we have received "Who's Who" for 1911 (price 10/- net). Apart from being indispensable to everyone who is doing any public or commercial work, "Who's Who" contains many facts of considerable interest and not a little humour, as those will find who take the trouble to dip into its concise biographies. From the same publishers comes the "Englishwoman's Year Book" (price 2/6 net), which this year has been divided into two parts, the first dealing with education, professions and social life, and the second with philanthropic work more particularly.

The "Writers' and Artists' Year Book" (price 1/- net), is chiefly of value to literary people and should be of particular use to those who are thinking of getting a living by their pen.

"The Year Book of Scientific and Learned Societies," published by Messrs. Charles Griffin & Company (price 7/6), has for more than a quarter of a century given the more important details with regard to all the scientific and learned societies in this country, and set forth the titles of every paper and lecture read or delivered before them during the year with the name of the author. The issue for 1910 is in every way equal to its predecessors and it is obvious that few scientific workers fail can to get some information or inspiration from a study of its contents.

Among other Year Books which we have received are "Whitaker's Almanack" (price 1/-; in cloth 2/6 net.), and "Whitaker's Peerage" (price 5/- net.), which present certain new features but which are more particularly useful on account of the old ones.

SCIENTIFIC INSTRUMENTS.—We have received from the Cambridge Scientific Instrument Company, two illustrated leaflets. The first deals with a large sliding microtome which is important from a scientific point of view as with it very large sections can be cut from material embedded in celloidin. In point of fact the maximum size is 150^{mm} by 120^{mm}, that is, the largest section will measure 6 × 4¾ inches; and in illustration of the capabilities of the instrument a figure is given of a complete section of a human leg six inches above the ankle, which was prepared and cut by the new microtome at the Anatomy School at Cambridge University.

The other piece of apparatus is an automatic temperature regulator which is specially valuable in its application to industries. In jam factories, for instance, the girls often badly scald their hands owing to the water used for washing jars becoming too hot. To take another case, the hot potash used by electro-platers can be kept at the most efficient temperature and prevented from boiling over. The thermostat, which does the regulating, is dependent upon the fact that a tube of brass expands with heat while a rod of nickel steel within does not appreciably change its length.

APPOINTMENT.—We are pleased to notice that Messrs. E. Dent and Company, Limited, of 61, Strand, and 4, Royal Exchange, have received a royal warrant, appointing them watch, clock, and chronometer makers to His Majesty King George the Fifth.

QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are printed [illegible] page.

QUESTIONS.

Numbers 14, 16, 17, 18, and 20 (Page 461) still remain unanswered.

21. ASTRONOMY AND GEOGRAPHY.—Will any fellow-teacher advise me as to good school experimental and observational courses in astronomy and geography?

BELLERBY LOWERISON.

22. RADIUM.—Seeing that Radium is not a stable substance, but is continually changing with other forms of matter, none of which are stable as far as we know, how is it that Radium is still found in the crust of the earth?

J. G. SPARKE (Lieut.-Colonel).

23. THE GULF STREAM.—A friend mentioned the Gulf Stream the other day, and I remarked that I understood that this was now considered to have no effect whatever on Britain. Will you briefly inform me, in "KNOWLEDGE," if I am correct, and what are the facts of the case: how far away is the nearest trace of this stream perceptible, and so on?

S. P. ROWLANDS.

24. DREAMS.—I should be pleased if some of your readers would give an explanation of the following common occurrence in dreams. Suppose one dreams of an impending railway collision. In the ordinary sequence of events, one dreams of the two trains approaching one another before the actual collision. Now it is a peculiar fact the collision is frequently emphasised in the world of reality by a door banging, or some such sudden noise. In fact, one might almost say that every real occurrence impressed on our senses during sleep fits in perfectly with the whole plan of the dream. In the example I have just cited one expects a noise at the moment of the collision, and it happens. If that particular door was not about to slam it is probable, in fact almost certain, that that dream would not have occurred.

Do you think this any evidence that the mind is often aware of the events of the future?

J. C.-W.

TIDES.—There is a point in connection with the tides of the ocean which I have never seen elucidated in any popular manner.

Tidal friction causes retardation in the rotation of the earth, and by the principle of conservation of the moment of momentum the revolution of the moon is accelerated. This is the basis of Darwin's theories of tidal evolution, and, of course, remains true whatever may be the lag of the tides behind the moon. The acceleration of the moon is sometimes further explained by a diagram illustrating that the nearer tidal protuberance exerts greater attraction on the moon than the one opposite, much as the precession of the equinoxes is always illustrated. Now the depth of our oceans being less than the critical depth of about fourteen miles, our tides are inverted, that is, high tide where low tide would be expected, and *vice-versa*: but if the depth were greater than fourteen miles the tides would be direct, and the nearer tidal protuberance should be behind instead of in front of the moon, and it seems to need popular explanation why a retardation of the lunar revolution does not result. The whole question of the lag of the tides on an ocean-covered earth might receive more notice in popular accounts, though probably too mathematical for full elucidation.

J. H. G.

REPLIES.

10. WATER AND ITS OWN LEVEL.—[illegible] a little perplexed myself about what G. G. B. has men[illegible] about water and its own level.

It is, I believe, one of the strongest arguments [illegible] flat earthists, and the flat earth idea is certainly wrong, s[illegible]re must be some explanation that will answer his query.

Is it that, taking for example a square mile of ocean, it is such a small area that the water certainly finds its own level within that radius, but taking the oceans themselves they must take the curvature of the earth, so in the one sense does the water find its own level, while in the wider sense we must also forget that the earth has a great power of attraction, and so the gravitation of the earth makes the oceans take the shape of the globe.

A. MERCER.

11. A BOOK ON WASPS.—In answer to Mr. Sandeman's enquiry for a book on wasps, I venture to recommend "Wild Bees: Wasps and Ants and other Stinging Insects," by Edward Saunders, F.R.S. It is a popular work of about one hundred and fifty pages, with four coloured plates, and other illustrations, published two years ago by Routledge. The price, I think, is 3s. 6d.

M. A. S.

13. THE FINDING OF THE TIME AT NIGHT.—The time may be found at night approximately by means of the accompanying adjustable dial; this may be used either by direct comparison, or studied until it can be retained in the memory sufficiently for comparison with observation.

Polaris and β Ursae minoris.

1 Jan.	1 July	VIII	1 Apr.	1 Oct.	II
1 Feb.	1 Aug.	VI	1 May	1 Nov.	XII
1 Mar.	1 Sept.	IIII	1 Jun.	1 Dec.	X

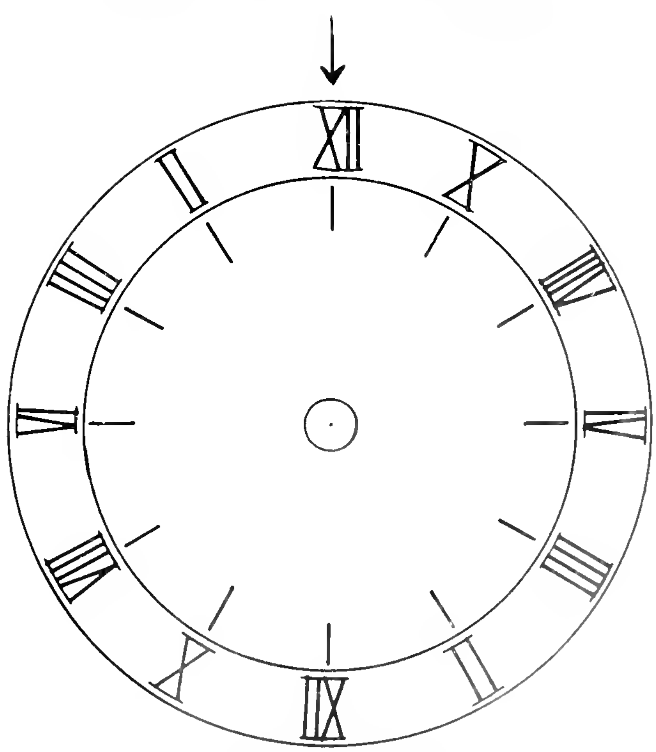


FIGURE 1. The Dial.

The moveable circle is adjusted in accordance with the little table. The number given for the 1st of the month is brought opposite the pointer, which represents the top of the imaginary celestial dial at the Pole. The circle is then moved on, counter clockwise, through the fraction of the next two-hour interval which corresponds to the fraction of the month elapsed.

In direct comparison the dial is held up with its back towards the Pole, with the pointer at the top. The line joining Polaris and β Ursae Minoris is compared with it; and an imaginary line is drawn across the centre of the dial parallel to that line. This imaginary line shows the time according to the hours marked on the dial.

If it is desired to study the method so as to be able to work without the dial, the student may keep the dial by him, adjusting it every few days. He should study the dial, the adjustment of which changes slowly, and remember it, so as to be able to work without it at night; using it, if necessary, for verification. The changes run through a year, sometimes the one star and sometimes the other being uppermost. After a year's practice the changes should be sufficiently engraved on the memory to admit of finding the time roughly without the direct use of the dial. But the scheme is a little complicated; and it will be convenient to have the dial at hand to refresh the memory.

The principle is not difficult. All star phenomena occur about four minutes earlier for every day that passes. This arises from there being one more sidereal day in the year than the number of solar days. The resulting change of twenty-four hours is distributed over the year in a manner strictly proportional to mean time. Thus, if the months were of exactly equal length, the change in each month would be exactly two hours. As it is, a small irregularity arises from the varying lengths of the months, which may be neglected for our purpose.

It is desirable to take stars always visible. We take the Pole-star and β Ursae Minoris. The latter is the nearer to the Pole of the two conspicuous stars β and γ Ursae Minoris, which lie near together at distances of about sixteen degrees and eighteen degrees from the Pole respectively.

The times indicated by the line joining any two stars near the Pole can be determined by a single accurate observation. This observation should be made when the line is either vertical or horizontal, or preferably, observation should be made in both positions. In other positions the observation is much less certain. In the present case the observations were made a day or two before and after 1st December, 1910, when the vertical position occurred at ten o'clock, and the horizontal at four. This determines the table of adjustments.

In estimating angles it is sometimes of use to note that the stars β and γ Ursae Minoris subtend just half an hour at the Pole; and we may take it that the angle at Polaris is sensibly the same.

In one of Hardy's novels (I think "Far from the Madding Crowd") the shepherd is said to be able to tell the time from the stars. I have often speculated whether this is possible for an uneducated man. It appears to be possible, though improbable, given the outdoor habit at night, a clear head, and either a good memory, or a habit of making notes.

Any observant person much out at night must notice that the star phenomena change their times, being earlier every night. Also he might notice that they recur after a year. The deduction of the two hours change per month seems to present the greatest difficulty from this point of view, though it is quite simple when explained. Then, one good observation only is required to determine the time by any line joining two stars near the Pole. But it would want a clear head to keep the changing scheme of the hours always in view.

The same moveable disc would do for any pair of stars near the Pole, the setting table only being determined by observation.

This method is not susceptible of considerable accuracy. It is a recognised principle in naked eye astronomy that the roughest measurement is better than the best eye estimate. Here there also appears to come into play, for positions intermediate between the vertical and horizontal, one of those illusions which depend on the structure of the eye. I myself see the bisector according to time between the horizontal and vertical positions decidedly nearer the vertical than the horizontal. This is in the sky, not in the dial, which subtends a comparatively small angle at the eye. The resulting error may be either fast or slow, according to the position. I believe it depends on the fact that, in a figure subtending a considerable angle at the eye, the eye estimates vertical distances on a larger scale than horizontal ones. This may arise from the retina being slightly flatter vertically than horizontally. If one is able to estimate the amount of this error for one's own eye, one may allow for it roughly. The vertical and horizontal positions admit of fairly accurate observation.

R. H. M. B.

ECLIPSES.—The two following questions have not been numbered, as they are here answered.

Does a total eclipse of the sun occur, on an average, ten times in one hundred years—of course, astronomically?

A total eclipse of the sun may occur on the earth more than once in a year. From the year 1851 forty total eclipses have occurred, but may have not been observed (astronomically) owing to inaccessibility (near the poles), to being only visible at sea, or to cloud interference. Total eclipses of the sun occur in cycles, the path of total phase gradually moving southward or northward over the earth's surface and taking over one hundred years to return to a similar point; and a cycle of about fifty-four years, which may be divided into three periods of eighteen years, the area of total phase moving east to west; so that every fifty-four years the eclipse is at the same longitude, though gradually moving to greater or less latitude, according to the other cycle movement.

Was a total eclipse of the sun visible at Greenwich in the year 1900?

No total phase was visible at Greenwich in 1900; no total eclipse had been visible in Great Britain for about one hundred-and-fifty years; there will be a momentary one about 1927, and again in 1999, and possibly for a second or so in one or two other years this century.

NOTICES.

X-RAYS.—The Sanitas Electrical Company, of 61 New Cavendish Street, W., have sent us a booklet containing a large number of testimonials from workers in X-rays and electro-therapeutics, as well as physicists, upon the results obtained with their apparatus, including "Sanax" X-ray Outfits, Intensified Induction Coils, and the Motor Mercury Interrupter; as well as their "Multostat" Universal Apparatus. In addition to illustrations of the apparatus, reproductions of two remarkably fine radiographs are given.

EXPOSURE RECORD.—"The Wellcome Photographic Exposure Record and Diary for 1911" has also reached us. It contains a great many hints for the benefit of photographers, in addition to a neatly arranged series of tables in which the owner may record all the details with regard to his exposures. There is, besides a diary, an exposure calculator and several interesting illustrations, including the reproduction of a colour photograph developed with tabloid photographic chemicals. The price is one shilling.

NOTE.—The motion round the Pole looking N. appears counter clockwise. Looking S. the motions seen appear clockwise.

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, 1911.

APPARATUS FOR PHOTOGRAPHING NATURAL HISTORY OBJECTS.

By W. FOTHERINGHAM.

COLLECT, examine and record, is probably a good summary of the work of the average Nature student.

He has not gone far in his work when he finds that to properly examine all he collects he requires a microscope, and that to record his finds in the easiest and most truthful way, he must have a camera. Now the enthusiast will soon find himself in difficulties about apparatus, especially apparatus for recording his facts, either for future comparison or for the benefit of others. What ought to be a pleasure, the making of an interesting, perhaps pretty, picture of his facts, is, owing to faulty apparatus, a disagreeable task, costly in time and uncertain in results. So for every ten who are skilled in the first two parts of the work there is probably not one in the third. To carry out this programme let us see what is needed. Supposing the collecting and examining be "taken as read," he requires:—

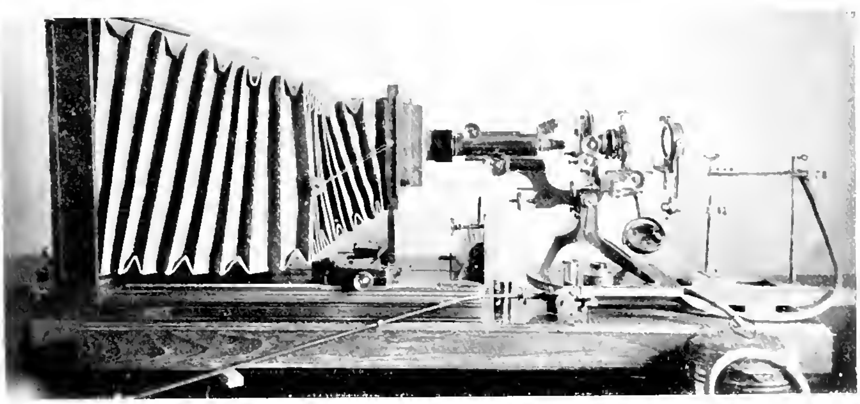


FIGURE 1.

A 15 × 12 Photomicrographic Camera.

With wooden optical bench, Watson "Van Heurck" microscope, Nelson Condenser, and acetylene jet on sliding wooden feet, permitting right angle centring adjustments.

(1) A Field Camera. If this is of the "hand or stand" type, it will "cover a multitude" of things.

With it he may, with some circumlocution, even take at home, with pains, indifferently good pictures of "birds, beasts and reptiles."

Ultimately he will probably get a bigger camera on legs, that behave themselves better on a floor than do those of the ordinary field tripod.

Even then he will be annoyed to find that he cannot take a picture of many things, in spite of much pinning-out and arranging on board or wall, and that such things as eggs have an ugly shadow round them, while fragile dissections are out of the question, as is any preparation floating in fluid. He will probably long for a vertical arrangement that will enable objects to be

FIGURE 2.

The Camera used for enlarging or reducing.

With improvised condenser and jet on optical bench. Also a supplementary board, on which objects may be pinned out when the apparatus is used as ordinary or copying camera.

laid beneath the camera, and yet be properly illuminated either by transmitted or incident light.

(2) To get photographs of minute objects through the microscope, he probably has the usual horizontal photomicrographic camera, and nothing can be better for mounted objects: but the biologist, as distinct from the photographer, wants to preserve the record of objects as they appear when fresh, and not formalined or dehydrated and beautifully "squashed" on neat slides.

So here also he wants a vertical apparatus to take such objects as cannot be pinned up.

(3) To complete his work he probably also has an enlarger, and an arrangement for making lantern slides.

Now, with a full knowledge of practically all that is offered by both English and Continental makers, I am yet of opinion that there is no handy apparatus that will do all this, and that the various equipments now on the market, although vastly improved within the past five years, are still unsatisfactory.

Most of them are too small and incomplete, being without stability, adaptability, and rigidity, and without optical bench, which means *sans* everything that is essential.

Writing some time ago to the maker of a new photomicrographic camera, I pointed out that this camera failed to meet my needs and gave details of objects I wanted to photograph. He replied: "We prefer to use separate apparatus for such work."

Exactly! So have I in days past: and the result has been: two ordinary cameras, two photomicrographic cameras, a bulky enlarging and reducing camera, and a host of fakes and fitments in the shape of easels, backgrounds, glass platforms, and so on—a lot of dusty, unready apparatus that lumbers one's working space and would require one's whole time to keep in order.

How often after a clean up have I said: "I wish they could all be rolled into one" and one day—happy thought!—I said, "I will roll them all into one," and almost literally did so.

FIGURE 3.

Camera raised to vertical position on hinges.
It is secured by two T bolts with Bausch and Lomb "Y" dissecting microscope, Nelson condenser and jet.

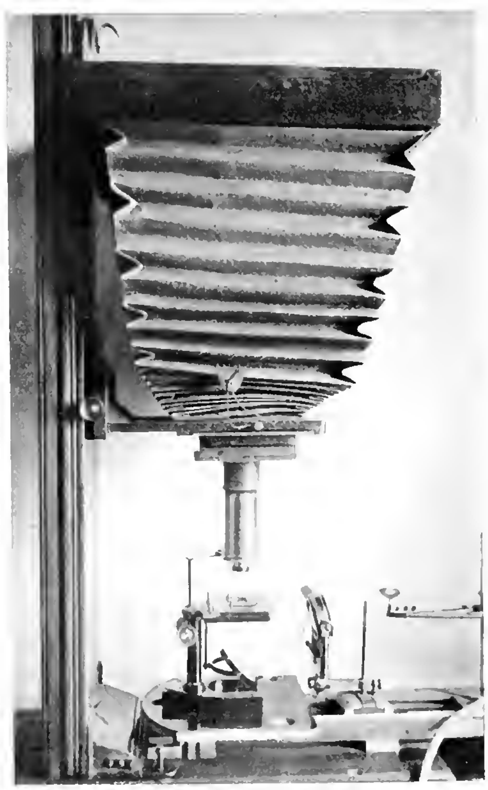


FIGURE 4. Camera.

With sliding glass platform on which is glass tank. An optical bench support with large sheet of ground glass, prevents reflections from the water.

The result is a camera, suited for practically every need of the biologist, more easy of manipulation, and withal a lot cheaper than anything I can find elsewhere.

Being composed mostly of parts of other apparatus, as I am no tradesman, it may appear a bulky collection of odds and ends, but it is at least as compact as any other one photomicrographic camera, and more useful than any other two, covering with great ease an enormous range of work.

The idea, however roughly carried out, is sound, for both English and Continental makers have been groping their way to this type for some years.

Unquestionably this type is the apparatus of the future in all but the largest laboratories, where space and expense do not require consideration.

In Figure 1, it is shown as the usual horizontal photomicrographic camera, having four feet of bellows extension, capable of the highest power work.

Without the microscope, but with a sliding easel in the wooden runners (an improvised optical bench), it makes a splendid 15×12 copying camera.

In Figure 4, it is shown as a vertical photomicrographic camera. An ordinary dissecting microscope stand, with a wide tube fitted to the arm, will be found to make an excellent substitute for the costly big microscope, especially when large wet objects are being dealt with. A Dunning's live cell is a very useful adjunct for such work, and a mess of water round the stage will do the stand no harm.

Figure 3, shows the camera as a purely vertical camera, plus a sliding glass platform on the same upright as the camera, upon which even such contrary things as eggs may be laid, a morsel of "Plasticine" on the underside preventing rolling.

Or a glass tank may be set on the transparent platform, and here the apparatus is invaluable—difficult and fragile objects may be displayed in water, any suitable background can be put in below, or various tints easily tried, without disturbing the object.

Further, a fish or other object can be hardened in formalin in a lifelike attitude, or simply spread out in water. A background of weeds, sand, shells, and so on, can be arranged on an opal glass below, the object being raised up or down from the background on the sliding platform, till the correct effect and the absence of shadows has been obtained, and the subject photographed in apparently natural surroundings, with striking results.

To prevent reflections from water and wet preparations, a ground glass screen can easily be adjusted on the optical bench, as shown, or coloured glass to get orthochromatic effects without screens in front of the lens.

If need be, a condenser can be made to play a beam of light on the object, with no more trouble than adjusting [illegible] on the optical bench.

Figure 2 shows the apparatus being used as an enlarging and reducing camera, which can be used with or without artificial light.

The essential features of this apparatus are :—

1. A camera, sliding easily in a central groove, and giving about four feet of extension, with suitable fittings, as indicated.

2. An optical bench, with fittings, [illegible] of sliding platform for microscope, condenser, [illegible] and troughs or screens, also sliding fittings capable of taking a glass or board easel : all being centred [illegible] the bench.

This last is vital : to have all parts in alignment and centring adjustments to keep them so, is the secret of success. A camera of this type without an optical bench as a permanent fixture is only half finished, and will infallibly lead to waste of both time and plates.

In my opinion such a camera complete need not cost more than ten pounds, and could be made so as to secure some measure of portability.

JAMES WILLIAM TUTT, F.E.S.

ON January 10th, there passed away the well-known entomologist, Mr. Jas. William Tutt, who for the past twenty years has been the editor of the *Entomologist's Record and Journal of Variation*, and who, for many years, has been a regular attendant at, and participant in the work of several of our London Societies. He was a native of Strood, Kent, where he became a pupil-teacher, and from whence he passed to St. Mark's College for Schoolmasters. He entered the service of the London School Board, and having been promoted time after time, was last year selected to open one of the first of the new Central Higher Grade Schools, which are now being established by the London Education Authority. The study of insects was his hobby, and in spite of the onerous burden of his educational duties, his ability, capacity for work, and his forceful character, brought his writings many an eulogistic recognition, not only from all parts of the United Kingdom, but from many Continental circles as well as from America. At the time of his death he was President-elect of the great Entomological Society of London. For some years past he had been the editor of the annual organ of the South-Eastern Union of Scientific Societies. His earlier writings were more of a popular nature than his later work, and we may mention those admirable descriptions of country rambles, "Random Recollections of Woodland, Fen and Hill," and "Woodside, Burnside, Hillside, and Marsh." For the past fifteen years Mr. Tutt had spent his holidays in the Alps, and his enthusiastic nature pictures in "Rambles in Alpine Valleys," and in many articles written by him in the *Record*, have led numbers of our insular workers, including the present writer, to extend their narrow experiences and views, by investigating the insect fauna of numerous beautiful regions outside the routes of the ordinary superficial tourist. "The British Noctuae and their Varieties" was a book giving an intimation of the more serious work of which Mr. Tutt was capable. This was succeeded by "The Migration and Dispersal of Insects," "The Natural History of British Butterflies," and so on, works requiring much research and leading up to the commencement of a huge encyclopaedic work, which was of so ambitious a nature that one individual could only have imagined himself, even with long life permitted him, able to write but a small instalment. This was the "Natural History of British Lepidoptera" of which he issued eight volumes, and was at the time of his death engaged upon two more. Mr. Tutt had attracted around him an enthusiastic band of co-workers, Continental as well as British, and the original work done by these gentlemen, his own work and criticism, with a huge amount of all the best done in the past, he welded together with a master hand and had illustrated by the best men, acting under his skilful advice and supervision. The study of Entomology, by his death, has lost a huge force, and it will be long ere another can step in to fill his place.

HENRY TURNER.

THE SUN SPOT GROUPS OF 1906.

A SPECIAL interest attached to the Sun Spot groups of 1906, because in that year sun spot activity or prevalence was hypothetically at the end of the thirty-five year cycle which has been assigned to it, and should have reached its last maximum. Activity on the solar surface was much less in the early part of that year than in the corresponding period of the previous year. The last phase of the maximum spot period seems to have begun in the earlier half of 1906. A comparative calm prevailed till May 12th, when a great outburst of solar activity occurred. At the end of July two large spots appeared, both of which became visible to the naked eye during August. The larger of the two spots developed a great deal during its passage across the Sun's disc. When first seen on July 28th it appeared as quite a small spot and in the course of its transit had grown to ten degrees in length and six degrees in breadth. A period of calm followed, which was broken by a stream of spots lasting through November till the middle of December. In the next year, the maximum appeared to have been passed.

Dr. C. L. Poor, as the result of his discussion on the figure of the Sun, derived partly from a study of the solar photographs of the Rutherford series extending over several years, and also from the heliometer measures made by the German Transit of Venus Expeditions, concluded that the ratio of the polar to the equatorial diameter of the Sun was a variable quantity, and had relation to the presence or absence of solar spots. This is a conclusion which has since been disputed, but is one of the more interesting speculations with regard to the periodicity of sun-spot areas. Schur and Ambronn did not support Dr. Poor's inferences ; and Dr. C. G. Abbott's recently published memoirs on the Sun, while favouring variations of solar radiation and brightness, does not relate them to variation in the Sun's figure.

Royal Observatory, Greenwich.

Sun Spot Group. August, 1906. 3d. 17h. 10m. Greenwich Civil Time. Enlarged two diameters.
Diameter of Sun's image 5 feet.

(See page 13).

SIR FRANCIS GALTON, D.Sc., F.R.S.

Sir Francis Galton, D.Sc., F.R.S., who closed a long life of many and useful activities on Tuesday, January 17th, after a very brief illness, was born on February 16th, 1822. He came of a long-lived family, a fact on which it does not seem superfluous to dwell, seeing how great a stress Sir Francis Galton laid on parentage and family in determining the characteristics of the individual. To his kindred and ancestry he attributed not merely his physical and mental attributes, but his predilections and his length of years. A reference to his work on "Noteworthy Families," which was compiled chiefly by reference to the Fellows of the Royal Society, discloses that on one side he sprang from the Galtons and the Barclays, and on the other from the Darwins. Among the Barclays was that Captain Barclay who astonished the early Victorian world by walking a thousand miles in a thousand hours, and it was to this strain that Sir Francis was accustomed to refer his own unusual power of enduring physical fatigue without harmful results. His longevity he attributed to the Darwins, and some of his mental powers must have been inherited from the same fount; but his paternal grandfather was a scientific man as well as a good man of business, and the Barclays, apart from the peripatetic Captain, were bankers. It was, however, to the commingling of ancestors that he owed, as he observed in his Reminiscences, a considerable taste for science, for statistics, and for poetry.

His education was not less composite than the qualities which were bequeathed to him by his progenitors. His mother would have had him become a physician like his grandfather, Dr. Erasmus Darwin. But he developed a mathematical gift and, after a boyhood spent at two French schools and one English grammar school, he went up to Cambridge as a mathematical aspirant. His fine health failed him there, however, and after a severe illness he left the University with nothing better than a pass degree. He used to say in after years that when he found himself one day elected to an Honorary Fellowship of Trinity College, he was so surprised that he thought it was a mistake. After Cambridge he walked the London hospitals, but here again he failed to find his vocation, and the death of his father found him with his career in life still undetermined. So, having private means, he went, like many another in the same case, on his travels. But his "wanderjahre" was prolonged. It comprised the Soudan as far as Khartoum—in the pre-Khalifa days—Syria and Palestine, all viewed under conditions very different from those of to-day. But his travels were actually his first passport to the world of scientific research, for in 1854 the Royal Geographical Society awarded him its medal for his explorations of Damaraland and Namaqualand.

But before that his marriage (in 1853) had settled him in England; and he began to interest himself specially in meteorology. He was associated with that Royal Observatory at Kew which is now a landmark for golfers; and among the important and permanent measures which arose from the association were the standardising of sextants and other angular measuring instruments, the verification of thermometers, the Kew rating of watches. Under Dr. Francis Galton the old Kew Observatory became the first English Reichsanstalt: the primitive ancestor of the National Physical Laboratory at Bushey. He did lasting work in meteorology while at Kew, and the term "anti-cyclone" as descriptive of a weather type which lately has overhung the larger part of Western Europe, was of his coining. The counter-clockwise movement of winds in cyclones had been appreciated and understood before his time, but the movements of the complementary atmospheric systems had received hardly any notice or explanation.

It is, however, Galton's work in heredity which seems now to have been his most important contribution to science. Heredity had always interested him; and his researches may be said to have been based on Gauss's theorem. Gauss supposed all variability to be due to different and equally probable combinations of a variety of causes. Galton desired to test this theorem by the light of those characteristics of human kind which are measurable. He therefore set up, in 1884, an Anthropometric Laboratory, in which were measured the more obvious characteristics, such as height, weight, span of arms, and so on, as well as the less obvious ones of keenness of sight, colour sense, lung capacity, reaction time, personal equation in various aspects. By examination of data thus derived he hoped to find what influence parentage had on the physical attributes of offspring—and for a generation he preached the multiplication and usefulness of such laboratories. It was while examining the Bertillon system of anthropometry that Galton developed another measurement of idiosyncrasy—the finger print—though in his Reminiscences he is careful to say that Sir William Herschel in India had experimented with finger prints as a method of identification since 1887; he gave priority of method to Mr. Henry Faulds, who is still living. As a necessary corollary, if indeed it may not be more properly described as the fount and well-spring of his work in anthropometry, arose his investigations in that science of "Eugenics," to which he gave its name; and which is the science (of right breeding) that aims at the discovery in man of those qualities which are desirable for his survival and progression. One may say in summation of his theoretic position, that he was a disciple of Weissmann rather than of Hering or of Butler; and that he was tempted to reduce the conditions of inheritance to a mathematical formula, as Pearson and the geometricians seek to do, and to suppose that each ancestor contributes a share to the individual proportional to the distances of relationship.

CORRESPONDENCE.

POLAR PH[illegible]ENA.

To the Editor [illegible]KNOWLEDGE."

SIR[illegible]—"Anxious" as[illegible] [illegible]tion with reference to the per[illegible] of slow motion [illegible] Sun in the Arctic Regions. Perhaps the following [illegible]ation may throw some light on the problem.

Let QQ^1 be the cel[illegible] equator, and EE^1 the Ecliptic, the angle ω of inclinati[illegible]ng 23° 28′ approximately. Let S^1 represent the sun wh[illegible]lose to E^1, the Solstitial Point, and S the sun when in th[illegible]er.

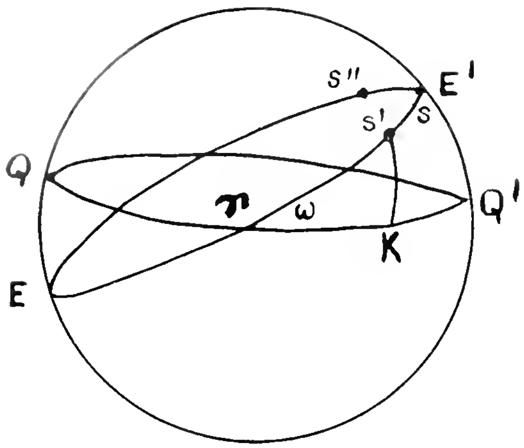


FIGURE 1.

Let δ be the declination at S^1, and $\delta+\Delta$ the declination at S, where Δ is very small. Let the arc S^1S be χ. (For the present we ignore the latitude of the place.) See Figure I.

Now, the problem is to find the value of the arc S^1S, and from this the number of days corresponding. Consider the spherical triangle $E^1Q^1\Upsilon$ sin E^1Q^1 = sin ω sin ΥE^1, or (1) sin $(\delta+\Delta)=\sin\omega$, since ΥE^1 is 90°. Similarly, from the spherical triangle $S^1K\Upsilon$ sin S^1K = sin $S^1\Upsilon$ sin ω. Now S^1K is δ the declination, and $S^1\Upsilon$ is $90-\chi$

$$\therefore \sin\delta=\sin(90-\chi)\sin\omega$$
$$\text{or } \sin\delta=\sin\omega\cos\chi. \quad (2)$$

Subtract (2) from (1), and we have

$$\sin(\delta+\Delta)-\sin\delta=\sin\omega\,(1-\cos\chi)$$
$$\text{or } \sin\delta\,(\cos\Delta-1)+\cos\delta\sin\Delta=\sin\omega\,(1-\cos\chi)$$

Now Δ is very small, and $\delta=\omega$ approximately

$\therefore \cos\Delta=1$, and $(\cos\Delta-1)$ may be neglected in the above equation,

$$\therefore \cos\omega\sin\Delta=\sin\omega\,(1-\cos\chi)$$
$$\text{or } 1-\cos\chi=\sin\Delta\cot\omega.$$
$$\cos\chi=1-\sin\Delta\cot\omega. \quad (3)$$

Now, let us suppose that Δ does not vary by more than one-fifth the Sun's diameter, say 6′. Such a small variation in the Sun's declination would practically give him the appearance of being stationary. Substitute in (3), 6′ for Δ

$$\cos\chi=1-\sin 6'\cot 23°\,28'=1-{\cdot}001746\times$$
$$2{\cdot}303={\cdot}9959 \quad \therefore \chi=5°\,10'.$$

Hence S^1S is an arc of 5° 10′. As the sun will attain the same declination after passing through the Solstitial Point at S^{11} where $SS^{11}=SS^1=5°\,10'$, the actual arc traversed by the Sun, while his declination changes by 6′ is 10° 20′. Reckoning approximately 1° per day for his motion in the Ecliptic, the number of days during which the declination varies by 6′ is about $10\frac{1}{2}$.

Now, suppose we allow Δ to vary by 10′, or about one-third the Sun's diameter.

In this case

$$\cos\chi=1-\sin 10'\cot 23°\,28'$$
$$=1-{\cdot}002909\times 2{\cdot}303$$
$$={\cdot}9933005$$
$$\therefore \chi=6°\,38',\ 2\chi=13°\,16'$$

and time is about 13 days.

Let Δ vary by 20′: then

$$\cos\chi=1-\sin 20'\cot 23°\,28'$$
$$=1-{\cdot}00582\times 2{\cdot}303={\cdot}986596$$
$$\chi=9°\,24'\ 2\chi=18°\,48'$$

and the time is about 19 days.

Let us now assume a latitude of $86\frac{1}{2}$ say.

In Figure II Z is the Zenith, P the pole, HR the horizon for latitude $86\frac{1}{2}$: the arc ZP is then $90-86\frac{1}{2}=3\frac{1}{2}°$. At the vernal equinox, the Sun, being in the equator, will describe the arc QQ^1, but when the declination is $3\frac{1}{2}$, he will not set, but at midnight will just graze the horizon. After this he will

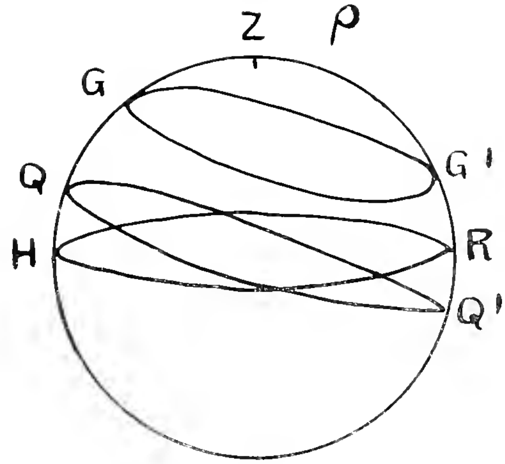


FIGURE 2.

continue to rise each day higher above the horizon, and at the Solstice his path during the 24 hours is the small circle GG^1. The time he appears to stand still is evidently the same for any latitude, for the changes in declination are in no way affected by the latitude of the place. Thus, though he does not set when describing the small circle GG^1, his declination is slowly changing at the rate of about 6′ for $10\frac{1}{2}$ days, or 20′ for 19 days. This causes his diurnal path to suffer very little perceptible change during this period, and at a latitude where he rises and sets he will appear to do so almost at the same point of the horizon each day.

(REV.) M. DAVIDSON, B.Sc., B.A.

ASTRONOMICAL APPOINTMENTS.

To the Editors of "KNOWLEDGE."

SIRS,—I read Mr. F. A. Bellamy's letter with great interest, and many of us must agree with the justness of his remarks.

As a perfectly independent person I have often thought that they manage astronomical appointments much better in America, and that this accounts for the splendid work accomplished there in late years. I believe the Americans allow proved merit to guide their selections in some degree, and thus their great telescopes can be utilized by the best observers. If Barnard, Burnham, Brooks, Swift and others had worked in England they would have had to content themselves with such appliances as their own private means could provide. But in America their abilities were recognised, and they were placed in positions where observational skill and powerful instruments could be employed in combination. This was, it is true, owing to the beneficence of Lick, Yerkes, Warner and others, and it is, perhaps, curious that we very seldom read of such benefactions in our own country. In America it is not unusual to hear of liberal bequests on behalf of astronomy, but in England large sums are rarely, if ever, devoted to such a purpose. They are applied to building public libraries, benevolent institutions, laying-out parks, or some such purpose.

When British millionaires fittingly recognise the claims of our sublime science, and apportion some of their wealth in furtherance of its progress, then our countrymen will be in a position to effect more rapid advances. The most capable observers should be given the use of the largest instruments, so that, from their work in unison with able mathematicians, valuable results would naturally accrue. It is not often that a good mathematician is a master-hand at observation. By mere examination in figures and eye-sight it is not always possible to discover astronomical geniuses, or the men best qualified for astronomical observatories. Those should be selected who have previously exhibited abilities of a high order, and have gained experience necessary for the best work.

W. F. DENNING.

SPECTROSCOPIC DOUBLE STARS.

To the Editors of "KNOWLEDGE."

SIRS.—In your November number a correspondent inquires about the determination of orbits of spectroscopic double stars. To elucidate this fully in popular language is not easy, but I think the principle involved can be made clear. To take the simplest particular case, and considering one component of the binary system only, if during the period of one complete revolution the four intervals between the moments of maximum positive and negative velocities and the two zero velocities in the line of sight be all equal, a little consideration will show that the orbit must be circular, and the two maximum velocities, positive and negative, will be equal. In this particular case the data being insufficient to give a value for the inclination of the orbit to the line of sight, the linear dimensions of this orbit, which would vary inversely as the cosine of this angle of inclination, and hence also the masses of the stars, cannot be determined. In general the four intervals are all unequal, and the two maximum velocities are also unequal, and from a knowledge of these quantities and the known law of variation of the velocity in elliptic orbits, it becomes possible to calculate the inclination of the plane of the orbit to the line of sight, and thence the dimensions of the orbit and the total mass involved. It may make clearer the conditions involved if it is noted that at the moments of successive zero velocities in the line of sight the star is necessarily at opposite extremities of some diameter of its elliptic orbit, but at the moments of successive maximum velocities in the line of sight this is not so, but the positions are shifted to points in the orbit where the absolute velocities are greater, that is, to points nearer to the focus in which the centre of gravity of the system lies, and it is in effect these shiftings (which depend in amount on absolute velocities in the orbit), which make possible a solution of the problem. The case of a circular orbit considered above illustrates this, for since the absolute velocity in the orbit is constant, the positions in the orbit which give the maximum velocities in the line of sight are not shifted, and the problem is indeterminate. Practically in any case the solution depends on the determination of six quantities, the four intervals and two maximum velocities. To determine these with the greatest accuracy numerous observations at successive intervals of time are necessary. Needless to say, the measurements are of the utmost delicacy, and the proper combination of them makes a problem of great complexity. So far, only one component of the binary system has been considered. In all cases the orbits of the two stars are similar ellipses with a common focus, and in the same plane, but with their major axes oppositely directed, and if each component gives a measurable spectrum, the orbits and masses of both become completely known, but if one is a dark body or too faint, it is only possible to determine the orbit of the brighter component and the sum of the two masses. In cases of variables of the Algol type, the variation of the light during the partial eclipses gives further data from which some idea of the volumes of the stars can be obtained.

The degree of attainable accuracy varies very greatly in different cases; the most favourable conditions are when the orbits are much elongated, the period short, and the inclination of the plane of the orbits to the [illegible] sight small. I believe that in the majority of well-obse[illegible] the elongation of the orbits is considerable, and this [illegible] gest an origin for these systems very different from tha[illegible] lar system.

J. H. G.

THE INCLINE[illegible]POSITION OF THE [illegible]ARENT VERTICAL [illegible]RIDIANS OF THE [illegible]

To the Edit[illegible] of "KNOWLEDGE."

SIRS.—In answer to the c[illegible]nication entitled "[illegible] Images" in the December num[illegible] of "KNOWLEDG[illegible] p. 476, the facts are as stated. The whole subject of bin[illegible] vision is treated in the most thorough manner by Helm[illegible]ltz in the "Physiologische Optik": Leipzig, 1867. The chapter on binocular double vision begins at page 695; but I should recommend the student to consult first the historical *résumé* at page 702. The discussion of the vertical meridians begins at page 703; a number of measurements are given, and the inclination of the apparent verticals is deduced at about 2½° for normal eyes (705). Perhaps the most important suggestion is on page 715. I must premise that by the word "horopter" is meant the locus of points seen with both eyes as single points. The general form of the horopter is complex, and is the subject of abstruse mathematical investigation; but, in the particular case of a man standing or walking, looking straight before him, the horopter reduces to a plane, which practically coincides with the ground, as seen in this position. The distance of this plane from the eyes is governed by the convergence of the apparent verticals; and the point in which they intersect is the point of the horopter which lies near the feet. Helmholtz then suggests that the necessity, which exists in walking, of having clear vision of the ground where the foot is to be set, may be the origin of the convergence, and thus of the inclination of the apparent verticals.

The word "horopter" is derived apparently from the Greek words, ὅρος, a line, boundary, land mark; and ὀπτήρ, a seer, one who sees. The meaning does not obviously follow; but Helmholtz clearly means by it, "the assemblage or locus of points seen as single." The word was originated by Aguillonius, who used it to denote a plane, on which he supposed everything seen to be projected.

The subject is of great extent and great interest. There may, probably, be more modern developments, and there should certainly be some English book on the subject; but I do not know of any.

R. H. M. B.

THE MOON AND THE WEATHER.

To the Editors of "KNOWLEDGE."

SIRS.—You were good enough to insert in your September number a letter of mine on "The Moon and the Weather."

This year I have watched again, and carefully, and send you the readings below, taken 6 a.m. and 1 p.m.:—

Dec.	1	33—40	
,,	2	38—38	
,,	3	31—39	
,,	4	28—30	1½" snow
,,	5	32—40	
,,	6	32—38	Snow, sleet, mist
,,	7	32—39	Bright sunshine
,,	8	40—42	Warm rain cleared off snow from fields
,,	9	38—42	S.W. wind
,,	10	34—38	N.E. to S.W.
,,	11	26—40	N.E. to S.W.
,,	12	40—47	S.W.
,,	13	36—42	N.E. to S.W.
,,	14	33—42	N.E. to S.W. Fog on the river
,,	15	29—37	N.E. to S.W. Fog higher up

Dec.		38—38	...	S.W. Fog higher
..	1	.. 34—40	...	S.W. Fog on of mountains
..		... 34—36		Ditto
	19	... 34—3[illegible]	..	and N.E. to S.W. No mists
	20	... 28—		Ditto
..	21	... 31—		Ditto
.,	22	... 31	.	Snow from S.E. falling on foot hills

You will see fro[illegible] [illegible]ve that the high tides of December may have somethin[illegible] [illegible]o with weather here.

While writing [illegible] [illegible]ask. Are there what are known as half tides anywhere e[illegible] on Pacific Coast—what are known as a long run in and [illegible]hort run out and a short run in and a long run out?

GEO. DITCHAM.

THE ETERNAL RETURN.

To the Editors of "KNOWLEDGE."

SIRS,—In a book by Mr. J. M. Kennedy, on the German philosopher Nietzche, the following theory is promulgated by the latter, the data being derived from the work of the great French astronomer La Place; and it appears that the same theory was evolved independently by Blanqui, the famous agitator, also Dr. Gustave Le Bon, and Heine, the German poet, and is said to be found in Ancient Greek Philosophy. I will endeavour to express it as succinctly as possible.

"Time and space are infinite, but the sum total of the forces in the Universe appears to be constant and determined. It is impossible to conceive their diminution or increase. There is therefore a sum of constant and determined forces not infinte. If these forces could ever attain a position of balance it would have already happened, as an infinity of time has passed, and the world would be for ever immobile, as it cannot be conceived that once attained such a state could alter. The sum total of these forces will bring about in infinite time a vast number of combinations, and produce some that have already been realised, and therefore the entire series of combinations that have existed. Universal evolution brings about the same phases, and travels round in an immense circle for all eternity, from which it follows that every identical individual has already lived the same life an infinite number of times and will continue to do so for ever." Dr. Le Bon expresses it thus: "If it is the same elements of each world which serve after its destruction to create a new one, it is easy to understand that the same combinations, viz., the same worlds inhabited by the same beings, may be repeated time after time, the possible combinations being limited and time unlimited."

I write to ask is there any flaw in this reasoning, and if so what is it? This theory seems to me to pre-suppose that every world is destroyed by collision with another before being renewed, but as space is infinite it is difficult to understand why a dead world may not continue to travel for ever without coming in contact with another. What ground is there for thinking that the sum total of the forces in the Universe is constant and determined? In an infinity of space one would suppose that these forces must pervade infinite space, as absolutely vacant space seems unthinkable. What is the opinion of scientists on the subject?

H. D. BARCLAY.

PODURA SCALES.

To the Editors of "KNOWLEDGE."

SIRS,—In reply to Mr. T. E. Smith's correspondence it is quite evident he has "blundered greatly."

It is not sufficient that his 1·4 objective, with cedar oil to the cover glass, be connected with the scale, in what Mr. Smith believes to be optical contact, to obtain an aperture of 1·4, but that the cone of light which impinges upon the scale shall also have as large an angle. Now this is impossible with scales simply mounted in air; the way Mr. Smith has his mounted (what other medium does he suggest is between the cover glass and the slip?) even supposing the scale really was in actual contact with the cover all over—he will understand I cannot possibly agree that this is so under the circumstances appertaining—beneath the scale and above the glass slip is—what? Air? Now, even if using an oil immersion condenser of 1·4 made homogeneous with cedar oil to the slip, so soon as the cone of light had passed through this, into the air space—however small—down would drop the aperture to 1·0, as air cannot possibly convey a greater angle than this between two parallel surfaces.

This fact is used as the standard or starting point of refractive indices, and known as the "normal of air." If, again, he had the scale mounted dry between two cover glasses, as he says, truly this would make "confusion worse confounded"; in the first place it would simply throw his condenser out of correction, as they are all corrected for a certain thickness of slip, and should he have used a dry condenser he would have had two layers of air instead of one for the light to pass through. It is quite evident he has forgotten one of the principles of microscopic vision, and that is, it is not the actual object he sees when looking through the eyepiece, but simply an image of that object formed some distance up the tube of the microscope, and given an incident air angle of 1·0 upon an object it would not matter if an objective of 2·40 were immersed upon it—the resolving power would be no greater than 1·0. Again, if, when looking down the tube he thought he was getting 1·40 N.A., and which I have shown could not possibly be more than 1·0, he *further* closed this aperture until only three quarters of that opening was visible, he was actually getting much nearer ·75 than 1·40, an aperture not so great as a good dry quarter inch objective would have given him as regards resolving power. The cover glass idea might also be shown to be fallacious from the very fact that such a small stratum of air intervenes, apart from condenser uncorrections.

There is an axiom also which seems so often neglected, that the visibility of very minute structure is proportional to the difference between the refractive index of the object and the medium in which it is immersed,—which I particularly tried to emphasize in my previous letter—and that it is essential if the whole aperture of an objective is to be utilized to mount such minute structures in some medium other than air. As this has never been done successfully (so far as I am aware) with the Podura Scale he will be able to realize what I mean when I say that "here, then, we make no advance upon the very earliest methods." Until such a medium is found and the scale successfully mounted, we are left with the only alternative in contrast between the 1·0 of air and the 1·5 of the scale itself, a practicability of vision of ·5 only. It may be —I cannot say—that with vertical illumination a slightly greater angle than 1·0 might be obtained, but that, it seems to me, would only help us with surface structure chiefly, and as this runs one into the province of the optician's art, I cannot venture to trespass.

I have not yet heard of a dry objective which can give an aperture of 1·0, and Mr. Smith's explanation of the "tilted light to the object" in the microscope and the "moon it is that revolves" are really too abstruse for me.

In conclusion, I must apologise for my photographs being too small for good reproduction, but if Mr. Smith would allow the Editor to forward me his address, I should be pleased to send him an actual enlargement of them, which would allow him a much clearer view, I feel sure, than he can have at present of their purport. I am obliged for his open remarks and candid reply, and would like respectfully to suggest this little experiment for him to make: take a slide, say, of Pleurosigma or Amphipleura, mounted in Realgar, and using his 1·40 objective immersed upon it, also a good condenser of 1·40 immersed to the under slide of slip. Now when the object is in focus and the light axial, take out the eyepiece and measure the diameter of light coming through the objective—then, take away this slide and substitute the slide of Podura, mounted dry on cover of the glass slip, using the same immersion objective and condenser, and when in focus upon the object, again take out the eyepiece and remeasure the diameter of light coming through. I think when he has thoroughly mastered this apparent elasticity of his 1·40 objective, he will have made [illegible] progress in the study of aperture, and, I trust, pardon [illegible] the suggestion.

You[illegible]

I. W. PLASKITT.

QUERIES AND ANSWE[illegible]

Readers are invited to send in Questions and to answer the Queries whic[illegible] printed on th[illegible]

QUESTIONS.

Numbers 16, 17 and 18 (December number, page 461), and 21 (January number, page 39) still remain unanswered.

26. LUNAR ECLIPSE.—What, for parallel red rays, is the *minimum* length of focus of the Earth and its atmosphere, regarded as a centrally-stopped lens?

ISIS.

27. MINOR PLANETS.—Excluding the Berlin Year-Book as being rather too expensive, is there any yearly publication which gives the ephemerides of the first score or two of the brighter Minor Planets, or of any of them whatsoever beyond the first four? Mention of the price and place where procurable would oblige.

ISIS.

REPLIES.

10. WATER AND ITS OWN LEVEL.—In Mr Mercer's reply (page 39) the word *not* in the concluding phrase was omitted; it should have read: "While in the wider sense we must also "not" forget that the earth has a great power of attraction, and so the gravitation of the earth makes the oceans take the shape of the globe."

10. If a level surface is defined as a mathematically plane surface then, except in imagination, no such thing exists in nature, and "water finds its own level" is neither true nor false, but simply meaningless, no definite level surface existing from which to measure. The curvature of a puddle is exactly the same as that of a still ocean, and if by level is meant the imaginary plane which touches the surface of the water at a given point, the statement that water finds its own level is false, but it is very approximately true for distances which are very small compared with the radius of the earth, and it is in this restricted sense that it is used.

J. H. G.

20. THE DISTANCE OF THE SUN.—I think it may be asserted categorically that no reward ever has been, or ever will be, offered for the discovery of a more accurate method of determining the sun's distance. Offers of reward are not likely to elicit new methods in abstract science.

This distance is probably known with an error of about one part in two thousand, that is, about two feet and a few inches in the mile, and if anyone discovered a new method which would reduce this error by even so much as six inches, I imagine the corrected distance would have but faint interest for any scientific man, it would be the one thing in the discovery of little moment, since it would certainly shortly be further corrected. The discovery of the novel method itself is quite another matter, and might well be of the greatest importance being almost certainly capable of application in many directions; as to the discoverer, he would probably feel the discovery itself sufficient reward. The Edisons and Marconis of the world are usually made of stuff that knows how to find its own reward, and no one grudges it them; the world has need of such; but the gifted discoverers of new methods in science look for their reward in a different direction, and I fancy are generally fairly satisfied with what they get, though it may not have been so at all stages of the world's history. It is always dan[illegible] [illegible] prophesy, but seems hardly likely that any really novel [illegible] will be discovered. What is certain is that the use and development of the already known methods will contin[illegible] reduce remaining error, and not improbably the next few ye[illegible] may see even more than the six inches mentioned above wiped out.

J. H. G.

22. RADIUM.—It is now accepted that radium is a disintegration product of the element uranium (at. wgt.—239). In minerals, the ratio of radium to uranium exhibits a constancy, as the former element has had time to reach its equilibrium amount. This ratio appears to be about $3{\cdot}8 \times 10^{-7}$ gram per gram of uranium. Owing to the comparatively feeble activity of uranium, its period (*i.e.* time of half-transformation) is enormously long,—about 5×10^9 years, and certain products intervene between it and radium, viz: Ur. X and ionium. Uranium, therefore, passes into radium through intermediate stages, and so long as these disintegration products remain associated with the uranium in the mineral, radium and all *its* disintegration products are maintained in their equilibrium amounts, while all *non*-active products gradually increase. In this way the α particles (atoms of the gas helium, (at. wgt.—4.), become occluded in radioactive minerals, and this occluded helium increases in quantity with time. The theoretical rate of evolution of helium can be estimated with fair accuracy, and by comparison of the calculated annual evolution of helium per gram of the mineral with the actual amount found occluded in it, an estimate of the age of any active mineral can be made. The method may not be entirely free from uncertainty, but there can be little doubt of the general correctness of the values found, which amount in some cases to hundreds of millions of years.

As to the origin of uranium itself, it is hardly possible to speculate. As no element of higher atomic weight is known, we cannot assume it to be a disintegration product. The same question as to origin might be asked of any element,—we have always the problem of the evolution of the elements before us.

CHARLES W. RAFFETY.

23. THE GULF STREAM.—It is thought now, by many of those who have studied the subject, that the influence of the Gulf Stream on the climate of the British Isles is by no means so great as was formerly believed to be the case. Owing to investigations made in the North Atlantic ocean, and examinations of samples of sea water taken by the "Challenger" and "Michael Sars" Expeditions, it is found that the Arctic Current which flows past the coast of Labrador cuts into the tropical water brought north by the Gulf Stream off Newfoundland, and considerably modifies the temperature.

The question as to how much of the actual current from the Gulf of Mexico crosses the Atlantic is a complex question, and requires further investigation, for it is found to vary at different times.

The climate of the British Isles is largely affected by the eastward drifts from the North Atlantic, which consist of heated waters from the Equatorial regions, and these flow north-eastwards as a warm surface current into the Arctic Seas.

F. ROSS THOMSON, F.R.G.S.

24. DREA[illegible] I am convinc[illegible] t[illegible]nty years of experience, t[illegible] scientific posi[illegible] r[illegible]spect to dreams is, that they [illegible] have an *objec[illegible]* [illegible] well as a subjective origin. J. [illegible] W. rightly says [illegible] *ts and it happens*": we hear c[illegible]ng upon our slee[illegible] n. "Here is the Queen of Hea[illegible] and we wake [illegible] full moon beaming into our f[illegible]: the sensation [illegible] l between the sleeping and the [illegible]king is as a cen[illegible] ncentric curtain shutting. S[illegible] are common to th[illegible] njoy or suffer from a cosmic t[illegible]pathy; an intellig[illegible] ed as within and without, and [illegible]nich communicates [illegible] clairaudient, often to his dismay and terror. Interp[illegible] hould be guarded: the phenomena are certainly *not* [illegible] subjective. We know this is the case by such exp[illegible] of a *sensed expectation becoming a realisation* [illegible]g as the lower notes of a gamut, of which the hi[illegible]s are an inter-communication of brain to brain as [illegible]s a telephone, and which is known to theosoph[illegible] others. The most scientific book on dreams is by Dr. [illegible]te-di-Sanctis, "I Sogni," but his first edition in not recognising the *objective* possibility of dreams, is, like the great classic books on psychology and mental pathology, deprived of half its value. To those who know first-hand telepathic phenomena, there are no secrets which can be hidden, and the demonstration of a disembodied intelligence is ever sensed and accepted by them as an elementary natural phenomenon, not of necessity spiritual, but a form of radiant energy, and to which a few may possess the key—even human beings.

J. B. S.

25. TIDES.—J. H. G. has made some slip in his question, when he says that with *deep* oceans the tidal protuberance should be behind the moon with *direct* Tides. I think that, perhaps, if he re-reads pages 240–242 of Darwin's Tides he will see that he is mis-stating the facts. He is unquestionably right in saying that the whole subject might, with advantage, receive more notice in popular accounts. I may refer him to "Chapters in Astronomy," by Claudius Kennedy.

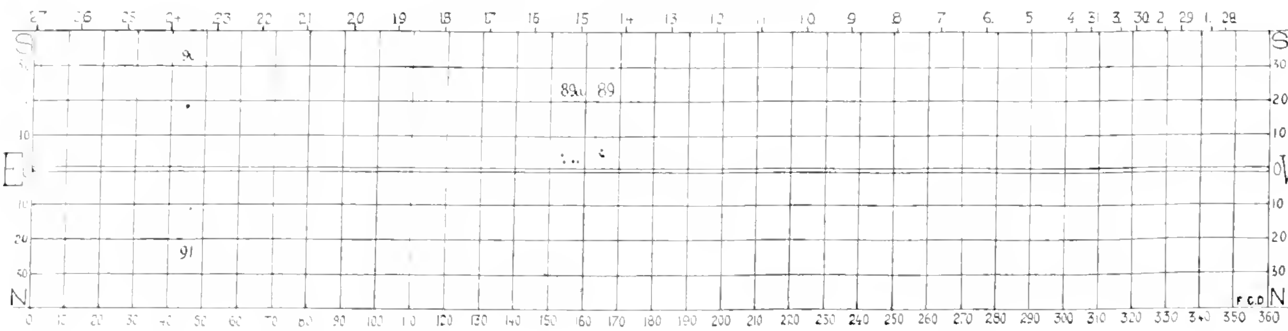
J. A. HARDCASTLE.

SOLAR DISTURBANCES DURING DECEMBER, 1910.

By FRANK C. DENNETT.

DECEMBER has been marked by a still further decrease in solar disturbance. On six days out of the twenty-three on which it was found possible to observe, no spots, maculae or faculae, were visible, and on six others only faculae were noted. At noon on December the 1st, the longitude of the central meridian was 342° 52′.

DAY OF DECEMBER.



No. 89.—A group of three larger pores with smaller points close up, seen on the 11th; after slight changes it had dwindled to a poorly-seen marking, on the 15th, when last observed.

No. 89*a*.—A triangular group of spotlets, from the 11–13th; the rear spots were not seen after, but pores had developed in front of the preceding one on the 14–16th, but it was not seen after. The length of the group was 30,000 miles.

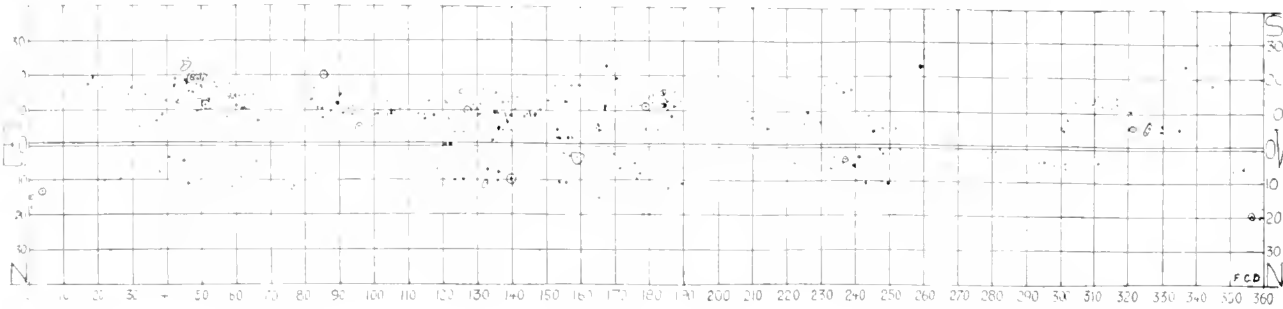
No. 90.—A small spot had come round the eastern limb and dwindled away from the 18th until the 22nd, when last seen. A faculic disturbance was observed in the same area on the 29th, which may possibly have contained a pore.

No. 91.—A pore amid a small faculic disturbance, only recorded on the 28th.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and F. C. Dennett.

The second chart shows the distribution of the dark spots upon the entire surface of the sun during the whole year. Ninety-one primary and thirty-one secondary outbreaks, of which eighty-nine were in the southern, and thirty-three in the northern hemisphere. It will be noted that certain areas appear to be far more subject to disturbance than do others.

DISTRIBUTION OF SPOT DISTURBANCES DURING 1910.



BRITISH EARTHQUAKES.

By CHARLES DAVISON, Sc.D., F.

EARTHQUAKES, according to their nature and origin, may be divided into three classes—simple, twin and complex. In simple earthquakes the shock seldom exceeds a few seconds in duration, and its intensity increases to a maximum and then dies away. In twin earthquakes the shock consists of two distinct parts, separated by an interval of rest and quiet, lasting, as a rule, for two or three seconds, each part resembling a simple shock in nature and duration. Complex earthquakes are usually of considerable duration and great violence. They may last as long as three or four minutes, and there are many fluctuations of intensity and frequent changes of direction. Corresponding to this difference in nature there is also a diversity in origin. In simple earthquakes the focus consists of a single region, near the centre of which the initial impulse is greater than elsewhere. In twin earthquakes there are two such regions, almost or completely detached from one another. In complex earthquakes the focus consists of many portions, which may or may not be directly connected, and the violence of the shock is due partly, as in simple and twin earthquakes, to the friction of sliding rock-surfaces, partly to the rapid translation of the rock-masses themselves. In other words, the movement which gives rise to the shock is not as a rule permanently perceptible at the surface in simple and twin earthquakes, while in complex earthquakes it often remains manifest in the form of fault-scarps and horizontal displacements.

Whatever may have been the case in times past, this country is now, fortunately, exempt from all earthquakes of the complex order. Occasionally, about once in ten years, a shock causes damage to houses within a limited area, but the houses affected are usually of an inferior class. The great majority of our earthquakes are so slight that they would have passed unnoticed if they had not occurred during the hours devoted to rest and sleep.

FREQUENCY.

During the last twenty-one years (1889–1909), in which the greater part of my spare time has been devoted to the study of British earthquakes, the total number known to me is 250, or almost exactly one a month. The number of disturbances described as earthquakes in newspapers is of course considerably larger, but many of these disturbances prove on investigation to be artificial or partly artificial in their origin. Many of them are caused by the firing of heavy guns at a distance, their true character being generally revealed by the explosive nature of the sound, the apparent transmission of the waves through the air and not through the ground, and by the increasing confidence with which observers in one direction attribute the shock and sound to gun-firing. Others are due to the explosion of meteorites: a few, and their spurious origin is soon detected, to the explosion of dynamite or powder magazines. An interesting class of local shocks is found to be confined to mining districts. They are often of considerable intensity within a very small area, but are imperceptible at a distance of a few miles from its centre. They may sometimes be caused by the fall of masses of rock from the roof of the workings, but most of them appear to be caused by slips of the superincumbent strata along a fault-surface, the slips being started by the withdrawal of rock from the workings or by that of water in pumping. During the last twenty-one years not less than seventeen local shocks are probably due to this cause.

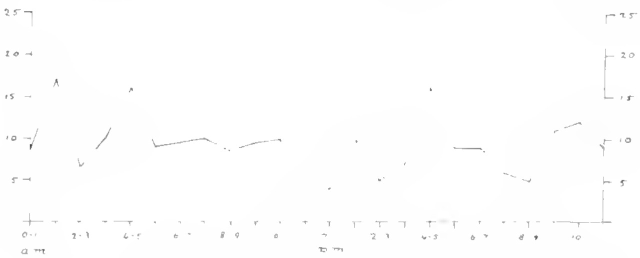


FIGURE 1. A curve shewing the number of shocks felt in this country at different hours.

Now, just as many slight shocks are wrongly confused with earthquakes and must be eliminated as far as possible from our earthquake-catalogues, so a large number may also escape detection, or, at any rate, record. They may be attributed to artificial operations, such as blasting, gun-firing, thunder, or the passing of a distant train or vehicle. There is other evidence than mere probable supposition. The curve in Figure 1 illustrates the number of shocks felt in this country during the different hours of the day. It shows that they are recorded more frequently during certain hours, and especially from 1 to 2 a.m., 4 to 5 a.m., 4 to 5 p.m., and 9 to 11 p.m. But the varying frequency is, in all probability, more apparent than real. All earthquake-catalogues founded on personal, and not instrumental, records, show the same increase of frequency late in the evening and in the early hours of the morning. It is no doubt due to more favourable conditions of observati[illegible] the streets [illegible], observers are generally [illegible]ng down, a[illegible] they awake, as persons [illegible]en do betwee[illegible] 2 a.m., they are in a nervous condition, the[illegible] are alert and ready to de[illegible] the slightest [illegible]nt. The increase in [illegible]uency from 4 [illegible]n. seems to be due to [illegible]ilar condition[illegible] the sixteen earthquakes recorded during [illegible]our, seven occurred on a Sunday aftern[illegible] others possibly in the restful interval devo[illegible] an early tea. Now, as shocks recorded ins[illegible]tally show a tendency to greatest frequency [illegible]ocal noon at any place, it follows that th[illegible] shocks, which are only perceptible under [illegible]onditions alluded to above, must be muc[illegible]re numerous tha[illegible]n catalogues would le[illegible] us to suspect. We s[illegible]ll probably not be [illegible]ver-estimating their number if we consider that twenty earthquakes occur in this country on an average every year.

PERIODICITY.

Whether there be any real variation of frequency throughout the day must for the present remain uncertain in the case of British earthquakes. For this purpose the only records of any value are those which are registered by properly erected instruments, isolated completely from all artificial disturbances. Personal observations are, however, sufficient to determine whether any annual variation exists in the frequency of earthquakes, for there is no reason for supposing the conditions of observation to be sensibly better at one time of the year than another. In Figure 2, the continuous line represents the numbers of earthquakes recorded during the different months, account, of course, being taken of their varying lengths. The curve, it will be seen, is irregular, the monthly number of shocks being greatest in September and December. The actual frequency of earthquakes may, however, be due to different causes, which may be themselves subject to variations of different periods,—just as, when a chord is played on any instrument, the movement of a particle of air in its neighbourhood is compounded of several movements, each with a different period corresponding to those of the notes that are struck. To separate out the different periods which produce the actual variation in frequency, some method of harmonic analysis must be employed, and, as great accuracy is not essential, the method of overlapping means will be be found sufficient for the purpose. The method consists in finding consecutive six-monthly means of the monthly numbers of earthquakes. Thus, the mean of the numbers for the months from November to April inclusive, corresponds to the middle of that interval, that is, to the end of January; the mean of those for December to May corresponds to the end of February, and so on. In this way the broken line in Figure 2 is obtained. The effect of taking six-monthly means is to smooth the curve by eliminating or reducing periods of six months and less. The broken line therefore, represents with sufficient accuracy the annual variation in frequency of British earthquakes. The maximum of the annual period, it will be noticed, falls in October, that is, in the middle of two months when the actual frequency is less than in the two months of September and December on either side. A similar method may be used for determining whether a six-monthly period exists, but the resulting variation is not pronounced enough for us to feel convinced of the reality of a period of this length. All that we can regard as proved is that there is a marked annual periodicity, and that its maximum occurs in October and its minimum in April.

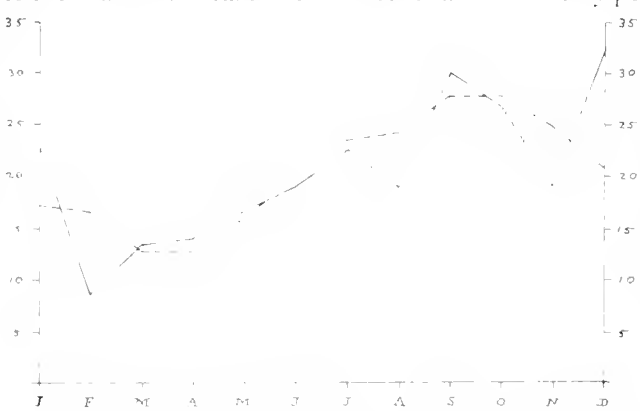


FIGURE 2. A curve representing the number of shocks recorded in this country during different months of the year.

INTENSITY.

The intensity of an earthquake is generally denoted by its greatest intensity within the central region of the disturbed area. For this purpose an arbitrary scale is used, known as the Rossi-Forel scale. In this there are ten degrees, the two lowest and the two highest being inapplicable to the earthquakes here considered. The remaining degrees are as follows, only one test being given under each heading: the shock being strong enough:

Intensity

- 3 for the direction or duration to be sensible;
- 4 to make doors, windows, and so on, rattle;
- 5 to cause the observer's seat to be perceptibly raised or moved;
- 6 to make chandeliers, pictures, and so on, swing;
- 7 to overthrow ornaments, vases, and so on;
- 8 to throw down chimneys or crack the walls of some houses.

Of the two hundred and fifty earthquakes, three were of intensity 8, nine of intensity 7, seven of intensity 6, twenty-nine of intensity 5, sixty-four of intensity 4, one hundred and twenty-seven of intensity 3 or about 3, while the remaining eleven were merely sounds without any tremor being felt.

As a rule, of course, the area disturbed by an earthquake increases with its intensity, the average disturbed area of an earthquake of intensity three being one hundred and twenty-six square miles, and of one of intensity eight about sixty-six thousand square miles. Earthquakes of the same degree of intensity are, however, felt over widely differing areas. For instance, for the intensity seven, the disturbed area may be as low as one thousand square miles and as high as sixty-three thousand six hundred square miles: for the intensity six, the area ranges from seventy-four to three thousand one hundred square miles; and so on. Thus, actual intensity near the centre cannot be regarded as a measure of an earthquake's strength. Nor, on the other hand, as some seismologists maintain, can the extent of the disturbed area be employed as such a measure, for this area depends on several conditions, of which one of the most important is the time of occurrence. For instance, the Pembroke earthquake of 1892 was felt over forty-four thousand eight hundred and sixty square miles, and the distinctly weaker shock of 1893 over sixty-three thousand six hundred square miles, the reason being that the former movement occurred at 0.24 a.m. and the latter at 5.45 p.m. In like manner the disturbed areas of the Derby earthquakes of 1903 and 1904 were twelve thousand and twenty-five thousand square miles, the former occurring at 1.30 p.m. and the latter, which was somewhat weaker, at 3.21 on a Sunday afternoon. In each case the disturbed area of the earlier shock was bounded by a line of intensity four, and of the latter by one of intensity three. On the whole, if area is to be used at all as a measure of strength, it would seem better to employ the area within a given isoseismal line, or line of equal intensity, say that corresponding to intensity four. For British earthquakes it is convenient to regard as *strong* all those in which this area exceeds five thousand square miles, as *moderate* all those in which it lies between one thousand and five thousand square miles, and as *slight* all those in which it is less than one thousand square miles. Making use of this convention it would appear, then, that during the twenty-one years considered there have been in this country nine strong, seven moderate, and two hundred and twenty three slight earthquakes, and eleven earth-sounds.

Distribution.

There is very little approach to uniformity in the distribution of British earthquakes. Some parts of the country are frequently visited, others only rarely, or not at all. Thus, of the total number, fifty originated in England, twenty-seven in Wales, and one hundred and seventy-three in Scotland. In the latter country certain limited districts are subject to numerous shocks. Thus, in the low-lying country between the Ochil Hills and the Firth of Forth eighty-three shocks were felt, several of them of intensities six and seven; in Glen Garry, in Inverness-shire, forty-one shocks, all of them slight; while, in the small tract lying along the line of the Caledonian Canal between Inverness and Loch Ness, thirty shocks originated, two of them disturbing areas of seven thousand five hundred, and thirty-three thousand square miles.

In England, the country between Hereford and Ross has been visited by thirteen shocks, one of them the strongest felt in this country during the last quarter of a century, in w[illegible]hev[illegible] way strength be measured. In Derbyshire, [illegible] Ashbourne and Wirksw[illegible]h, eight earthquak[illegible] occurred, two of them strong. Other parts o[illegible]try are not specially fav[illegible]d, with the excep[illegible]ps of the county of Co[illegible]ll, to which ten s[illegible]t shocks must be credited.

The Welsh ea[illegible]akes are occasi[illegible]on-siderable strength. [illegible] occur for the [illegible] three districts, one [illegible] in the nort[illegible] Carnarvonshire, the oth[illegible] in the south[illegible] country, in Pembrokeshire and Glamorgan. [illegible] number among them four of the nine strong e[illegible] quakes, and all four, it may be noticed, were felt across the channel in the eastern and south-easte[illegible] counties of Ireland.

Only a small part of Great Britain has been undisturbed by any sensible earthquake during the twenty-one years, the only unshaken districts being the extreme north-east of England and the southern part of Scotland. The greater part of Ireland has entirely escaped from all terrestrial disturbance, and, so far as I know, not a single earthquake has actually originated during the interval considered within the area of this island.

Nature of the Shock and Sound.

The first intimation that we generally receive of the coming earthquake is a low rumbling noise. Within a second or two, as the noise grows louder, a tremor begins to be felt, the separate vibrations being small and occurring at the rate of about five or six a second. Within two or three seconds these merge into the main part of the shock, consisting of larger vibrations or jolts, with a period of perhaps one-third of a second and a total range, even in the strongest earthquakes, of probably only a fraction of an inch. Close to the centre these vibrations have been described as like the fierce beats of a railway engine travelling rapidly; but at a distance of fifty miles or more they become smoother and slower, like the movements felt in a carriage with good springs. During the whole of this time the rumbling sound continues, becoming louder and more grating with the principal vibrations, and occasionally interspersed with deep explosive crashes. As a rule the strong vibrations begin to die away after two or three seconds, and are succeeded by a weaker tremor and noise, until, finally, after the lapse of six or eight seconds, both die away, the sound continuing for perhaps a second or two after the shock. The total duration of the shock in a strong earthquake is thus from six to eight or nine seconds.

In slight earthquakes the phenomena are much simpler. Sometimes only a tremor is felt, lasting for at most two or three seconds, and accompanied by the usual rumbling noise; but, as a rule, among the tremors, and generally at the beginning, one prominent vibration is felt, so that it seems as if a heavy weight had fallen with a thud upon the ground, with the brief quiver following as such a thud might be expected to cause in a building.

The so[illegible] which forms [illegible]tial a part of an earthqua[illegible] is a low, r[illegible]or grating noise. Near th[illegible]entre it is he[illegible]ll observers, but as the d[illegible]ance increas[illegible]mes inaudible to a l[illegible] and larger per[illegible]f persons. The reason [illegible]at the numb[illegible]rations occurring every [illegible]cond is very ne[illegible]hich forms the lower limit of audibility, [illegible] sixteen to thirty-two a second: and, [illegible] slight decrease in strength, these vibrati[illegible] to affect the ear. Moreover, this limit v[illegible] different persons, so that some, and not [illegible]re able to hear the sound. Thus, in one [illegible] and even in the same house, one observ[illegible] declare that the shock was unaccompani[illegible] sound, while another will record a noise loud[illegible] than thunder or than many traction engines p[illegible]ng together.

Some observers find it difficult to describe the sound, remarking that it resembles no noise with which they are acquainted. The majority compare it to some well-known types. Those most frequently referred to are the rapid passing of heavy waggons, traction-engines, steam-rollers, or railway trains, on a hard road, over a bridge, or through a tunnel; the deep roll of thunder, and generally distant thunder; and the rising of a strong wind or a chimney on fire. Less frequently in strong earthquakes, but more often in slight ones, we have comparisons to sounds of short duration, such as the tipping of a load of stones, the fall of a heavy muffled weight, the firing of a distant gun, or a blast in a quarry.

By most observers, by two out of every three, the sound is heard just before the shock begins. A smaller proportion, about two out of every five, hear the sound after the shock is over. In many foreign countries the sound is heard before the shock only, and this has led to the impression that the waves which form the sound travel more rapidly than those which form the shock. The true explanation of the discrepancy is that the British, as a race, are more capable of hearing low sounds than most other people. They possess a lower limit of audibility, which, in earthquake-countries, may be of service in enabling them to escape into the open air with the first rumble of the on-coming earthquake. That the two series of waves travel with approximately, if not quite, the same velocity is evident from the fact that, in strong earthquakes, the percentage of observers who hear the sound before the shock, and also of those who hear it after the shock, is almost exactly the same at all distances from the origin. If there were any appreciable difference in velocity, the sound and shock would soon become separated from one another.

Simple and Twin Earthquakes.

The great majority of British earthquakes belong to the first of the three classes mentioned at the beginning of this paper. Of the two hundred and fifty earthquakes, two hundred and thirty-nine were simple, and eleven twin. The latter include, however, most of the strong shocks felt in this country. Of these, nine in number, two were simple earthquakes, the average area disturbed by them being twenty-nine thousand square miles. The remaining seven were twins, and disturbed, on an average, an area of forty-seven thousand square miles. The latter include also the four strongest earthquakes of the period considered, namely the Pembroke earthquakes of 1892 and 1893, the Hereford earthquake of 1896, and the Swansea earthquake of 1906. The average disturbed area of these four earthquakes is sixty-eight thousand square miles, or three-quarters of the total area of Great Britain.

Another point in which simple and twin earthquakes differ is in the number of minor shocks which attend them. The total number of such shocks during the twenty-one years is seventy-one, all but five of which preceded or followed the nine strong earthquakes and the Inverness earthquake of 1890. This earthquake, which belongs to the class of simple earthquakes, just falls short of the test required to place it among the strong earthquakes. The area included within the isoseismal of intensity four, is four thousand three hundred and forty square miles, and the area disturbed by it about seven thousand five hundred square miles. Of the sixty-six minor shocks which attended these ten earthquakes, fifteen were fore-shocks and fifty-one after-shocks; and, of the after-shocks, thirty-three followed the three simple earthquakes, and eighteen the seven twin earthquakes. In other words, the average number of after-shocks of a simple earthquake is eleven, and of a twin earthquake between two and three.

Minor Shocks.

Besides the slight shocks which are intimately connected with the strong earthquakes, there have been two series of shocks, for the most part of slight intensity and confined to certain limited districts. Both of these districts are in Scotland, and are responsible for the large number of slight shocks felt in that country. The first series lasted for about twelve years, from 1888 to 1899, and were confined to Glen Garry, a valley in the west of Inverness-shire. In this interval fifty slight shocks were recorded, but owing to the mountainous character of the district little more is known about them than their time of occurrence and their nature at one or two places. The shock was invariably a slight tremor of very brief duration, and accompanied by a sound compared most frequently to a carriage passing, but occasionally to thunder.

The series of earthquakes felt chiefly in the district lying to the north of the Firth of Forth and south of the Ochil Hills is more interesting, on account of the larger number of observers, though here again the presence of a range of hills to the north prevents us from determining the disturbed areas of all but the strongest shocks. This series began with four shocks in the year 1900, and then ceased, with one exception in 1903, until 1905, when both the number and intensity increased. In this year ten were recorded, one of them being felt over an area of a thousand square miles. In the four succeeding years, the numbers observed were nineteen, thirteen, seventeen and eighteen, and they show no sign at present of abating in frequency or strength. During the ten years 1900–1909 the number felt was eighty-three. They are interesting from their probable connection with the great fault which skirts the southern side of the Ochil Hills, which, notwithstanding its advanced age, still seems to be growing. The small movements, which give rise to the earthquakes, appear to be limited to the portion of the fault between Airthrey (near Bridge of Allan) and Tillicoultry, and to take place at a very small depth below the surface.

Observations in Mines.

Isolated observations have been made in mines in many cases, both in this and other countries, the general result being that the shock is more feebly felt in mines than upon the surface of the ground. Several recent British earthquakes have occurred within or near mining districts, and these, especially the Derby earthquake of 1903 and the Swansea earthquake of 1906, have thrown further light on an interesting subject. They confirm the previous impression that the shock is more manifest on the surface than underground; indeed, the disturbed area in mines is only a small fraction of that upon the surface. On the surface, again, the sound in strong earthquakes is heard over an area much smaller than that within which the shock is felt. In mines the sound is observed as far as, or farther than, the shock. Some interesting observations were made on the sound in mines in the two earthquakes referred to. They show that the sound appears to travel through the rock overhead rather than through that below, but this is only the case at distances of more than five miles from the centre. Again, in both earthquakes, there is some, though not decisive, evidence showing that the intensity of the shock increases with the depth of the workings below the surface. This point is one on which it would be worth while to make careful investigations in future earthquakes.

Origin of British Earthquakes.

The most interesting result to which the study of British earthquakes has led is the proof of their connection with the slow growth of faults. The longer axes of the isoseismal lines are parallel, or very nearly so, to the main faults of the central district, or, if the faults be unmapped, to the principal lines of folding. The centres of the earthquakes lie on the side towards which the fault-surface is inclined, and at a short distance (generally a mile or two) from the fault-line. When many after-shocks occur, as with the Inverness earthquake of 1901, their centres lie within a narrow band parallel to the fault, and again on the side towards which the fault-surface slopes. It is possible, indeed, to trace the migrations of the seismic foci from side to side along the fault, and gradually, as the series come to an end, towards the surface of the earth.

The occurrence of th[illegible] earthquakes in this country is therefore decisive [illegible] that the growth of British faults, ancient as m[illegible] them are, is not yet at an end. This is not the [illegible] course, with all our faults. The great majority [illegible] perhaps, at rest, possibly [illegible] altogether ceas[illegible] grow. But some, it may be [illegible] very small minor[illegible] have kept themselves by co[illegible]t, if slight, exe[illegible] to move. That the abs[illegible] displacements [illegible]ll account is evident fr[illegible] the fact that th[illegible] seldom destructive to property. But the displ[illegible] to which any one earthquake is due extends ove[illegible] considerable area. In the Carlisle earthquake o[illegible] 1901 and the Swansea earthquake of 1906 the total length of the focus exceeded twenty miles.

The length of the focus of an earthquake can only be determined roughly; in any particular case the error may amount to one, or several miles. But there is a curious relation between the average length of focus in the different classes of earthquakes. In strong earthquakes this average length is twelve and a quarter miles, and in moderate earthquakes thirteen miles. Slight earthquakes may be divided into two well-marked groups. In one the focus is nine miles or more in length, and the average length twelve miles; in the other the focus is six miles or less in length, and the average length four miles or less. Further evidence on this point is afforded by the nature of the sound. Dividing the types of comparison into two classes, according as they are of long or short duration, we find that the percentage of references to types of long duration is eighty-four for strong earthquakes, eighty-one for moderate earthquakes, eighty-four for slight earthquakes with a long focus, and sixty-three for those with a short focus. Thus, except for the slightest of all earthquakes, the average length of focus is practically the same in all three classes. Their difference of intensity depends only on the amount of displacement within the focus.

There must be some reason for this close correspondence in average length of focus. What the reason is cannot at present be definitely settled, though it can be surmised. The late M. Marcel Bertrand published a map of France on which are depicted the courses of the anticlines and synclines of the great folds which traverse the rocks of that country. The average distance between successive anticlines or crests, measured along several lines at right angles to them, varies from nine to twelve miles. For this country no similar map, so far as I am aware, has been prepared. But it is at least a probable supposition that the average distance between the crests of the great crust-folds does not differ widely in the two countries. If this be the case, then it would seem that the length of a crust-fold, or distance from crest to crest, may govern the length of the displacements along the faults which intersect them. In other words, the growth of the faults to which our earthquakes owe their origin is at present chiefly due to the growth of the transverse crust-folds.

[illegible]HE V[illegible] [illegible]AN OBSERVATORY OF TO-DAY.

By W. ALFRED PARK.

[illegible]LTHOUGH it v[illegible] until comparatively recent years that the [illegible] Observatory entered upon that active pl[illegible] its existence which recognises in it the w[illegible]n and well-equipped *Specola Vaticana* of [illegible]esent day, it is, in reality, one of the most [illegible]le European institutions dedicated to the [illegible]f the heavenly science; for its early hist[illegible] tes from a peri[illegible]ch precedes the fou[illegible]ation of our own n[illegible]nal observatory at [illegible]eenwich by nearly a [illegible]ntury, while it can claim intimate connection with one of the most epoch-making events in the annals of Astronomy. The significant appearance on its official seal of the Ram's Head, symbolical of the sun's position at the vernal equinox, still serves to commemorate this event—the reform of the calendar, under Gregory XIII—which may, indeed, be said to have called the observatory, as such, into being, as it was the famous meridian line, drawn by Ignazio Danti about 1580, to demonstrate to the Pope that the sun no longer entered the sign Aries on the orthodox date of March 21st, assigned to it by the Council of Nicaea in A.D. 325, that represented the nucleus around which astronomical instruments of all kinds soon collected to form the embryo of the present Vatican Observatory. A reform of the calendar had been proposed and discussed as early as 1414, but as the accumulated error in Gregory's time amounted to more than ten days, a circumstance which seriously affected the date of Easter, the long-desired amendment, projected by the Neapolitan astronomer, Lilio, and more fully demonstrated by the Jesuit Clavius, was established by Gregory in 1582, who, by this means, conferred a lasting *éclat* on his pontificate. As is well known, this reform, enforced "under pain of excommunication" throughout the Roman Catholic world, met with the greatest opposition in those countries which did not recognise the papal supremacy, and it was not adopted by Germany until after the energetic representations of Leibnitz and others in 1700, nor by Great Britain until more than half a century later, when its establishment by Act of Parliament caused the members of the calendar-reforming government to be mobbed in the streets of London by the populace, who, imagining they were being defrauded of their natural rights, noisily demanded the restitution of the eleven days, which, by that time, had to be suppressed in order to set chronological matters on an accurate footing.

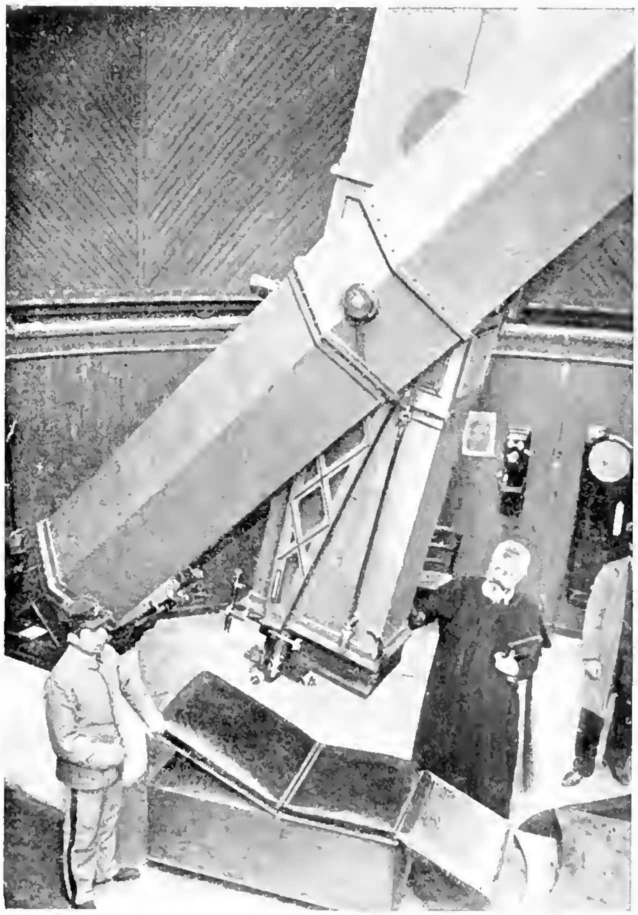


FIGURE 1.
The Astrographic Refractor.

Danti's meridian line was contained in that lofty portion of the Vatican Palace known as the *Torre dei Venti*, and this "*turris astrorum speculatrix*," as it was referred to in the inscriptions, remained for over two centuries the only astronomical, as it was until recently the principal meteorological, station of the Vatican. The output of work, however, was at first but small and intermittent, and long periods of "repose" alternated with sporadic outbursts of activity, a notable manifestation of the latter quality occurring towards the end of the eighteenth century, when Gilii, by unremitting diligence in observation, succeeded in restoring some measure of prestige to the venerable institution, which, it is interesting to find, had already acquired, in addition to other notable instruments of the period, a Dollond achromatic telescope from England. Meteorological, however rather than astronomical work now absorbed the energies of the observatory, for it had been found that the proximity of the great dome of St. Peter's unduly circumscribed its southern view, thus rendering the site less favourable for astronomical observations than that occupied by the observatory of the Collegio Romano, which had then but recently (*i.e.*, in 1787) been founded by Calandrelli, and

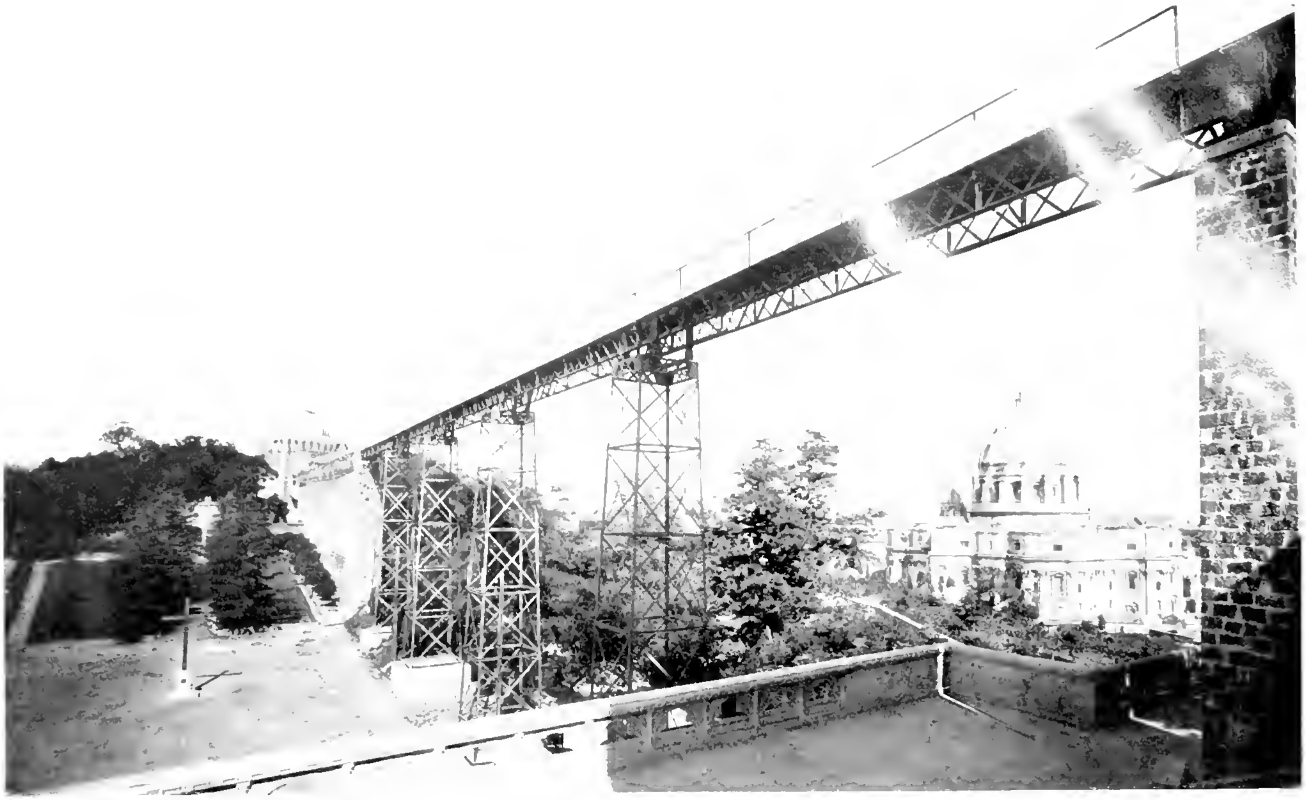


FIGURE 2. The Dome containing the sixteen-inch Refractor, and the Bridge connecting the Observatories.
Seen from the terrace over the Grotto of Lourdes. St. Peter's is on the right of the picture.

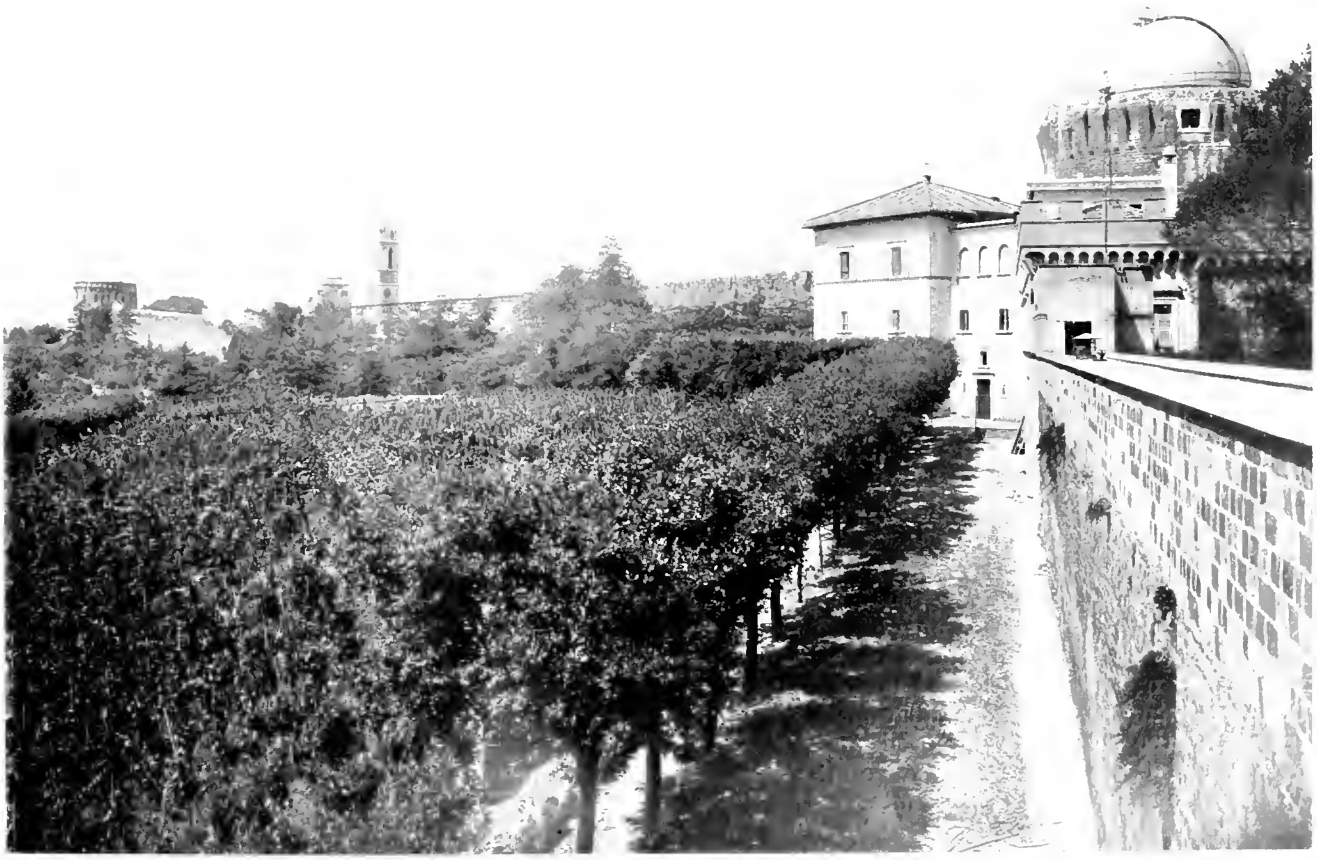


FIGURE 3. A nearer view of the Refractor Dome with attached dwelling house, shewing also other domes and the spire over the Lourdes Grotto.

[illegible]hich was [illegible] to become [illegible]us through the labours of [illegible] Vico and [illegible]rious successor Secchi; [illegible] thither, at [illegible]commendation of Boscov[illegible], the astronomi[illegible]on of the instruments was [illegible]ordingly trans[illegible] For an astronomical [illegible]atory to be de[illegible] its instruments would see[illegible] sufficiently fat[illegible] existence, but worse was [illegible] follow. After t[illegible]al events of 1870, when the Italian troops t[illegible]al possession of the Eternal City, and Piu[illegible]atered upon his self-imposed imprisonment [illegible] Vatican, the old *Torre dei Venti*, owing to th[illegible]n demand for room, was finally transform[illegible] dwelling apartments!

But [illegible]s resurrection was now approaching. When [illegible] XIII celebrated his jubilee in 1888, a scien[illegible]xhibition was held in Rome to celebrate th[illegible]nt, and a considerable number of astronomic[illegible]nd meteorological instruments figured amongst [illegible] numerous presents received at the Vatican. [illegible]fter the close of the exhibition the question naturally suggested itself, What should His Holiness do with all these scientific instruments? Fathers Denza and Lais, who had had charge of the scientific section, at once proposed that the collection should be utilized to reconstitute the Vatican Observatory, and as the project found immediate favour with the Pope, who was himself not only a mathematical prizeman of earlier years, but a man of high intellectual attainments generally, it was rapidly pushed forward, with the gratifying result that the newly-reconstructed institution was soon enabled to claim a place among the eighteen great international observatories taking part in Admiral Mouchez's comprehensive plan of photographing the entire heavens. Under the directorship of Denza, a *zona vaticana* was accordingly commenced with the arrival, in 1893, of the Henry-Gautier astrographic telescope from Paris (see Figure 1). This instrument, however, which, like the similar one at the Paris Observatory, is mounted on the so-called English system, was no longer placed on the old "Tower of the Winds"—now given over to the housing of the archives—but in a free position some four hundred meters distant and on the summit of the Vatican hill, far from all disturbing influences. To ensure its best performance, moreover, it was mounted on one of the massive turrets (see Figure 5) forming part of the ancient fortifications erected in the ninth century by Leo IV, who, converting the tribute offered by the Emperor Lothair to this practical end, thereby sought to put a stop to the frequent incursions of the Saracen hordes. Despite the curious anachronism involved in providing a highly specialized instrument of the nineteenth century with a foundation dating from the ninth, the experiment proved an unqualified success, and the remaining towers of the Leonine wall were one by one pressed into the service of science as the observatory acquired additional telescopes. Four modern observatory-domes now surmount these ancient ramparts in a line, and as the distance separating the extreme domes is something like half a kilometer, the Vatican astronomers may be said, with Professor Turner, to be living in space of one dimension only. Nor is the uniqueness of the situation diminished by the fact that for a space of about eighty-five meters where Leo's cyclopean masonry has yielded to the ravages of ten centuries, a slender steel bridge (see Figure 2), the gift of a wealthy American, has replaced the massive walls, thus enabling inter-communication between the domes to be maintained.

The largest dome, nearly nine meters in diameter (see Figures 2 and 3), covers the new sixteen-inch visual refractor by Merz, which ranks with the similarly sized instruments at the Collegio Romano and at Dr. Vincenzo Cerulli's private observatory, Collurania, at Teramo, as one of the largest telescopes in Italy after the nineteen-inch Merz refractor of the Brera Observatory at Milan. It was mounted by Gautier, of Paris, after the advent, in 1906, of the present director, Father J. G. Hagen, who left the observatory of Georgetown, Washington, to assume the astronomical leadership at the Vatican. His monumental work, the *Atlas Stellarum Variabilium*,[*] which was prepared in America and completed at Rome, undoubtedly marks an epoch in the study of variable stars, and it is a great satisfaction to know that the same careful observer has been for some time past engaged upon an extensive research into star-colours. These latter investigations have been carried out with a small Merz refractor of only four inches aperture, and Father Hagen has already paid a handsome tribute to the clearness of the Italian skies in expressing the opinion that the colours of stars appear more vivid at his new post than they did on the American continent.

The site of the Vatican Observatory might indeed arouse the envy of many a larger and less favourably situated institution, and the writer having, through the courtesy of the director, as well as of Dr. Cerulli (who kindly furnished the introduction[1]), but recently enjoyed the privilege of visiting the institution, can bear witness to the natural advantages of its position, no less than to the natural charm of its surroundings. Nature, Science, and Art appear here in the happiest alliance. A spacious vaulted apartment in the great tower, now bearing the sixteen-inch refractor, had been utilized by Leo XIII as an audience chamber, and is decorated in an ingenious manner. The constellations visible from the latitude of Rome are painted, together with their appropriate figures, upon the domed ceiling, which thus represents the celestial vault, and as the various human figures standing for *Gemini*, *Virgo*, and so on, are most artistically treated,

[*] For an able review of this fine work, see *Journal, British Astronomical Association*, Vol. xvii., page 407.

[1] I take this opportunity of acknowledging my indebtedness to these gentlemen for the material aid they have afforded me in collecting the notes for this article.

the impression of the whole, which is the work of the well-known painter, Seitz, is an exceedingly pleasing one. The constellation *Leo*, in honour of the late Pope, is not only shown at its culminating point, but its principal stars are replaced by minute electric glow-lamps, so that their effect, when lighted, is very charming. Hard by, in the Vatican gardens, a surprise of a different kind, but also conceived in honour of Leo XIII, awaits the visitor, in the shape of a large open-air den containing the two magnificent lions presented to His Holiness by the Emperor Menelik. As in Rome itself, that city where of all others the centuries may be said to meet, and where the works of widely distant ages unite in strangest famous grotto of Lourde[illegible]s bubbling spring of healing waters all compl[illegible]

Fathe[illegible] Hagen, however, [illegible]ceeded with masterly skill in uniting t[illegible]us outlying departments of his observator[illegible] organic whole. New [illegible]struments have be[illegible]urchased, new measuring ap[illegible]tus introduced t[illegible]asurement of the as[illegible]raphic plates (on[illegible] the [illegible]hief tasks of the obser[illegible], and new work[illegible]t; while the substitutio[illegible] of a spectrohel[illegible]n Professor Hale's system for the existin[illegible] heliograph will probably take place in t[illegible] future. With so able an observer at the he[illegible] affairs, assisted as he is by the energetic coöper[illegible]

FIGURE 4.
The Dome containing the Photoheliograph.

FIGURE 5.
In this Dome is the Astrographic Refractor.

contrast, so in that portion of it represented by the Pope's garden the juxtaposition of incongruities is not wanting. Mention has already been made of electrically-driven observatory-domes and steel girder bridges crowning the mighty bulwarks of a bygone day, but this is not all. Midway between the observatories themselves there rises the slender spire of the chapel surmounting an exact replica of the of Fathers Lais and Stein, the Vatican Observatory, now fully reconstructed, and equipped with modern appliances, has certainly entered upon one of the brightest periods of its long career. The massive character of its foundations, the seclusion of its position in the midst of the Vatican gardens, and the singular purity of the Roman sky under which it works, all conspire to render its observations of exceptional value.

DEMONSTRATION OF THE PRESENCE OF STARCH IN A LEAF.

IT is customary to hold, in connection with the Annual Meeting of the Association of Public School Science Masters, an exhibition of scientific apparatus and books likely to be of use in science-teaching. The show is divided into two parts, one consisting of exhibits by members of the Association, and the other of displays by opticians, instrument-makers and scientific publishers. There was an exceedingly fine exhibition at the January meeting, and the present writer was particularly interested in a modification, devised by Mr. O. H. Latter, of Charterhouse, of the usual experiment to demonstrate the presence of starch in a leaf which has been exposed to sunlight.

For those who do not know the details, one may say that a leaf is exposed to sunlight for some hours, gathered, boiled in water for a few moments, and the green colouring or chlorophyll, dissolved out by means of methylated spirit. In turn the alcohol is washed out by water, and finally the leaf is placed in iodine solution, which turns the starch blue. Although it is possible to get an intensely blue colouration of the leaf, especially if a suitable one has been chosen, and iodine dissolved in a solution of potassium iodide has been used, as the writer can testify by experience, Mr. Latter thinks that this method of showing the leaf when in the iodine solution makes a considerable demand upon the imagination; for he describes the colour produced as a dull purple-brown, that is, a mixture of the colour produced in the starch with that in the other constituents of the leaf.

His plan is to remove the leaf from the iodine and place it at once in benzole. The benzole then dissolves out the iodine from the cellulose walls of the cells and from the protoplasmic contents, but does not break up the blue starch-iodine compound. Hence the blue colour shows up very plainly in the leaf, being no longer masked by the yellow-browns of the iodine stained cellulose and protoplasm.

NERVES AND NERVOUSNESS.

DAVID FRASER HARRIS, M.D., B.Sc. (Lond.)

(*Lecturer on Physiology, University of Birmingham.*)

(*Continued from page 22.*)

TH[illegible] to-day to our question is that we do kn[illegible]ething of the material basis of nerve e[illegible], although only a few years ago we should [illegible] had to confess complete ignorance. We believe [illegible] to be related to microscopic granules named after [illegible] German neurologist, Nissl. These granules of Nissl are known to break up in cells that are fatigued, but to be reformed when the cells have rested, so that we infer they are connected with the output of energy. In various mental diseases they are altered, also in alcoholic poisoning: the brain is never in good health if these granules are not of normal aspect. It is these granules which contain a high percentage of phosphorus. Long before they were discovered it was known that nerve-matter possessed much phosphorus, and hence arose the popular notion that to gain nerve-strength one ought to eat foods containing much phosphorus—fish and animals' brains for instance. Now while it may be good to eat fish and brains, the notion underlying the practice is based on the fallacy that we can increase the amount of any element in the tissues provided we eat food containing much of it. But the fact is we cannot in this way over-saturate the tissues with any given element: the tissues can absorb (assimilate) only a certain quantity of it, corresponding to their particular chemical affinity for the substance in question. In conditions of health this affinity limit cannot be exceeded, but it is otherwise in cases of pathological deficiency of the element in question. For instance, a healthy man by taking a great deal of iron in his diet will not cause a greater quantity of it than normal to be retained by his tissues; but the case of a person who has not been absorbing enough iron is quite different. If now capable of absorbing it, he may, by taking foods rich in iron, bring up the iron-content of his tissues to the normal but not beyond it. The case of phosphorus is similar. If for any reason the central nervous system has been starved of phosphorus, then food containing it may be given with advantage, but the phosphorus-content of the brain cannot be raised above the normal. Wasting diseases of the central nervous system certainly involve loss of this element which ought to be compensated for. The same reasoning applies to phosphatic tonics. They may benefit the body in certain ways, but they cannot become the means of increasing the percentage of phosphorus beyond its normal in the nerve-tissues.

We may now ask ourselves what is it that keeps up the continual outflow of impulses from the centres to the periphery? The answer is that this energy is liberated in the special granules already alluded to by the inpouring of afferent impulses constantly arriving at the centres of the nervous system. When one thinks carefully about it one sees that a vast number of all sorts of impulses must be pouring into the nervous centres both from all the sense-organs as well as from the internal organs. Sensory impressions from the organs of vision, hearing, smell, taste and from the skin—those of contact, pressure, heat and cold—and others of a less well defined nature from internal organs are continually arriving at the nervous system. Painful impulses are from time to time also coming in. We are not, of course, conscious of a tenth part of all these, but they are pouring in nevertheless; some of them even in sleep, when those from the skin and internal organs are still entering the nervous system. The nervous system is never without some incoming impulses, and we are powerless to prevent the entrance of the vast majority of them. Just as the hum or roar of the traffic of a great city pours into the room when the window is opened, so do the afferent neural impulses pour into the brain and spinal cord. The general tendency for these impulses is to cause the nerve-centres to discharge: that all the centres are not simultaneously discharged is due to a large number of coöperant conditions. Some impulses may be too feeble to arouse the first centre encountered, as when the fly is not felt until it has stung you; but a series of such too feeble impulses may, by being summated, effect what no one of the series is able to do. Or, again, two impulses may meet and interfere with each other in such a way that no action is aroused, just as when two sound-waves meet in a particular fashion and give rise to silence, or two colour-waves to blackness. This last case is one of "inhibition by interference" of neural currents.

There is no doubt that the general incoming neural "hum" goes to produce those outflowing currents which maintain the unconscious general tissue-tone. In proportion as we cut off the multitude of incoming impulses so tone vanishes: as, for instance, in sleep, in which no impulses are coming in from the higher sense-organs, and therefore the centres for tone to a large extent are unstimulated.

Keeping animals in the dark and in silence lowers their tone: cows kept in dark byres secrete poorer milk than those in well lighted ones. This is due to the depressed chemical tone of the cells of the mammary gland. It has been experimentally proved that if the afferent nerves from a limb are cut, the muscles of the limb suffer diminution of tone. It is evident, therefore, that the afferent nerves and the efferent nerves are functionally very closely related through the intermediation of their common centre. The entire nerve-path from the periphery, up the afferent nerve through the centre and down the efferent nerve is known as the "reflex nerve-arc." A vast number of the functional units of the central nervous system can be looked upon as reflex or "sensori-motor" nerve-arcs. These arcs are continually receiving impulses one way, and sending them out the other way, that is transmitting them in one fixed direction only. The impulses which go out are not identical with those that come in; in many cases, although they come in continuously, they go out intermittently by special rhythms of their own.

Now the intensity of the response given by a centre depends upon two things—first the intensity of the incoming impulse, and secondly its own condition of being affected by the stimulus easily or the reverse (Affectability). This applies to all centres, whether those in the cord unrelated to consciousness, or those in the brain related to perceptions, emotions, ideas and the will. Now one form of nervousness is that associated with an abnormally violent response to a stimulus. This form of nervousness is that of the "nervous temperament" as opposed to the phlegmatic, for there is more than a grain of truth in the old classification into lymphatic or phlegmatic, nervous, sanguine and melancholic temperaments. The nervous temperament has in recent times merely been rechristened "neurotic." A neurotic person is one whose nerve-centres are, as compared with those of the majority of people, unduly affectable. This condition of undue affectability manifests itself in many very different ways. If a hundred people are in a hall and a door bangs loudly, three of them may jump up from their seats while the other ninety-seven merely turn their heads in the direction of the sound; the three would be for the company in question the representatives of the neurotic constitution. The physical intensity of the stimulus was presumably the same for the whole hundred, but it produced a greater effect on three of them because their nerve-centres were in a state of excitability greater than the average for the particular company in the room at the time. Again let us suppose a hundred people come into a place where there is a large bowl of powerfully perfumed roses: ninety-seven appear indifferent and settle down to various occupations; one is delighted with the odour; a second says, "That is a smell I detest," while the third gets an attack of asthma. The last three are "nervous" as regards the general average of the assembly. Their nervous systems are unduly affected by the perfume of roses: the form it takes in one is a distinct aesthetic pleasure, in a second well-marked aesthetic pain, in the third it gives rise to a motor effect, a spasm of the muscles of the bronchial tubes. This last is known as an attack of asthma; it belongs to a class of conditions called neuroses. Neurotic people exhibit neuroses. A neurosis is an excited or excitable state of a centre or centres of the nervous system expressing itself in an outflow of nerve-energy into such channels as injuriously affect certain organs or tissues. Nervous attacks or "attacks of nerves" may be taken as the popular synonyms for neuroses—fits of trembling, limbs shaking, "the quivering like an aspen leaf" of the novelette, palpitation and other visible effects of fear on the approach of an ordeal ("stage-fright," examination fright), blushing, blanching, perspiring, dilatation of the pupil, and in some cases even vomiting, all well-known results of stimulation of lower centres acted on by impulses descending from higher ones. Popularly the "nervous" person is the one who blushes, pales or perspires too easily, whose centres for these expressions of emotion are abnormally affectable and are set in motion by conditions which would have little or no effect on a person perfectly normal as regards the nervous system, a person with what is called a "well-balanced nervous system." What, however, is the cause of the abnormal affectability of the centres in a nervous person it would be difficult to say. In many cases it is probably due to malnutrition of the centres. Nerve substance is chemically only a very complicated form of fat, and fat people are almost never neurotic. We must not jump to the conclusion that because a person is fat his nerve-centres are of necessity well nourished, though they usually are. There are various kinds of obesity, some not indicating good nourishment; but as a rule it is lean people who are nervous. This is, of course, what Shakespeare alludes to when he makes Caesar say—

> "Let me have men about me that are fat:
> Sleek-headed men and such as sleep o' nights:
> Yond' Cassius has a lean and hungry look:
> He thinks too much: such men are dangerous."

Of course we must distinguish between the thin, pale, neurotic person, and the thin, "wiry," fit person whose nerve-centres may indeed be affectable without being abnormally or weakly affectable. For there is the healthy, robust nervous system with plenty of nerve-energy able to be discharged, and there is the weakly, excitable system with little energy always tending to leak away. The two conditions are quite different. The ease of response to a stimulus is one thing, the amount of energy liberated by a stimulus quite another thing. The same amount of pull will fire off a pop-gun [illegible]nd a "tw[illegible]inch," but [illegible] of energy liberated [illegible]hese equally [illegible] mechanisms are immeasu[illegible]ly different. [illegible] words, there is a hi[illegible]h [illegible]ectability coup[illegible] the output of much ner[illegible]ergy, and ther[illegible]affectability coupled w[illegible] the output of [illegible] this latter constitutes "[illegible]itable weakne[illegible]kness to be wroth with [illegible]eakness"): it i[illegible]at is the basis of neuroses, of nervousness[illegible] brain-centres related to consciousness [illegible]o exert on the lower centres a restraint [illegible] learnedly called "inhibition." Inhibition [illegible]int by the higher on the lower plays a [illegible]t in the activities of the central nervous [illegible]n. Persons neurally robust have inhibi[illegible]ll developed, nervous people have it poor[illegible]loped. Inhibition is of two kinds, that un[illegible]ciously and that consciously exerted. The fo[illegible] is the more mechanical kind of restraint [illegible]ch any one centre exerts on any one lower down [illegible] the neural scale. Thus it is that when the head is cut off, the posterior part of a worm wriggles more actively than the head end: it has lost the automatic restraint of the head end. The legs of a decapitated crayfish "work" much more rapidly than in the intact animal. We may ourselves employ this form of mechanical inhibition in restraining, for instance, an awkward sneeze by firmly pressing on the upper lip. The otherwise uncontrollable tendency to sneeze is abolished by the impulses from the skin of the lip; they act here as inhibitory. That it is only inhibition of the tendency and not removal of it is interestingly brought out sometimes by the fact that after a certain interval of time the sneeze may be produced in what would have been all its original intensity. The stillness of an attentive audience is a case of unconscious inhibition; the subsequent coughing and restlessness is evidence that it was only inhibition and not abolition that was at work. But by means of the will we can consciously inhibit or restrain. What we call "education" is very largely the cultivating of latent powers of this order: the psychological difference between a Hottentot and an ambassador is the high development of the powers of inhibition acquired by the latter. Training in children and animals means their acquiring inhibitory powers: a performing tiger has to restrain many instincts and tendencies before it can be conveniently exhibited in public. Now some forms of nervousness are the result of loss of inhibition resulting in the expression of violent emotions and violent responses of all sorts. The strong man is not the violent man: the strong man is the man who restrains the exhibitions of his strength, who strongly controls strong emotions for his own good and that of the community. The neurotic person, not possessing the necessary power of inhibition, does not do this. Better is "he that ruleth his spirit than he that taketh a city": that was written long ago, but the nervous system was the same then as now; in modern language it is inhibition that is alluded to. Nervousness may, then, in one form be a condition of diminished restraint. We talk about a nervous dog that barks apprehensively at every little incident, of a nervous horse that jibs and shies at all sorts of harmless objects; inhibition is that in which these animals are deficient. It is, then, clear that the development of inhibition is the essence of foundation of character: a person with little inhibition may do all sorts of wild things, succumb to all sorts of temptations: conscious inhibition is the physiological name for self-control. Lack of inhibition is one of the elements in neurasthenia, that low nervous state to which reference has already been made. Hysteria, again, is a form of nervousness; it is a morbid state of the central nervous system, and has been described as the acting or imitating of some other disease. "A fit of hysterics" is really a violent emotional display due to diminished inhibition. In true hysteria all sorts of morbid conditions are imitated,—fainting, paralyses of various kinds, and so on. Some hysterical people cannot walk, cannot talk, cannot eat, cannot get out of bed, and so forth. Hysteria is a form of "nervousness," if "nervousness" means anything unusual in the nervous system, which is apparently all that in certain cases it does mean. The term as popularly used covers a large number of very different conditions. By a nervous child is meant sometimes a shy child, one not sufficiently self-reliant, who shrinks from strangers, and is not soon at home amid new surroundings. It may only mean a child that does not like to be left alone in the dark.

A very well marked form of nervousness is the "fear" of various conditions, such as fear of looking over heights, fear of open spaces, fear of enclosed spaces, fear of the presence of crowds, and so on through all the various "phobias," as they are called, many of which are ludicrous to those incapable of experiencing them. Allied to hysterias and phobias are certain harmless obsessions which, however, lead right on to the illusions, delusions, and hallucinations of typical mania.

In connection with nervousness we have the factor of *suddenness* to reckon with. Something happening without warning will *un*nerve a man or animal which it would not do had the occurrence been foretold or developed gradually. Just as a sudden knock will break a glass, which the same pressure cautiously applied would not, so a sudden mental blow will injuriously affect the nervous system in a way it would not have done had it fallen more gradually. Both non-living and living molecules resent sudden changes of state: both can endure strains if gradually applied which would not be withstood if applied without warning. Especially should the affectable and plastic nervous systems of children be protected from sudden impacts. Permanent damage may be done them by "taking them by surprise," "giving them frights," suddenly showing them "horrors" and so forth. The nervous system will "endure" (almost) "all things" provided they are presented to it in graded order: it may be trained by degrees to suffer conditions which if suddenly developed would have overwhelmed it altogether

SOME MAORI CUSTOMS AND BELIEFS

By R. W. REID

(New Zealand).

Though the Maoris of New Zealand are rapidly adopting the civilisation of the whites, they seem reluctant to part with many of the customs and beliefs of their forefathers. The settlement of the country by the British and the introduction of British law rendered the old mode of life impossible. Most of those peculiar observances witnessed by early navigators and others, which were opposed to English ideas, had perforce to cease. But long-established social customs, when not very harmful, albeit not always strictly legal, were never, and are not now, subject to interference from the authorities. Keen recollections of early days in New Zealand, while police, courts, and judges were yet unknown, abide to-day in the memories of not a few grizzled and tattooed veterans. Thus the writer's friend, Hori (the distinguishing appellation had better be here omitted!) a Bay of Plenty chief, is able to confide to those he deems worthy of being entrusted with the interesting autobiographic information, that, when a young man, he, on several important occasions, did partake of "kai tangata." An unsuspecting enquirer, learning that "kai" is Maori for "food," and that "tangata" is the equivalent to "man," might hastily conclude that "kai tangata" represented an article of diet neither uncommon nor alarming. Hori, however, could explain that, used by him, the phrase meant, not "the food of man," but "man, the food," and that, in ancient Maoriland, was a difference indeed.

Polygamy, never a common practice among Maoris, and generally confined to men of rank, is now almost extinct. An official report of recent date states that there are only three or four cases of Maoris having more wives than one, and that these are among the Ruatahuna natives on the Bay of Plenty. Rua, who lives in the Urewera country, and claims to possess certain supernatural powers, six months ago had eight wives. Very likely he has more now. He is the most married inhabitant of New Zealand; the Maori next to him possesses but the relatively modest number of three. When a dweller in pah or kainga (village) dies, the event is followed by a "tangi" or weeping. If a chief, or person of importance, his "tangi" is attended by hundreds of Maoris; relations and friends are there, and, in addition, nearly all the natives of the district. The proceedings are not infrequently prolonged over many days, and become a medley of formal weeping, of feasting and of merriment. Immense sums are often expended on tangis; the cost may vary from £50 to £500, according to the rank of the deceased and the financial capabilities, or inclinations, of his relatives. Among the very old, and more curious customs which survive is that of "tapu." By that wonderful law shrines, burial places, chiefs, and all things a chief handled, were, in former days, believed to be rendered sacred. Whatever was "tapu" must not be profaned by the touch of common mortals; in olden days death by execution followed an act of desecration. At the present time, even among educated Maoris, a more or less shadowy belief lingers that "tapu" is not yet bereft of its awful potency. For example, the decaying wood of an empty, unclaimed wharē, or house, would not be interfered with by a strange Maori. The wharē might be "tapu," and its desecration might bring disease and death.

A striking illustration of the present-day belief in "tapu" on the part of the Maoris is provided by the settlement, or village, of Maungakawa, near Cambridge, in the North Island, which place was once the home of Tawhiao, King of the Maoris. Grey, bleached wharēs are scattered about on the hilltop, grass and wild-flowers grow close to door and window. Roofs are falling in, gaps are appearing in the raupo walls. Within the buildings lie household goods, articles of clothing, mats; everything remains as it was when, sixteen years ago, the owners were called upon to go forth and seek a home elsewhere. For Tawhiao had died and the tohungas, or priests, had laid tapu on the king's council hall and on his house, on the dwellings of the people, and on all the lands of Maungakawa. Since that day, whatever curiosity irreverent pakehas (whites) may have exhibited, it is safe to say that few, or no, Maoris have entered within the now sacred circle of the one-time royal settlement. The late king's wharē stands apart from the other houses, and is rendered conspicuous by its large size and the wealth of Maori carving with which it is ornamented. Rumour states that Tawhiao's body lies beneath the floor of the wharē. Another, and a more probable, story is that, after its interment with Christian rites within the [illegible]tly churchy[illegible] in accordance with [illegible]aori custom, [illegible]ed. Following the prac[illegible] of their an[illegible] Maoris would remove [illegible]e flesh from [illegible]t rangatira's bones wi[illegible]ces of sharp [illegible] and the bones would b[illegible]anted dark re[illegible]gether with ropes of grass, and deposi[illegible] secret cave somewhere among the neigh[illegible]ountains.

At the large[illegible]rincipal native settlement of Mataatua, in t[illegible]wera, is a much carved temple, or praying [illegible]hich was built by the Hauhaus to the me[illegible] their great warrior, priest, and prophet, [illegible]a. Until recently it was altogether tapu: [illegible] some reason not clearly understood by th[illegible]r, tapu seems to have been partially rem[illegible] But visitors, before entering, pakehas not ex[illegible]d, are compelled to leave outside such [illegible]ane articles as purses, tobacco, knives and [illegible]ches. The presence of food within the building [illegible]ould still be considered a desecration. This temple, or wharētapu, is considered by authorities to be probably the most interesting specimen of Maori decorative architecture in New Zealand. Surmounting the entrance to the temple, which is always spoken of by the Maoris as "Te Whai-a-te-Motu," is a carved head or "teko-teko," dark red in colour, its large, shell-made eyes aglitter. This represents the warrior-chief, Te Unu-ariki, who, more than a hundred years ago, was the most prominent brave in Tuhoeland. Below the "teko-teko," carved and painted, appears a monster, half-dog, half-crocodile. This effigy is that of Tangaroa, the enchanted dog of Taneatua, a chief who, six hundred years ago, reached the Bay of Plenty in the famous canoe, Mataatua. The dog, according to Maori belief, was left by Taneatua at a small lake among the Urewera mountains, where it can still be seen as a "tipua," or demon. Within the temple are many carved images of entirely fabulous creatures, and numerous extremely grotesque statues of the tribes' ancestral heroes.

Ancient Egypt is recalled by a visit to an old, well-preserved, highly-decorated Maori settlement. In the painted and sculptured scenes depicted on Egyptian tombs the kings stand out boldly in the foreground, and their tall figures tower above all else. So it is in Maoriland. The greatness of the chief is represented by his colossal size. Rudely drawn and glaringly coloured canoes are favourite subjects with the Maori artist. Every canoe must have its chief, and he is shown usually four times taller than the others. Egyptian-like ideas, as well as Grecian, still prevail as to the close connection between gods and men, as between men and trees, and certain lowly animals. Tane, the god of the forests, yearly sheds his blood when the rata blooms tinge the sombre woods and tree-covered hills with glowing crimson. For misdeeds, and by the evil agency of tohungas, men and women have been transformed into rocks, into trees, and into lizards. The Maoris claim to have descended from different objects, animate and inanimate. High-born individuals, that is chiefs or rangatiras, favour the genealogy that gives them the tuatara lizards for ancestors. And that belief is by no means extinct at the present time. Not many months ago, in the New Zealand Native Land Court, a Maori title to lands was in question. The appellant, who founded his hereditary claim on remote antiquity, proceeded to recite his list of distinguished forefathers. There was Te So-and-So, the original holder of the land, whose son was Te So-and-So, whose son was Te So-and-So——"Hold on," called the judge, as the list was being rolled out—he knew the Maori ways—"These names you have been giving us, are they the names of men?" "Oh no," replied the Maori, "not come to men yet. The names I give you are of tuataras." "I thought so," responded the judge, "better skip the lizards and come to the men."

"Muru" is another Maori law descended from remote antiquity. It means an act of revenge, or of justice, carried out by those who deem themselves wronged, against the wrongdoer, real or imaginary. A man or woman commits what is considered an offence against an individual, a family, or a tribe, whereupon all available members of that tribe, who may be joined by friends, swoop down upon the offender, and carry off all his or her possessions: everything is taken that can be transported or is capable of walking. A frequent cause of muru was, and is, domestic infelicity. That the muru-ing party was frequently of considerable dimensions is seen from its name—taua muru, which signifies "a hostile, plundering expedition." A few months ago, on the Bay of Plenty, the present writer witnessed a process of muru-ing. A young man, recently married and well off, as the average Maori would consider, disappeared, and with him the unmarried daughter of a neighbour. The delinquent left behind him, not everything, but sufficient to satisfy the inevitable taua muru. Had he removed all his property the friends of his discarded wife would have been justified—in their own eyes—in raiding his relatives. Two days after the elopement the taua muru arrived at the home which was about to be broken up. The forsaken wife was there, by no means broken-hearted. Indeed it was a noisy, jubilant, jovial company of marauders. The greater part of a long morning was occupied in collecting the plunder—namely, bags of maize, quantities of kumeras (sweet potatoes), rewi (potatoes), and corn; horses, dogs, pigs and poultry, household furniture and utensils. It was a happy procession which wended its way towards the west that evening; every member of the company, from the oldest to the youngest, had secured a more or less valuable souvenir of the day's interesting proceedings. The writer has been informed of a remarkable cause of muru-ing which came to light two years ago, also on the Bay of Plenty. A young child, for health reasons, was brought from Tuhoeland to be nursed by relatives on the coast. The child died, and its father and his friends unflinchingly harried the hospitable coast-folks.

THE FACE OF THE SKY FOR FEB[illegible]Y.

By W. SHACKLETON, F.R.A.S., [illegible] R.C.S.

THE SUN.—On the 1st the Sun rises at 7.42 and sets at 4.46; on the 28th he rises at 6.52 and sets at 5.35. The equation of time is nearly 14 minutes throughout the month, the Sun being later than the clock; this makes the afternoons longer than the mornings. Sunspots may occasionally be observed, though they are not very numerous. The positions of the Sun's axis, centre of disc, and heliographic longitude are given below:—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Jan. 31	11° 40'W	6° 1'	250° 28'
Feb. 5	13° 41'W	6° 20'	163° 38'
" 10	15° 30'W	6° 38'	127° 48'
" 15	17° 22'W	6° 52'	61° 58'
" 20	18° 50'W	7° 2'	356° 7'
" 25	20° 20'W	7° 10'	290° 16'
Mar. 2	21° 48'W	7° 14'	224° 24'
" 7	22° 58'W	7° 15'	158° 32'

Towards the end of February and early March the Zodiacal Light should be looked for in the West, immediately after Sunset.

THE MOON:—

Date.		Phases.	H. M.
Feb. 6		First Quarter	3 28 p.m.
" 13		Full Moon	10 38 a.m.
" 21		Last Quarter	3 44 a.m.
Mar. 1	●	New Moon	0 31 a.m.
" 7		First Quarter	11 2 p.m.
Feb. 6		Perigee	4 54 p.m.
" 21		Apogee	4 30 p.m.
Mar. 6		Perigee	4 30 p.m.

OCCULTATIONS.—The following are the principal occultations visible in this country:—

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. point E.	Reappearance. Mean Time.	Reappearance. Angle from N. point E.
Feb. 7	A^1 Tauri	4·5	p.m. 5.20	8	p.m. 6.4	304
" 11	χ Cancri	5·0	5.59	102	6.53	272
" 13	42 Leonis	6·1	8.57	103	10.5	306
" 15	*b* Virginis	5·2	8.24	80	9.17	327
" 20	δ Scorpii	2·5	a.m. 2.4	30	a.m. 2.20	14
" 21	B.A.C. 5335	5·7	5.47	134	7.5	206
Mar. 6	A^1 Tauri	4·5	p.m. 11.57	71	a.m. 0.47	270

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
Feb. 1	19 10	S 21 20
" 11	20 0	21 7
" 21	20 50	18 48
Mar. 3	22 2	S 14 18'

Mercury is a m[illegible] star throughout t[illegible] [illegible]g in the S.E. by E. at a[illegible] [illegible]0 a.m. The pl[illegible] [illegible]test Westerly elongation [illegible] 17' on Febr[illegible] [illegible]he elongation is moderately [illegible]rable and abo[illegible] has the best chance of se[illegible] this elusive pla[illegible] will be necessary to observe be[illegible]e 7 a.m.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
Feb. 1	22 1	S 13 40
" 11	22 48	9 11'
" 21	23 34	S 4° 11'
Mar. 3	0 10	N 1 6'

Venus is an evening star in Virgo, setting about two hours after the Sun towards the end of the month, and thus observable for a short time in the West, immediately after Sunset. In the telescope the planet appears nearly at "full," 0·97 of the disc being illuminated, with an apparent diameter of 10".

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
Feb. 1	18 2	S 23 40'
" 11	18 33	23 44
" 21	19 5	23° 15'
Mar. 3	19 37	S 22° 22

Mars is visible in the mornings, rising about 5.15 a.m. near the middle of February. The planet is situated in Sagittarius, but is rather an inconspicuous object and ill-suited for observing through the telescope, the apparent diameter of the disc being less than 5".

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
Feb. 1	14 45	S 14 42
" 11	14 48	14° 53
" 21	14 50	14° 58'
Mar. 3	14 50	S 14° 58

Jupiter rises in the E.S.E. before midnight at the end of the month; on the 1st February he rises at 1.20 a.m., and on the 1st March at 11.35 p.m. The planet, with his bright moons, dark equatorial belts and spots, is an interesting object even in small telescopes. He is in quadrature on the 3rd February, and at the stationary point on the 1st March. The equatorial diameter of the planet is 38", whilst the polar diameter is 2"·5 smaller. This polar flattening is readily observed in telescopes powerful enough to see the belts, but the satellites may be seen in small telescopes, such as deer-stalkers of about 1¼ inches aperture, or even in a good pair of prismatic binoculars magnifying eight times. The Moon appears near the planet on the 19th.

SATURN

Date.	Right Ascen[illegible]	Declination.
	h.	
[illegible] 1	[illegible]	N 9° 20′
10	[illegible]	9° 50′
[illegible]r. 3	[illegible]	N 10° 2[illegible]′

Saturn is gett[illegible] to the West, but is observable throughout the [illegible] [illegible]0 p.m.

The planet is [illegible] [illegible]uous object in the South-West portion of the sky, a[illegible] [illegible]s in Pisces about ten degrees South of α Arietis. [illegible] [illegible]n the telescope, the ring appears open fairly wid[illegible] [illegible] are looking on the Southern surface at an angle of [illegible] [illegible]e apparent diameters of the outer major and minor [illegible] [illegible]he ring are 40″ and 12″ respectively, whilst the diam[illegible] [illegible]he ball is 16″. In the telescope, in addition to the rin[illegible] [illegible]ts on the planet's disc—although not so conspicuous as [illegible] on Jupiter—may easily be discerned. The Moon [illegible] near the planet on the 5th.

URANUS:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Feb. 1	19 53 20	S 21° 24′ 3″
Mar. 1	19 59 39	S 21° 7′ 15″

Uranus is a morning star, rising about 6.30 a.m. near the middle of the month, and for all practical purposes is unobservable.

NEPTUNE:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Feb. 1	7 24 28	N 21° 23′ 1″
Mar. 1	7 21 59	N 21° 28′ 45″

Neptune is situated in Gemini, about three-and-a-half degrees South-East of the star δ Geminorum. The planet is on the meridian about 9.40 p.m. near the middle of the month, and is practically above the horizon the whole night throughout the month. He is difficult to detect except in large telescopes, but he may be identified in small telescopes by his relative motion if successive observations are made some few days apart.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Near to	Characteristics.
	h. m.			
Feb. 5–10	5 0	+41°	η Aurigae	Slow; bright.
„ 15	15 44	+11°	α Serpentis	Swift; streaks.
„ 20	12 4	+34°	Cor Caroli	Swift; bright.

Minima of Algol occur on the 19th at 8.38 p.m., and on the 22nd at 5.27 p.m. The period is $2^{d}\ 20^{h}\ 49^{m}$ from which data other minima may be calculated.

Mira (o Ceti) is due at minimum on February 26th, its magnitude being about 8·5.

Double Stars. *Castor*, separation 5″·6, mags. 2·7, 3·7. Excellent object for small telescopes. The brightest pair to be observed in this country; can always be relied upon as a good show object.

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

ζ Cancri, separation 0″·9, 5″·2, mags. 5·5, 6·5, 7·5; with small telescopes the wider component is readily seen.

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

CLUSTERS.—M 44, the Praesepe in Cancer, visible to the naked eye as a nebulous patch, best seen and easily resolvable with a pair of opera or field glasses. On account of the scattered nature of the group the cluster effect is lost when observed with a telescope unless very low powers be employed. Situated about midway, and a little to the West of, the line joining α and δ Cancri.

THE ASSOCIATION OF PUBLIC SCHOOL SCIENCE MASTERS.

AT a general meeting held at the London Day Training College, on January 11th, Sir Ray Lankester, F.R.S., the President of the Association of Public School Science Masters, gave an address upon "Compulsory Science *versus* Compulsory Greek." So far as his own experience went, he condemned public schools. At the one which he himself attended, he maintained that he learnt nothing, though he was at the top of his various forms, and finished as the head boy. He thought that all the public schools should be day schools, that no master should be allowed to keep a boarding-house, being paid sufficiently well to make it unnecessary, and that only the very ablest teachers should be employed. He urged that the boy should have home surroundings, plenty of time to himself, and a place in which he could work undisturbed. Sir Ray Lankester brought many arguments to bear against compulsory Greek, and among the strongest of these were the following:—That although Latin had in times gone by been a necessity to the educated man, and was required if the scientific progress of the day was to be followed, the intention of learning Greek was to be able to read the works of the Greek authors in their own tongue. Many of the translations which exist render this unnecessary, and as an answer to the contention that Greek should be studied because classical men appreciated the Greek ideals, a translation was given of Aristotle's description of what constituted a good education. This coincided almost exactly with what a scientific man would lay down to-day.

In conclusion, a detailed scheme of work beginning with what Sir Ray Lankester called Equipment Studies, was laid down, and the way in which it could be carried out with efficiency was outlined. Among the Equipment Studies were these, in the order in which they were given:—English language, Latin, French, German, and Arithmetic.

After the Presidential address, Mr. A. Vassall (Harrow) dealt with the education of a medical student. He pointed out some common misunderstandings with regard to the powers and functions of the General Medical Council, and thought that if there was a movement in favour of one central qualifying body, the latter would probably be the Council in question. "The Association," he said, "must watch that this does not happen without the Head-masters' Conference being aware of it, otherwise, when it was too late, public schools would find themselves burdened with yet one more syllabus forced upon them as necessary for a good general education."

On the second day of the meeting, among the subjects down for discussion were the teaching of English in connection with science lessons, introduced by Mr. W. D. Eggar (Eton), and the use of the wave theory and of rays in teaching light.

NOTES.

ASTRONOMY.

By F. A. Bellamy, M.A., F.R.A.S.

THE ASTRONOMICAL SOCIETY OF BARCELONA.—The first annual meeting of this Society was held on the 8th December last, when, in accordance with the rules, the new president and executive council were elected. Interesting addresses were delivered by the retiring President on the progress of astronomical science during the year 1910, and by the Secretary on the development of the Society since its foundation. The inaugural meeting of the Society was held on the 30th January, 1910, at the University of Barcelona, as a result of the labours of Don Salvador Raurich, who had been carrying out valuable educational work in the city by means of popular articles on astronomical and allied subjects, contributed to the columns of *Las Noticias*, a well-known Barcelona journal. There were present at the inaugural meeting ninety persons from all branches of Society, including several professors of science from neighbouring colleges. Dr. Estéban Terradas, Professor of Science in the University of Barcelona, was elected first President, and a strong executive council was formed. In April, King Alphonso became a life member, and was elected Honorary President. In July, the first number of the monthly Bulletin was published, and this is now exchanged with all the leading societies and observatories. In the following month a prize medal was coined from the designs of Don Dionysius Renart. At the present time the membership numbers two hundred-and-thirty, and as a result of the first year's work the Society finds itself with a bank balance of £80, after paying all expenses. In the future it is intended to devote the accumulated funds of the Society to the erection and equipment of an observatory, where members may meet regularly, in a social way, for practical observation and the informal discussion of questions of astronomical interest. In the meantime, arrangements have been made with those members possessing private observatories to allow other members access thereto on specified occasions.

During the year eight lectures on astronomical subjects have been delivered in the Grand Saloon of the University of Barcelona, and numerous addresses on a smaller scale were given on practical spectroscopy and general astronomy in the private observatories of certain members.

The following is a list of the officers of the Society for the year 1911:—

- President: Professor Eduardo Fontsere, D.Sc., Chief of the Time Service of Barcelona.
- Vice-Presidents: Professor Luis Canalda and Don Ferdinand Tallada.
- Secretary: Don Salvador Raurich.
- Vice-Secretary: Don A. Pulvé.
- Treasurer: Professor M. Font y Torné, M.D.
- Other Members of the Council: Professor Ignacio Tarazona, Professor of Astronomy in the University of Valencia; Dr. Enrique Calvet; Don Jose Subiranas, and Don Juan Mercadal.

The address of the Secretary is Diagonal, 462, Barcelona, where all communications should be addressed. The Society is entering upon its second year of activity with bright prospects, and is very successfully cultivating a taste for astronomical study among all classes in Spain.

William Porthouse.

PRELIMINARY GENERAL CATALOGUE OF 6188 STARS.—The publication of this catalogue is the most important piece of computational work of its kind since the British Association Catalogue of 8377 Stars was compiled and published under the direction of F. Baily, about sixty years ago. Both these works differ from most other star catalogues in that they are not composed of observations made with one instrument or at one observatory, but the observations are collected from the best star-catalo[illegible] records mostly already published at various institutio[illegible]

The main principle pervading this w[illegible] Professor Boss is to determine accurate positions for a de[illegible] 1900·0,—we heartily wel[illegible] the adoption in [illegible] catalogues of such very convenient epochs as 1900, 1925, [illegible] and so on, rather than the usual p[illegible] of taking the mea[illegible] the observations, so any odd [illegible] may result,—of all [illegible] that indicate a proper motion of 10″ a centu[illegible] with a number of other stars of less motion [illegible] various reasons; the computation of the motions of [illegible] stars became the primary aim. Compiling these re[illegible] catalogue form was considered the best way of exhibiting them.

The stars included in these 6188 are chiefly stars visible without a telescope, therefore of the sixth magnitude and brighter; there are 4030 of these, 1919 north stars, and 2111 south stars; of the 2158 remaining, all fainter than the sixth magnitude, most of them are stars observed by James Bradley about one hundred and fifty years ago.

A preliminary piece of work of fundamental importance was the preparation and publication of a Catalogue of 627 Principal Standard Stars. In that were described the methods employed, and upon those star places the present catalogue of 6188 stars was based. During the progress of the work it became manifest that a great extension of the scope of the work upon a "general catalogue" was desirable. Certain materials for a catalogue of 25000 stars, to about the seventh magnitude, were available; but to include all these additional stars would require re-observation of a great number; besides, the increased time and expense required would be very great. The Carnegie Institution of Washington having agreed to provide the money for this greater proposal, Professor Boss decided to complete and publish the smaller work to the sixth magnitude, much on the lines as planned, depending upon other observatories' work, and to treat the greater catalogue as an independent piece of research work, which it certainly will be, as all the 25000 stars will be specially re-observed at two places in order to produce more homogeneous results.

A list of catalogues from 1755–1900, which have been used in the compilation, is given in the Introduction. It should be noticed that, differing from the usual practice, the correction for eliminating the effects of the magnitude-equation has been included in the right ascensions at the rate of ·008 per magnitude (on Pogson's scale of log. ratio, ·4).

The magnitudes have been taken from Chandler's Normal Uranometry (in MS. only), wherein the light ratio ·36 is used instead of Pogson's ·4, hitherto almost universally used by astronomers; it is to be presumed that there is sufficient reason in that unpublished work for this change, otherwise the change is to be regretted. The result is that a magnitude-equation determined in conformity with the Pogson scale (log. ·4) should be multiplied by 0·9 in order to reduce it to the scale of this catalogue, or *vice versa*.

A large amount of valuable information is given concisely in the Introduction, and there are three appendices. Appendix I contains ephemerides of Polar stars between 1900 and 1925. Appendix II contains important notes upon certain special stars, mostly binaries. Appendix III, pages 279–345, has involved almost as much work as the actual catalogue, and is of little less importance. It gives concisely the systematic corrections to each catalogue used, the corrections used for magnitude-equation, and the value or weights given to each catalogue. Altogether, it is a most valuable contribution to accurate astronomy, as distinct from the speculative side; it is beautifully printed, and forms Publication No. 115 of the Carnegie Institution of Washington. Professor Boss acknowledges his indebtedness to that Institution, to Dr. S. C. Chandler, to Mr. A. J. Roy, Mr. W. B. Varnum, Miss B. Benway, and Mr. B. Boss, for their zeal and help in the work.

F. A. B.

VARIABL[illegible] OR NOVA LA[illegible]AE (ESPIN).—The beginning [illegible] end of the year [illegible] were characterized by important [illegible]ronomical discov[illegible] beginning was by the Daylight [illegible]omet, the end [illegible]nt New star, which is appro[illegible]ate at this particul[illegible] of Epiphany.

"[illegible] 0.55 p.m., rece[illegible]ford 7.33 p.m., December [illegible]st, 1910.

"To University O[illegible] Oxford.

"Nova Lacertae [illegible]w Law 30080 Dezember 07359 Greenwich 3380[illegible] 72239 47224 Helle Linien."

Thus runs the [illegible] received by the subscribers to the Central Office f[illegible]nomical Telegrams conducted by Dr. Kobold at K[illegible] meaning is that the Rev. T. E. Espin, M.A., F.R.A[illegible]rly of Exeter College, Oxford, and now the Rect[illegible]singham, Tow Law, near Darlington, by assiduou[illegible]ning the sky and examining the stars for duplic[illegible]variability, was able to detect the appearance of a [illegible] star of about the seventh magnitude near the edg[illegible] the constellation Lacerta, towards Cephens, at R.A. 2[illegible]^m 10^s 15′ 21″+52 (1911), and in the Milky Way, [illegible] p.m., on December 30th. Reference to maps failed to [illegible]w any star in that position, and upon examination with a [illegible]ectroscope, bright lines were noticed in such positions as [illegible]ndicated the star to be a new one, or one variable in magnitude. The evening of December 31st was very cloudy. At Oxford, on January 1st, two photographs of the region were taken with four exposures of a few minutes each, and the results of the measurement of one of these plates were communicated to the Royal Astronomical Society's meeting on January 13th, and will be published in the *Monthly Notices* in February. Photometric and eye estimations of its magnitude have been made by Mr. Espin, and at the observatories at Greenwich, Cambridge, Oxford (both observatories), Harvard College (U.S.A.); the magnitude was made out to be between 7·0 and 8·0, or one-and-a-half magnitudes brighter than the star near it. Various observers have noted it as "red"; the writer has not yet been able to make it deeper than "orange," and to him it appears to have nothing of the "Hind's crimson," R. or S. Cephei hue about it. The magnitudes deduced from photographic plates, however, do not fit in with the general ideas of chemical action, colour, and photographic results; for, if the colour be red or orange and less actinic to the sensitive film of a monochromatic plate (with emulsion such as is generally in use for hand-camera and extra-rapid work), one would expect to get a smaller image of it on the photograph than of a normal star, both being determined by photometric or visual observation to be of the same magnitude, say seven. But the photographs appear to give the magnitude on January 1st and 2nd as 6·7 or 6·6, or about two-thirds of a magnitude brighter than by other methods. During the first part of January the star changed or lost little, if any, of its brightness.

Mr. F. W. Dyson, the Astronomer-Royal, has received information from the Harvard College Observatory that the new star was visible on photographs exposed there on November 23rd, 1910, when its magnitude was determined to be equal to 9 Lacertae, or 5·0 photographically, and, therefore, quite visible without optical aid. The interesting feature in the examination of the Harvard store of photographs, going back many years, is that, on November 19th the star was not visible, *i.e.*, it was probably fainter than the eleventh magnitude, if at all visible in the sky; it was again photographed on December 7th, but, in spite of the large number of telescopes, photographs, and keen observers searching the sky, this naked-eye star was not detected until December 30th, by Mr. Espin.

Though some are disposed to consider the discovery to be merely that of a variable, because rumours have been current that Dr. Max Wolf has photographs, taken nearly twenty years ago, which show a faint star in the position of the Nova, —but we must wait for accurate measures, before accepting this information—there is plenty of evidence for us to consider it to be as much a new star as others. The immense and nominally instantaneous brightening up by eight, ten, or more magnitudes—as in the most prominent cases of T. Coronae (1866), Nova Andromedae (1885), Nova Aurigae (1892), Nova Persei (1901), and Nova Geminorum (1903)—classify these *Novae* as being of a different order from all known variable stars, though their spectra may be similar.

Two questions arise and present themselves for astronomers to solve, now that thousands of photographs, taken during the last thirty years, are available for reference. When is a *Nova* not a *Nova*? And who is to be entitled to the credit of the discovery in such cases as *Nova* Geminorum and the star which is the subject of this note? Surely not the one who first saw or photographed it, but the one who first drew the attention of the astronomical world to it.

F. A. B.

THE PRESENT STATE OF VARIABLE STAR WORK (II).—For the sake of convenience the following survey of variable star work has been arranged under the heading of countries, taken approximately in the order of their respective importance as regards this matter. I have made no attempt to write an historical sketch and, therefore, have confined myself essentially to present facts. As it may be easily understood, "absolute" completeness in such a work is difficult to attain; many astronomers have made purely accidental discoveries of variable stars in the course of other duties—such as observations of planets, comets, and double stars, zone observations, measures and comparisons of celestial photographs—without being really interested in this branch of astronomy, and it could be hardly possible to include their names here. I am satisfied, however, that no essential fact has been overlooked in the following.

GERMANY.—If the height of scientific activity resides in care, spirit of enterprise, continuity, abundance and accuracy of bibliographical sources and especially "thoroughness," rather than in multiplicity of discoveries, one must admit that German astronomers, following the glorious steps of their great Argelander, the initiator of the "science" of variable stars, always took the lead in this branch of astronomy.

A good deal of this result, in modern years, is undoubtedly due to the vivid interest shown in stellar photometry by the "Astronomische Gesellschaft," an international association of (principally professional German, Austrian, Scandinavian and Russian) astronomers, established in Leipzig in 1865. The "A.G.," as it is generally named for the sake of brevity, whose star catalogues are well known everywhere, controls three organizations of importance connected with our special subject.

(1) A "Committee on Variable Stars," at present composed of Professor N. C. Dunér, director of the University Observatory of Upsala (Sweden), Professor Dr. Ernst Hartwig, director of the Remeis Observatory in Bamberg (Bavaria), and Professor Dr. G. Müller, chief astronomer at the Royal Astrophysical Observatory of Potsdam (Prussia). When, in 1901 (See *Astronomical Journal*, Nos. 491–492 and Nos. 505–506), Mr. Seth C. Chandler, of Boston, to whom I will refer afterwards, declared that he was going to give up the important and strenuous task of collecting all available information on variable stars, and cease to assign definitive names to those whose elements were sufficiently known, a work which he had carried on for years with a great skill, the A.G. Committee on Variable Stars which, at the time, comprised also the Dutch Professor Oudemans, since deceased, at once took over the matter and has directed it ever since with a great exactness, Professor Müller especially taking a great share in the work. The Committee has made special and very wise rules (fully explained in *Astronomische Nachrichten* 171, 347) for the admission of suspected variable stars among the number of those to which definitive letters are affixed, the principal of them being that the range of light variation ought to be at least half a magnitude, that the character of this variation must be, at least roughly, indicated, and that it must have been confirmed by at least one other observer than the discoverer. Save some critical views uttered by that other well-known authority, Professor E. C. Pickering (See *Annals of Harvard College Observatory*, Vol. lv., page 87), and which serve only to demonstrate the fact that no human work

can reach perfection, the verdicts of the Committee have always met with the approval of the astronomical world, and received unanimous praise.

Once a year, generally in the month of November or so, the Committee publishes, in the *Astronomische Nachrichten*, a list of lettered variables, giving in tabular form, their name, provisional number, position for 1855.0 and 1900.0, value of precession, magnitudes at maximum and minimum, and indication whether these magnitudes are visual or photographical. This list is supplemented by notes giving references to catalogues ("Bonner Durchmusterung," or "A.G." numbers), indicating the name of the discoverer and "supporter," and giving a short historical sketch, with elements, colour, and other notes.

(2) The *Astronomische Nachrichten* (A.N.), the leading astronomical paper of the world, is published at Kiel (Schleswig-Holstein), at the rate of one or two numbers, generally of eight pages (or sixteen "columns" as they are numbered) a week, twenty-four numbers forming one volume. The character of this paper is thoroughly international and, though many papers are printed in the German language, French, English, Italian, Spanish, and even Latin memoirs are not uncommon. The *Astronomische Nachrichten*, founded by H. C. Schumacher, in 1821, September, and therefore the oldest amongst astronomical journals, is about to publish its one hundred and eighty-seventh volume (commencing with No. 4465, issued 1911, January 12th), and is under the editorship of Professor Dr. Hermann Kobold, astronomer at the Observatory of Kiel's University, who also directs the *Centralstelle* for the centralization and circulation in Europe of astronomical news. The collection of this paper includes also seventeen more or less extensive complementary numbers or *Ergänzungshefte* and six general tables of contents, a seventh being in course of preparation, as well as reprints of some old volumes.

The *Astronomische Nachrichten* contains the greatest part of variable star information and has, for a long time, been the medium through which new discoveries of these objects are announced to the world. In order to avoid confusion and to permit easy references, Professor Krentz, the fourth editor of the paper (the first was Schumacher), decided, in 1900, to affix a "provisional number" to new variables, pending their definitive lettering by the "A.G." Committee. This series of numbers is begun again every year, from No. 1, the name of the year being affixed to the number. So, for example,

BD+7 929 47.1910 Orionis RT Orionis.

This is a similar method to that followed for new asteroids, save that a reverse system is in use; newly-discovered small planets receive a double letter with the year prefixed, and are afterwards numbered and named.

(3) Some years ago the "Astronomische Gesellschaft," represented by its committee on variables, decided to compile and publish a great catalogue of these objects. As will be seen afterwards, works of this kind have been planned and partly printed elsewhere, but it may be confidently assumed that the bibliographical task now undertaken in Germany will go far beyond all that has been done till to-day, and will form a standard work, whose value, as it approximates to completeness, can hardly be overrated.

The catalogue will be divided in four great sections:—(*a*) Variable stars; (*b*) Suspected variable stars; (*c*) Variable stars in clusters; (*d*) New or temporary stars; dealing with one thousand objects. Other somewhat abridged monographs will deal with newly-discovered variables, for which the available material of observation is less abundant. The work will give for each variable the "complete" bibliographical sources and references, and a thorough discussion of all published (and, in many cases, unpublished) data. It will not include however, some well-known variables on which complete monographs have already been published, such as o Mira Ceti (Guthnick), χ Cygni (Rosenberg), δ Librae (Kron), R Coronae (Ludendorff) and U Geminorum (van der Bilt).

The discussion of this formidable material, always kept up to date, has been divided among a number of fellow-workers. At the time of writing, the MSS. for seven hundred stars is ready, two hundred are under [illegible] and one hundred are still in abeyance. In the cours[illegible]nty-third meeting, recently held in Breslau (see "Kn[illegible]" 1910, November and Decem[illegible]er), the Society voted a s[illegible] marks (£50) towards th[illegible] continuation of the wo[illegible],000 marks (£500) towards t[illegible] cost of printing the [illegible] [illegible]hich may be expected to app[illegible] in the course of the [illegible]sent year.

F[illegible]

Honorary Se[illegible]ry "Société d'Astro[illegible] d'An[illegible]ers."

(T[illegible] *continued.*)

BOTANY.

By Professor F. Cavers, D.Sc.

EOCENE FLORAS.—In a recent paper on "An [illegible] Flora in Georgia, and the Indicated Physical Conditi[illegible] Berry (*Bot. Gaz.*, vol. 50, 1910), draws an interest[illegible] comparison between the Eocene floras of Europe an[illegible] North America. The Middle Eocene floras of North America, like those of Europe, show distinctly tropical characters, which are absent in the earlier or Lower Eocene. These characters first become marked in the fruits from the London Clay and the leaves from Alum Bay, and in corresponding deposits on the Continent. These floras show much closer affinities with the modern floras of Malaysia and tropical America than with those of Australia—the supposed Australian affinities of the Eocene floras may now be regarded as an exploded myth. The Eocene genus *Nipadites* corresponds exactly with the modern Palm genus *Nipa*, which inhabits the tidal waters of the Indian Ocean, and ranges from India, through the Malay Archipelago, to the Philippines. The *Nipa* swamps of the Eocene period ranged northwards in Europe to southern England, and though *Nipadites* does not occur (so far as known) in the Eocene of America, the latter shows various forms, either identical with, or allied to, the plants associated with *Nipadites* in the Eocene of Europe, including various tropical Ferns. The existing flora of Florida, the Bahamas and Bermuda contains a large element which has been derived in comparatively recent geological times from the south, but the main elements of these modern floras were already in existence in the Middle Eocene, if not earlier. There is abundant evidence that nearly all modern plant families, excepting such specialised forms as the Orchidaceae among Monocotyledons and the Compositae and their allies among Dicotyledons, were at one time more widely distributed than they are at present, and that the details of modern geographical distribution represent in a less degree the interchange of types between different areas than they do the greater or less degree of segregation of descendants of forms once spread over much wider areas. The strictly modern movement of the subtropical flora along the course of the Gulf Stream has been from the south, northward, as the various coral islands of the Bahamas became evolved. This dispersal was preceded by a similar spread of the tropical flora on a much more extended scale during the early Tertiary.

AFFINITIES OF CACTACEAE.—The Cactaceae have attracted a large amount of attention recently. A special German journal has been founded to deal exclusively with this family of plants, and some interesting observations and speculations have been made by various writers regarding the affinities of the family and its position in the natural system. The Cactaceae have for long been regarded as an isolated group of obscure affinities, and in different systems of classification they occupy very various positions. Although the Cactaceae are highly specialised as regards their vegetative characters, there are many features in their floral structure that indicate affinities with the cohort Ranales, which includes the orders Nymphaeaceae (Water-lilies), Magnoliaceae (Tulip-tree, and so on), and Ranunculaceae, besides others. The most striking of these "Ranalian" characters are: (1) the numerous spirally arranged sepals, petals, stamens, and carpels; (2) the occurrence in some cases of a gradual transition from sepals to petals; (3) the insertion in some cases of the sepals and petals on the outer surface of a receptacle cup in which the carpels are embedded. There is an especiall[illegible]king similarity [illegible] h[illegible] flowers of such Cacti as [illegible]*cereus* and su[illegible]aceae as *Victoria* and *Eur*[illegible]. The suggesti[illegible]nalian" ancestry for the C[illegible], based on the st[illegible]t the flowers, is greatly stren[illegible]ened by the recen[illegible]liss de Fraine (*Ann. Bot.*, 1[illegible]) on the structure o[illegible]tion region between stem [illegible] root in the seedli[illegible]ous members of this order. It [illegible]as found that in [illegible] which have the least modified seedlings—those [illegible] we should expect to find that ancestral charact[illegible] be retained—the same type of transition of the [illegible]ndle system occurs as in certain Ranunculaceae. [illegible] Sargant (*Ann. Bot.*, 1900) showed that this partic[illegible]e of transition structure pointed to the origin of th[illegible]cotyledons from Dicotyledons allied to Ranuncul[illegible]

CHEMISTRY.

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

S[illegible]ILISATION OF WATER BY MEANS OF UL[illegible]A-VIOLET RAYS.—The use of ultra-violet rays for t[illegible]tive sterilisation of large quantities of water has been [illegible] the subject of several recent patents, and processes [illegible]sed upon the principle have been adopted in many places. [illegible] has been demonstrated by Messrs. Urbain, Scal and Feige. *Comptes Rend.*, 1910, CLI., 770,) that the most important factor in this method of sterilisation is that there should be uniform exposure of the particles of water to the source of light. In some types of apparatus this condition is attained by enclosing the mercury vapour lamp in a box with three quartz sides, round which the water is made to flow in a semi-circular trough in such a way that it moves alternately towards and away from the lamp, which forms the centre of the semi-circle. Again, in the apparatus constructed by Urbain and his collaborators, the water is made to circulate in a spiral within a cylinder about two-and-a-half yards in diameter, the opening into which is concentric with its axis. The water being forced into this cylinder at a tangent, whorls round so as to leave a nearly vertical cavity in the centre, and within this is suspended the lamp. Under these conditions, the maximum distance of the water from the source of light is about forty-two inches, and the minimum distance about three-and-a-half inches, while the period of exposure is about three minutes. The positive electrode of the lamp is composed of aluminium, coated with a thin layer of iron, while the negative electrode consists of carbon. The yield of sterilised water obtained from an apparatus of this kind ranges from ten to fifty cubic metres per hour, the average quantity being about twenty metres. A sterilising plant based upon this principle has been erected at Neuilly-sur-Marne, and gives a supply of sufficiently sterile water at an expenditure of twenty watts per cubic metre.

THE WATER OF GREAT SALT LAKE.—An interesting series of analyses of water from Great Salt Lake is published by Messrs. Ebaugh and MacFarlane (*J. Ind. Eng. Chem.*, 1910, II, 454), showing the variations in the amount of saline constituents during the last forty years. During the four years of drought ending in 1904, the level of the water fell to such an extent that the idea of the lake becoming dry was seriously entertained; but after the succession of wet years since that date, there is more likelihood of the surrounding country becoming flooded. These extremes are reflected in the composition of the water at the different periods, the specific gravity and the total solids showing an enormous decrease since the close of the dry period. Thus, in October, 1903, the water had a specific gravity of 1·2206, and contained 338·36 grammes per litre of total solids, whereas in October, 1909, the specific gravity was 1·1561, and the total solids were only 242·25 grammes per litre. The composition of the water varies at different periods of the year, the proportion of dissolved salts being greater in the autumn.

A NEW METHOD OF PREPARING ARGON.—A rapid method of obtaining large quantities of argon is described by M. G. Claude in a recent issue of the *Comptes Rend.*, (1910, Vol. CLI, 752). Oxygen obtained in the liquefaction of air is used as the source, for it has been found that the chief impurity in the oxygen is argon, the volatility of which is intermediate to that of oxygen and of nitrogen. To separate the argon, which then often exceeds three per cent., the oxygen is absorbed by means of copper, and the nitrogen by magnesium. For this purpose the gas is passed through a red-hot copper tube charged with reduced metallic copper and copper filings, and on leaving this passes through a red-hot iron tube containing magnesium powder. Lastly, it is passed through a tube of silica containing copper oxide to absorb any hydrogen derived from moisture in the oxygen or in the copper. From eight to twelve litres of pure argon may be obtained by means of this apparatus in about two hours, after which the copper becomes spent, and must be regenerated by a current of hydrogen.

THE SOYA BEAN INDUSTRY.—The importance of soya beans as a new commercial product may be gathered from the fact that during the year 1909, upwards of five hundred thousand tons were imported into this country from China, and were utilised in the manufacture of oil and of seed cake for cattle. Prior to 1908 only small consignments had been imported, but the great scarcity of fats and oils required for the manufacture of soap induced the manufacturers to make experiments with every kind of oil, and as soya bean oil was found well suited for the production of soft soaps and, in admixture with other fats, for hard soaps, it speedily established its present position. The beans, which are used in China and Japan in the preparation of soy sauce and other food products, yield, when pressed, about 10 per cent. of a yellow oil, which has weak drying properties and possesses many points of resemblance to cotton seed oil. The oil is used for food in China, and has been tried for the same purpose in this country. Attempts have also been made to employ it in place of linseed oil in the manufacture of paints and linoleum, but its inferior drying properties have prevented its application in this direction. The beans contain about forty per cent. of protein substances and twenty-three per cent. of carbohydrates, and the residue from which the oil has been expressed is thus a valuable feeding stuff. Unsuccessful attempts have been made to acclimatize the soya bean in Germany, but the plant has already been introduced into West Africa and the southern part of North America, with every prospect of success.

GEOLOGY.

By Russell F. Gwinnell, B.Sc., A.R.C.S., F.G.S.

A CENTRAL AFRICAN GLACIER of Triassic age is dealt with by Messrs. Ball and Shaler in the *Journal of Geology*, November-December, 1910. The glacial features occur in the Lubilache formation of the Belgian Congo (better known as the "Congo Free State"). This formation consists mainly of alternating beds of sandstones and shales of Triassic age. It is concluded from the evidence that a glacier or glaciers pushed in a tongue down the present valley of the Lualaba River; from the fact that large boulders probably dropped by icebergs are found at least two hundred feet above the base of the formation, it is believed that long after the glacier had retreated toward the south, glaciers still existed to the south-east. This glacial epoch must therefore have been of a considerable duration.

The glacial features presented are:—

(1) Striations having the characteristics of glacial striations, on pebbles in the basal conglomerate of this series, indicating morainal origin.

(2) The tongue-like form of the basal beds and the character of this conglomerate, including the size of the boulders, the lack of assortment, the patchy arrangement of the material and the preponderance of boulders of local origin.

(3) Erratic boulders, presumably dropped by icebergs, occurring in shales of this series.

(4) Probable glacial scratches, crescentic gouges and smoothings on the surfaces of older rocks upon which the Lubilache was laid down.

IGNEOUS ROCK COMPOSITION.—Several petrologists have calculated, from large collections of published analyses, the "average composition" of an igneous rock. In some cases no account is taken of the relative masses of the rocks represented by the analyses, in others these relative masses are reckoned with as far as possible. By the former method the average igneous rock appears to have a composition close to that of many pyroxene andesites and quartz-mica-diorites: in passing it is interesting to note that these are extremely common rock types. By the second method Professor Vogt finds the average rock to be far more acid—with about 74% of silica—and thus corresponding with a granite in this respect. In "An Introduction to Petrology" (1910), Mr. F. P. Mennell tackles the subject by this second method, dealing with the rocks mapped in the neighbourhood of Bulawayo, in Rhodesia. Putting minor rock types into one or other of larger groups, he estimates eleven thousand nine hundred and sixty square miles of igneous rock (assumed to extend one mile vertically downwards) to be made up as follows:—Granite, eleven thousand six hundred and seventy cubic miles; syenite, forty; picrite, two hundred and forty; dolerite and basalt, ten; and the average silica percentage becomes nearly seventy. If this is fairly representative of other large areas of the earth, it would indicate that granite represents the average composition of the igneous rocks.

A somewhat similar problem is attacked by R. A. Daly in "The Average Chemical Composition of Igneous Rock Types" (*Proc. Amer. Acad. Arts and Sciences*, xlv., 1910). The author, using various collections of analyses, calculates the average chemical composition of ninety-eight principal igneous rock types, and incidentally these may be used as a basis for finally calculating the "average igneous rock." The relative uniformity in the soda percentage of the more abundant types is specially noted in its bearing on the origin of oceanic sodium, and therewith, on the problem of the age of the earth. The striking similarity of the average granite analysis to the average analysis of the base (ground mass) in augite andesite, and the equally close resemblance of the average diorite analysis to the arithmetical mean of average basalt and granite, are illustrated.

The same author discusses the "Origin of the Alkaline Rocks" in *Bulletin Geol. Soc. America*, xxi. (1910). It is usually recognised that there are two great branches of igneous rocks—the "alkaline" (rich in soda and potash), corresponding in a general way with the areas of the Atlantic type of coast-line as defined by Suess, and the "sub-alkaline" or "lime-alkaline," corresponding with the Pacific type. In the present paper, Dr. Daly states that no alkaline province can be described as free from sub-alkaline eruptives, especially those of basaltic or granitic types. Emphasis is laid on the indisputable fact that the visible volume of all alkaline rock-bodies is a very minute quantity as compared with the visible volume of sub-alkaline eruptive bodies. An inductive study shows that most alkaline rocks cut thick masses of limestone or other calcareous sediments. This fact suggests the hypothesis that the absorption of carbonate disturbs the chemical equilibrium of sub-alkaline magma in such manner that alkaline fractions are produced by differentiation. Most of the alkaline species are ascribed to the interaction of basaltic magma and limestone (or dolomite), but more acid magma is also sensitive to the solution of carbonate. The hypothesis explains the concentration of alkalies, the desilication shown by the crystallisation of nepheline, leucite, corundum, and so on; the extreme variability of alkaline bodies in mineralogical and chemical composition, the occurrence of such lime-bearing materials as melilite, scapolite, melanite, and so on, and CO_2-bearing minerals, as cancrinite and primary calcite.

Alkaline rocks of exceptional interest are found in Ayrshire, and neighbouring parts of Scotland. A preliminary account of some of the types is supplied by Mr. G. W. Tyrrell (*Trans. Geol. Soc., Glasgow*, vol. xiii., pt. iii.), who promises a more detailed paper on the subject. Teschenite, essexite and trachyte are among the types, and some of the rocks contain much analcime, which appears to be primary. Thus there is an analcime syenite, composed principally of soda-orthoclase, albite and analcime, with purple titaniferous augite, barkevikite and aegerine. Another rock is composed principally of analcime, with a little nepheline, crowded with perfect euhedral barkevikite, sometimes with a [illegible]aferous augite and plagioclase.

In the *Geological Magazine* for Ja[illegible] 1911, Mr. F. P. Mennell describes dolerites of Rho[illegible]taining quartz, either in separate granules or in the [illegible]ropegmatite. The dolerite dykes penetrate the great [illegible] masses of the country, and the quartz, when occurring in [illegible]d-sized corroded fragments, is obv[illegible] derived from the gr[illegible]. [illegible] the case of the smaller gra[illegible] and the micropegma[illegible], the origin of the quartz is not so [illegible]. The phenomen[illegible] some respects, closely similar t[illegible]se which Professor [illegible] led in certain cases, which seemed to him to prove t[illegible] origin of micropegmatite and the growth of cryst[illegible] after their solidification (*Q.J.G.S.*, May, 188[illegible]. Rhodesian rocks there is clear evidence that the [illegible]pegmatite fringes represent the surviving portions of c[illegible] which have had their exteriors melted or corroded. "The outgrowths are, therefore, as Judd correctly surmised, [illegible] the nature of secondary enlargments long after the consolidation of the original nucleus. Where his suggestion was at fault, was in regarding the regrowth as having taken place at the expense of a non-crystalline ground mass. The outgrowths that we have been discussing are clearly due to the re-crystallisation, under the influence of heat, of the exterior portions of the original crystals, together, in some cases, with materials due to reactions with the surrounding crystals or with introduced substances. The light such an observation throws on the occurrences of quartz and micropegmatite among basic rocks, and upon the frequently-noted association of gabbro or dolerite with granophyre, is evident. There seems little doubt that it may usually be ascribed to the partial admixture, prior to intrusion, of acid and basic materials, not necessarily from related magmas, or even entirely of igneous origin."

Very similar rocks to these Rhodesian quartz and micropegmatite-bearing dolerites were described in the same magazine in July and August, 1909, in Mr. G. W. Tyrrell's "Intrusions of the Kilsyth-Croy District." These rocks, from Dumbartonshire, Scotland, are described as granophyric diabase, and the grains of quartz and patches of micropegmatite are said to be primary. It is here suggested that the gabbro-granophyre mélange rocks owe their origin to the interaction of a normal basalt-magma with a highly siliceous country rock, and that the normal granophyric diabases, with their remarkably constant chemical composition, represent the saturation-point of such a magma with silica. The excess of siliceous matter is believed to be thrown out as a separate body of material, usually consolidating as granophyre, in a manner analagous to the separation of the excess of a salt in a saturated solution.

While dealing with rock-magmas and solutions, reference may be made to a paper in the *American Journal of Science* for January, 1911.—"Solid Solution in Minerals, with Special Reference to Nephelite," by H. W. Foote and W. M. Bradley. It is a well-known fact that there are certain minerals to which no satisfactory chemical formulae can be assigned, which agree with the results of analysis. In general, the composition of a mineral, as obtained in analysis, varies from the composition of the ideal pure compound for two reasons, apart from errors of analysis. Either there is (*a*) isomorphous replacement of one element or radical by another, or (*b*) there are mechanical impurities present. The authors call attention to another influence, which must probably be taken into account in cases like that of nepheline (to which the formulae $NaAlSiO_4$ and $Na_4Al_4Si_9O_{19}$, besides others more complicated, have been given). It is assumed that in certain cases a substance on crystallising forms a solid homogeneous solution with foreign matter, which is neither isomorphous with any constituent, nor can be regarded as a mechanical mixture. It can be compared to the solution of salt in water, in which the salt takes on the appearance and form of the water without taking any part in the formula of the water. The authors maintain that the pure compound, which forms the basis of nepheline, is the orthosilicate $NaAlSiO_4$, and that the observed variations from this are due to silica dissolved in the silicate. Just as very little is known about the condition of dissolved substances in liquids, as to wheth[illegible]hey are combin[illegible] the solvent, so in this case it is [illegible]possible to say w[illegible] the silica is present as dissolved [illegible]lbite or silica, or [illegible] or in any other form. The ex[illegible]s of silica which [illegible]ken up by nepheline to form [illegible] saturated solut[illegible] apparently be determined. Wh[illegible]e albite is found [illegible] mixed with nepheline it is evident that the neph[illegible] be saturated with silica, and the excess of the [illegible] formed albite. The authors suggest the applic[illegible]heir arguments to other minerals, and state that w[illegible] already been begun on pyrrhotine, the magnetic s[illegible]f iron, the formula of which is variously given [illegible]S_7, Fe_7S_8, and so on. In this case, analyses vary [illegible] Fe_7S_8 up to $Fe_{16}S_{17}$, while conforming to the general f[illegible]e_nS_{n+1} (Dana's "Textbook of Mineralogy").

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

The [illegible]ather of the week ended December 17th was rough and [illegible]ually, with high temperature and much rain. Of the tw[illegible] districts into which the British Isles are divided for [illegible]eorological statistical purposes, five were noted as being very unusually warm, six as unusually warm and only one (Ireland S.) as moderate.

The excesses above the average varied from 3°·5 in the English Channel to 9°·1 in England E. The highest maximum was 57° which was recorded at Geldeston and also at Jersey, but in all districts readings of 50° or upwards were recorded. The lowest readings were 30° at Strathpeffer and Nairn on December 16th, but at no other stations in the British Isles did the temperature fall below the freezing-point. The rainfall was in excess in all districts, except Scotland N., where it was but little more than half the normal amount. In England S.E., the rainfall was three and a half times as much as usual. At many stations rain was measured each day, and at Llangammarch Wells, the total for the week was as much as 4·74 inches. Sunshine was generally below the average; in many places very much so. At Westminster, the total duration was 2·9 hours, or 5%. At Greenwich it was 6·7 hours or 12%. There was much strong wind during the week, and on the 16th there was a severe and widely-spread gale. The temperature of the sea water varied from 51° at Salcombe to 41° at Cromarty.

The week ended December 24th was much drier than those which had preceded it; still rain fell frequently, and at several stations on every day. The aggregates were less than the average in all districts except Scotland N., where it was double the usual amount. In England N.E., the rainfall amounted to only 0·08 inches, or less than one-sixth the normal. Temperature continued high, and there was excess in each district, as much as 6°·0 in Scotland E. The highest reading recorded was 57°, but in all districts readings of 53° and upwards were recorded. The lowest minimum was 27°, at Swarraton, Hants. Bright sunshine was also in excess generally, though some curious anomalies were reported; thus, for instance, at Birr Castle the total duration was 8·2 hours in excess, while at Dublin it was 7·0 hours in defect. The mean temperature of the sea water was higher than in the corresponding week of last year by as much as 6° at some stations. The individual readings ranged from 51° at Salcombe, to 40° at Pennan Bay and at Cromarty.

The weather of the last week of the year was unsettled, but there were bright periods in most parts, and several dry days. Temperature was rather above the average as a rule, and readings of 50° or above were recorded in all districts except Scotland E. The highest maximum observed was 53° at Killarney and at Jersey, while on the other hand the lowest recorded was 18° at West Linton, on the 28th, and 19° at Llangammarch Wells on the same day. On the grass the temperature fell to 8° at Llangammarch Wells, to 15° at Tunbridge Wells and to 16° at several places. Rainfall was scanty except in Scotland N., the amounts in many places being one-fourth or less of the average; at Leith the total for the week was only 0·01 inch. Sunshine was generally in excess, and the largest aggregate recorded, namely 25·3 hours, at Hastings, was 47% of the possible duration. On the other hand, at Westminster the total duration was only 2·7 hours or 5%. The sea temperature showed a considerable decrease as compared with the previous week and ranged from 50° at Scilly and Plymouth to 39° at Cromarty.

The weather during the first week of 1911 was generally dull and wet, except in the North-West, where it was dry and fine. Temperature was below the average, except in England, N.E., where it was 0°·2 in excess. The defect was, however, as a rule, not of great amount. Individual readings exceeded 50° in most districts, and in Ireland S., on the 7th, 52° was reported, both at Killarney and at Valencia. Frost was experienced in all districts except the English Channel. The lowest of the minima were 16° at Balmoral, 20° at Nairn, West Linton, and Strathpeffer, and 21° at Birr Castle and Cahir, in Ireland S. The readings on the grass were as low as 9° at Llangammarch Wells, and 14° at Balmoral. Rainfall was above the average in England N.E., E., and S.E., but was deficient elsewhere. In Ireland S., the aggregate fall was but little more than half the usual amount. Sunshine was, as usual, greatest where rainfall was least; the percentages of its possible duration ranged from 14% in England, N.E., to 37% in Ireland N. At Westminster the total duration of Sunshine for the week was only 0·6 hours. At Aberdovey it was 22·2 hours. A severe thunderstorm, accompanied by snow and hail, was experienced in Norfolk during the early hours of January 2nd.

The week ended January 14th was unsettled, with rain during the earlier days and sleet and snow later. Temperature was below the average in England S.W., English Channel, and in Ireland, but above it elsewhere. The departures from the mean, however, were not large. The highest reading was 54° at Killarney on the 8th, and temperatures of 50° or upwards were reported from each district. The lowest minimum was 22° at Kilmarnock and at Cally, Gatehouse, on the 13th. At several other stations the readings were below 25°. On the grass the temperature fell to 12° at Newton Rigg, and to 14° at Tunbridge Wells. Rainfall also was not far from the mean, being below it in the Midlands, England S.W. and in Ireland; equal to it in England N.W., and above it in the other districts. The heaviest fall was on the 10th when 1·36 inches fell at Poltalloch, 1·17 inches at Fort William, and 1·04 inches at Aspatria. Sunshine was in excess in all districts except Scotland N., where it was slightly in defect. The greatest divergence from the mean was in England S.W., where the district value for duration was 17 hours as compared with an average of 10 hours. At Westminster the aggregate was 8·1 hours (15%); at Falmouth 23·8 hours (42%). A thunderstorm occurred at Newcastle-on-Tyne on the 12th. Aurora was seen in Scotland on the 8th. The temperature of the sea water varied from 49° at Scilly and Plymouth to 36° at Cromarty.

THE RAINFALL OF 1910.—Dr. H. R. Mill, of the British Rainfall Organization, has an interesting article in the last number of *Symons's Meteorological Magazine* upon the Rainfall of the past year. The year was a wet one in nearly all parts of the Kingdom. The principal parts of the country having less than the average amount were Western Ireland (Counties Galway, Mayo, and part of Clare); Western Scotland (Argyll and the Western islands), South-Eastern Scotland and North-Eastern England; and a narrow strip on the coast of South Wales. Each country, however, had an excess, England and Wales of 11%, Scotland 2%, and Ireland 9%. For the British Isles, as a whole, the excess was 8%. February was the wettest month, with 61% excess, and September was the driest month, with 69% defect.

September, 1910, was one of the driest Septembers on record, and February was one of the wettest Februaries. The total rainfall for the ten months, January to September, was almost exactly equal to the average fall for the whole year.

Since 1889 there has been a marked sequence of two dry years followed by one wet year, but this relation has now broken down, and we have had two wet years in succession. Dr. Mill adds: "It seems possible that the swing of the pendulum is carrying us into a period of predominating wet years, corresponding to the wet period of 1874–1883."

MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD	ARTHUR EARLAND, F.R.M.S.
JAMES BURTON.	RICHARD T. LEWIS, F.R.M.S.
THE REV. E. W. BOWELL, M.A.	CHAS. F. ROUSSELET, F.R.M.S.
CHARLES H. CAFFYN.	D. J. SCOURFIELD, F.Z.S., F.R.M.S.

C. D. SOAR, F.R.M.S.

DR. ERNST LEITZ.—We have much pleasure in announcing that the University of Marburg has conferred the degree of Doctor of Philosophy *honoris causa* upon the principal of the optical works, Wetzlar. We congratulate Dr. Ernst Leitz on his well-deserved honour.

A NEW MICROSCOPE LAMP.—The lamp consists of a five-inch circular base, having a telescopic square vertical tube about six inches long, formed of two square tubes sprung so as to slide the one within the other. The outer tube is plugged at the bottom with brass and terminates in a three-eighths inch brass screw, fitting into a hole tapped in the base to receive it. This is turned up square at the bottom to ensure the upright tube being truly vertical. The inner tube is plugged at the top and terminates in a square boss bored and tapped (three-eighths of an inch thread) brass on two faces, but not right through—the two holes communicating with each other to pass gas, but not permitting gas to go into the inner tube. One face of the boss carries a one-and-a-half inch length of three-eighths inch tube having an ordinary three-eighths inch burner elbow screwed on to it. The other face has screwed into it a wooden nipple bearing a three-eighths inch screw, and formed to take a rubber tube. The nipple should be of hard wood in order that the heat of the lamp is not conducted to the rubber tube. The burner elbow projects downwards with a male thread three-eighths of an inch and takes an ordinary bijou incandescent burner of from thirty-five to forty candle power. In place of an ordinary glass shade, an opaque shade of one-and-three-quarter inches brass tubing is constructed, cut to take a projecting window for various light modifiers of glass three inches by one-and-a-half inches. Three holes in the top of the shade to match screws in the burner serve to attach it. The whole shade is chemically blacked to keep back extraneous and unnecessary light. As the ordinary lamp is seldom of more than four-and-a-half to five candle power the gain in illumination is very great, and the light being white instead of yellow, still further accentuates the advantage. For dark ground and polariscopic illumination, or that of opaque objects, the gain is enormous and, the mesh of the mantle in these cases forming no disadvantage, it can be recommended. It is not put forward for *critical* illumination with high powers but for more general use, where a brilliant rather than a critical light is desired.

With the silver side reflector the results are singularly bright and beautiful. As the gas does not traverse the upright tubes, it can be used at any height either above or below the stage.

CHAS. E. HEATH, F.R.M.S.

FIGURE 1.
A New Microscope Lamp.

ROYAL MICROSCOPICAL SOCIETY.—December 21st, 1910, Mr. E. J. Spitta, L.R.C.P., vice-president, in the chair. W. R. Traviss: A small microscope lamp, particularly suited for opaque objects and dark-ground illumination with high powers. The light used was a small inverted incandescent burner, carried at the extremity of a short arm, and could be easily moved up and down on a standard. The lamp can be brought very close to the table or raised to illuminate opaque objects on the stage.—M. J. Allan: An easy method of [illegible] [illegible] printing-out paper for all kinds of photography. The author recommends that the prints be washed in a strong solution of salt, then placed in a saturated solution of hypo., after which they are to be washed in running water.—Chas. H. Higgins: A new system of filing slides.—A. A. C. E. Merlin: On the measurement of Grayson's new ten-band-plate. The plate, comprising ten bands running from $\frac{1}{1000}$th to $\frac{1}{10000}$th of an inch, had been ruled by an improved machine, and was found to be much better even than Grayson's earlier productions. The author in measuring the bands used a selected objective of 1·32 N.A., having an initial magnification of one-hundred-and-forty-three on a ten-inch tube. A Nelson-Powell screw-setting micrometer, which is alone suitable for the purpose, was used. The result obtained was that the variation from the mean in the spacing of the lines did not exceed $\frac{1}{230000}$-inch. The mean diameter of the lines was ·00002488-inch. The author also made a series of measurements with one-inch, half-inch, and quarter-inch objectives, and came to the important conclusion that low powers were unsuited for micrometry.—Jas. Murray: Some African rotifers — Bdelloida of tropical Africa. Thirty-three species of Bdelloids were obtained from dried moss, sent by Mr. A. Allan and Sir Philip Brocklehurst, from British East Africa. Nine of the species are new to science. Several of them have very distinct characters, not previously noted for any Bdelloids. *Habrotrocha caudata* has a tail-like process, the function of which is unknown. The animal secretes a protective shell, and the "tail" is enclosed in a slender tube, open at the end, so that the shell has two openings. *Habrotrocha acornis* has no trace of spurs, otherwise universal in the order. Several other species approach it in this respect, having the spurs reduced to minute papillae. *Habrotrocha auriculata*, when feeding, has at each side of the head a peculiar ring-like auricle, giving it the appearance of a two-handled vase. The nature and function of the auricles remain unknown. Their form, even, is difficult to interpret, as they present apparently contradictory appearances from different points of view. The Bdelloids take a very important place in moss-faunas. In every country they are abundant, and in most regions there is a fair proportion of peculiar species. When more fully known, the Bdelloids seem likely to p[illegible] a group of hith[illegible]ected importance, both in p[illegible]t numbers and [illegible] forms. All these moss-dw[illegible]s can revive afte[illegible]. The adult animals become dormant when dep[illegible]oisture and revive when re-mo[illegible]ened. It is not[illegible] concluded from his experiments in 1886, th[illegible]val of the species is effected by means of eggs.

Mr. A. Earland [illegible]tern lecture dealing with the apparatus and met[illegible]yed in the cruisers of the International North Se[illegible]ssion, with special reference to the work of the "G[illegible], the cruiser of the Scottish branch of the Commis[illegible]

THE MI[illegible]OGIST.—We have to acknowledge the receipt fr[illegible]ublishers, Messrs. Flatters, Milborne and McKech[illegible] of the third part of their quarterly. It well mainta[illegible]haracter set in the previous parts and contains full p[illegible] details for the staining and mounting of animal and [illegible]able tissues, such as the pinnae of Ferns and the hea[illegible] the Crane-fly and Hive-bee. Pages 35–37 are devoted t[illegible] methods adopted for embedding in Celloidin, and the [illegible]ng and staining of such sections as those of the head of [illegible] Blow-fly. There are collotype reproductions of photomicrographs of several of the objects described. Mr. Chas. Turner, F.C.S., contributes an article on Collecting and Preserving Freshwater Algae. We much regret to see so many errors in the printing of scientific names, and would suggest to the publishers a more careful revision of the proof sheets.

We have also received a selection of the slides illustrated and described in Parts 1–3, and can recommend them both for quality and moderate price. The slides received with Part 3 are: vertical section of the head of the blow-fly, the pinna of *Aspidium Filix-mas*, stained and mounted entire, and the fruiting spike of *Selaginella* sp., showing micro- and micro-sporangia.

THE PREPARATION OF A ROCK SECTION.—When commencing the preparation of a rock section, either by hand or with the aid of a machine, the first thing to be done is to procure a suitably-sized chip or slice. The size I usually start with is from three-quarters of an inch to one inch square. This will probably lose a little in grinding, but will be a fairly large piece when finished.

If the work is to be done entirely by hand, it will be found possible in most cases to strike off suitably-sized chips with a trimming hammer, or by the aid of a chisel. The thinness of these chips will depend entirely on the texture of the rocks, and while it will be found comparatively easy to get large flakes off fine grained rocks, such as basalts or andesites, it is difficult to get even thick lumps off the coarse granitoid rocks. With the slitting machine, described and illustrated in "KNOWLEDGE" for January, page 30, however, it is easy to get slices about $\frac{1}{32}$nd of an inch, or even less, and it will be seen at once that this saves a lot of time in grinding.

The method usually recommended for using a slitting disc is to rub the edge with powdered diamond or bort, made into a paste with oil so as to incorporate it in the soft iron to make the cutting edge, but I have found a much easier and *cheaper* way is to apply a paste of carborundum and water with a camel-hair brush to the cutting edge just above the rock specimen. The grade of carborundum I use for this purpose is No. 150, which cuts fairly fast, and I find by actual timing that I can get through an inch of any ordinary igneous rock in from six to eight minutes without undue exertion.

When starting to cut a slice with the machine the rock is clamped in the holder in the proper position, so that the piece can be cut in the direction required, and the spindle is then screwed forward so that the rock projects over the cutting edge of the disc. The disc is made to revolve toward the operator, the edge is wetted with the carborundum paste, and the rock is then allowed to touch the wheel. It is advisable to keep the rock against the disc by the aid of the thumb of the left hand so as to prevent it from jumping. The edge of the disc must be kept well supplied with the carborundum and water, as the cutting is then much expedited.

When one piece is cut off, the rock is lifted free of the disc, and is moved forward by the spindle ready for the next slice to be cut.

Having obtained a suitable piece, either by chipping or cutting, the next thing to be done is to make one side of it perfectly plane and smooth. This can be done by rubbing the rock on a piece of plate glass, say, six to eight inches square, which is moistened with carborundum and water. A zinc or copper plate can be used instead of the glass, but I have found the glass to cut better and work more quickly. I use the same grade of carborundum for this as I do for slitting, as I find No. 150 is not coarse enough to tear the rock or fine enough to make the work tedious. Coarser grades can, of course, be used, if thought desirable, but it is not advisable to use anything coarser than No. 90.

With the machine described in the January number the rough grinding is done on the lap. I usually make the lap revolve in the opposite direction to the hands of a watch, and hold the rock in the fingers of the left hand against the left side of the lap, so that I push against the revolution of the wheel. This I have found easier than pulling against the wheel. It must be borne in mind that the periphery of the wheel cuts faster than the inner portions, and the section, therefore, must be frequently twisted and moved backward and forward from the edge of the wheel to the centre so as to keep a plane surface.

When a perfectly flat surface has been procured, the rock must be rubbed by hand on a sheet of glass with finer carborundum, say No. FF, so as to remove all coarse scratches. Care must be taken at this stage not to get any coarse powder on to the glass plate, or it will cause bad scratches on the rock. The latter can be finished off on FF emery cloth, which is supported on a glass plate, and it is then polished on a piece of worn emery cloth, No. 0. It is not necessary to get a high polish with ordinary igneous rock, so long as there are no scratches.

The next process is to fasten the piece of rock to a suitable handle for the grinding of the reverse side. It is customary to employ pieces of plate glass for this purpose, and those I use are one-and-a-half inches square. Various cements are used for fixing the rock, the one generally adopted being ordinary hard Canada balsam, although a better one can be made of Venice turpentine and commercial shellac (bleached), which can be procured at any ordinary paint and varnish shop. The proper proportion is about three of Venice turpentine to one of shellac. The turpentine is melted in a water bath, and the shellac is then stirred in, a little at a time, until it is thoroughly incorporated. Test the cement by dropping a little on a cold glass plate, and if it dries practically at once into a hard glassy bead, it is all right. If it is greasy-looking it needs more shellac, and if it is too brittle and chips, more turpentine must be added. When it is of the right consistency, it is poured out on a glass plate, and rolled into sticks like sealing wax, ready for use.

To cement the rock to the glass, put the latter on a hot plate over a spirit lamp and place a small portion of the cementing material in the centre. At the same time lay the rock on the hot plate to warm. When the cement melts and runs, pick up the rock in a pair of forceps and place it in the centre of the cement. Press down hard to squeeze out the excess of cement, taking care that no bubbles remain between the rock and the glass. If there are any, the rock must be melted off and the work started again. When the rock is cemented satisfactorily the glass plate is put away to get cold, say, for about an hour. Take care when heating the cement not to make it too hot so that it smokes, as this drives off too much of the turpentine and makes it brittle.

A method that I have found very satisfactory for fastening the rock to the plate glass holders is to use gum arabic, made into a thick solution about the consistency of treacle. A drop of this is put in the centre of the glass, the rock is placed in position and the excess squeezed out gently with a slight twisting motion. This will dry in about twenty-four hours and the rock can then be ground down in the usual way.

Having securely fixed the rock to the glass plate, the next step is to grind it down sufficiently thin. If the work is being done entirely by hand, and the rock has been cemented to the glass with balsam or shellac, it should now be rubbed on the glass plate until the section becomes translucent. During this operation the plate must be well supplied with a paste of carborundum powder and water, using plenty of water. The rubbing is done with a circular motion, and it is advisable to make the circles as small as possible, as then there is then less tendency to bevel the edges of the section. Care should be taken also to do the rubbing over the entire surface of the plate, so that it wears evenly.

If, on the other hand, the rock has been fastened on with gum arabic, the rough grinding by hand must be done on the glass plate with *dry* carborundum powder or otherwise the water will cause the rock to leave the glass. The rough work is done so quickly, however, with the grinding lap on the machine, that it can be used whether the rock is cemented with shellac or gum arabic, as the grinding is so rapid that the gum has no time to dissolve. When doing the rough grinding on the lap, great care must be taken that the section is ground evenly on all sides, and that the operation is not carried on too long, because the lap is revolving so rapidly that in a few seconds the whole of the rock may be removed from the glass.

It is difficult to give directions as to how long this grinding with the coarse powder should be continued, as it depends, in a great measure, upon the rock itself, but a little practical experience will soon decide this for the operator. A rough-and-ready rule is to stop when the rock shows signs of chipping off at the edges.

It should then be transferred to the other glass plate, with finer carborundum, and the grinding continued by hand until the rock is sufficiently thin. Great care must be taken in these later stages, and the rock must be examined under the microscope from time to time to see if it is thin enough. The final rubbing must be done on Water-of-Ayr stone, or one of the very fine carborundum stones used for razor sharpening.

When the rock is fixed with gum arabic, the final grinding, after the use of the lap, is done on a glass plate with FF carborundum used dry, finished off on FF emery cloth, and polished on No. O emery cloth. As mentioned previously, it is not necessary to get a high polish, and any small scratches are practically unnoticeable when the section is mounted in balsam.

The next operation is to remove the section from the glass holder. If it is cemented with balsam or shellac, it should be placed in ordinary commercial methylated spirit, and must remain out of reach of dust until it has left the glass. This usually takes some time, but it must not be assisted in any way by pushing the section with a brush or needle, as this is almost certain to destroy it.

If it is stuck on with gum, it is simply put in water and usually leaves the glass in about an hour. In either case after the rock has left the glass, it is rinsed in clean methylated spirit, and is then ready for mounting.

When moving the sections from one receptacle to another I always use large section lifters about one-and-a-half inches by one inch. These I cut out of thin sheet brass with a pair of scissors. They have practically no handle, and will, therefore, stand where they are placed without falling backwards. I find these very useful when placing sections in the final methylated spirit, as lifter and section are put in the receptacle together.

The mounting is done in the ordinary way in balsam and benzole. The most difficult part is the transference of the section from the lifter to the [illegible] The section [illegible] taken from the spirit is pushe[illegible] [illegible]le brush [illegible] over the e[d]ge of the lifter until it [illegible] [illegible]ar as is safe, and is then p[ick]ed up on the hairs of t[illegible] [illegible]d transferred to a heated [sli]de. The heat of the [illegible] [e]vaporates the spirit, and then [a d]rop of balsam c[illegible] [illegible] the edge of the secti[on] [illegible] [wh]ich it will be dra[wn] [illegible] the section in position [illegible] slip with a needle [illegible] [u]nder the microscope with [pola]rized light to see [illegible] [illegible] bits of fluff or other f[illegible] [illegible] stance, put a dro[p] [illegible] [bal]sam on the section and then the [cover] glass.

(To be continued.)

NOTE ON *HYDRACHNA GEOGRAPHICA* [illegible] —In May last, Mr. Braith[waite] found a female [illegible] *geographica* Mull. [illegible] Forest. This mit[e] [illegible] largest of all the kno[wn] mites. The female measures as much as [illegible] millimeters long in the bo[dy]. Mr. Braithwaite, hearing [I] was in want of a fully-developed female of this species, kindly sent it on to me. After I had drawn and measured the mite I dissected out the epimera and genital area, and mounted that part in balsam for future reference and for comparison with other species of the same genus. I did not know before, but while I was examining it during mounting I found the ovipositor was fully extended and that an egg was in the act of leaving the tube, and I am pleased to say this position has been retained, even now it is permanently mounted in balsam. I have mounted hundreds of genital areas of water mites, but never had the good fortune to find one like this before, and I do not expect to ever find another. I mounted it without pressure, placing the cover glass on the liquid balsam and allowing it to settle down by its own weight. No doubt the slightest pressure would have squeezed the egg out of its position. The length of the genital plates with the ovipositor is 1·04 mm., length of egg 0·24 mm. The drawing was made under the camera-lucida, with one-inch objective. It shows the exact position of the genital area, and its position between the third and fourth pair of epimera. The female was full of ova, but the eggs in the body were spherical, so the oval form taken by the egg shown in the figure is no doubt due to it being squeezed through the ovipositor.

FIGURE 1.

Ovipositor and Egg of *Hydrachna geographica* × 56.

CHAS. D. SOAR, F.R.M.S.

THE DIVISION OF THE COLLAR-CELLS IN *CLATHRINA CORIACEA*.—In the November number of the *Quarterly Journal of Microscopical Science* (Vol. 55, p. 611) a contribution is made under the above title, by Miss M. Robertson and Professor E. A. Minchin, to the theory of the centrosome and blepharoplast. It is now generally admitted that these bodies are of essentially the same nature. The centrosome may be briefly characterised as a body which exerts or governs kinetic functions in relation to division of the nucleus, while the latter, or blepharoplast, may be defined as a centrosome which governs motile organs, such as flagella, which arise from it, and are in more or less direct connexion with it. The results are briefly summarised by the authors at the end of the paper. The nucleus of the collar-cell migrates from the base to the apex of the cell, and so comes to lie immediately under the blepharoplast. The flagellum disappears, and the blepharoplast divides. The two daughter-blepharoplasts [illegible] travel to opposit[illegible] of the nucleus, and take on the fu[illegible]ion of centroso[illegible] nucleus breaks up into chrom[illegible]es, its membran[illegible]ars, a mitotic spindle is formed [illegible] the usual way, [illegible] two centrosomes at its poles. [illegible] two new flagell[illegible]t once begin to grow out from th[illegible] two centrosome[illegible] the original collar and before the equatorial pla[illegible]ded. The mitosis is completed, and as the cell-[illegible]es, the original collar breaks down and disappears. [illegible]rosomes become the blepharoplasts of the two dau[illegible]ls, the flagella continue to grow out from them, the [illegible]rs grow up round the new flagella, the daughter-nucl[illegible] to the bases of the cells, and the two daughter-cel[illegible]me the structure and appearance of the ordinary [illegible] collar-cell. It is thus seen that the blepharoplast-[illegible]ome is a permanent cell-organ which divides with t[illegible], while the collar and flagellum are formed afresh at [illegible]-division.

ORNITHOLOGY.

By HUGH BOYD WATT, M.B.O.U.

THE BOYD ALEXANDER COLLECTIONS.—The very fin[illegible] and extensive collections of bird-skins made by the late Lieutenant Boyd Alexander, in the course of his scientific journeys in Africa, are to go to enrich the national collections at the Natural History Museum, South Kensington. Lieutenant Alexander, who, it will be remembered, was killed in the course of explorations in Africa last year, died intestate, but, in accordance with his wish, the Museum abovenamed is to have his collections. These are housed at present in a private museum, which was specially built for them at Wilsley. The collections are from wide areas in Central Africa, visited since 1897, including the Cape Verde Islands, Zambesi River, Kumassi, Fernando Po, and the great regions travelled through from 1904 to 1907, described in Lieutenant Alexander's book, entitled "From the Niger to the Nile," also from the islands of San Thomé, Principe and Annabon, and Cameroon. Lieutenant Alexander obtained many species new to ornithology and science, and described (and in some cases figured) them in the pages of the *Ibis*, and of the *Bulletin of the British Ornithologists' Club*. In a comparatively short life, devotion to his favourite pursuit yielded a rich harvest, and the memory of this intrepid traveller and ornithologist will be further perpetuated by this splendid gift to the nation and to science.

MIGRATION.—It is good news to ornithologists that Mr. William Eagle Clarke, of the Royal Scottish Museum, Edinburgh, is about to publish a work dealing with the study of bird-migration in the British Isles. It is not too much to say that, despite much writing (or, perhaps, because of it) knowledge lingers here, still in the obscurity of conjectures and surmises, and the time is ripe to attempt an advance on a genuine scientific basis. From no one is new and clear light more likely to come than from Mr. Clarke, who has devoted many years, dating back to the days of the Migration Committee of the British Association, to the study and accumulation of facts and observations. Besides having at his command the long series of reports made year after year by many observers and recorders throughout the country, Mr. Clarke has, within recent years, spent lengthened periods at the migration seasons in outlying localities from the Eddystone Rock in the south to the remote islands in the north, on the fly-lines, or routes of migrants. Readers of his preliminary reports and notices know that he has gathered abundant and rich results. A mere enumeration of species does not in itself throw light on migration problems, still it is notable that the small Fair Isle (between Orkney and Shetland), has yielded records of no less than one hundred and ninety eight species of bird visitors, including many which experienced ornithologists have never seen in Britain. For instance, the year 1910 gave three species new to the fauna of Scotland, viz., the Hoary Redpoll (*Acanthis exilipes*), Holböll's Redpoll (*A. linaria holboelli*)—a second example occurred on the Isle of May, October 23rd—and the Yellowshank (*Totanus flavipes*). (*Ann. Scot. Nat. Hist.*, January, 1911, page 53).

A NEW BRITISH BIRD.—Amongst the birds observed and procured by Mr. Wm. Eagle Clarke at St. Kilda—the furthest west and most remote of the British Isles—last autumn (1910), was the American Pipit (*Anthus pensylvanicus*), new to the British fauna, and the Marsh Warbler (*Acrocephalus palustris*), new to Scotland. (*Ann. Scot. Nat. Hist.*, January 1911, page 52). The rarity of the Pipit named is so great that the only mention of it to be found in Dresser's "Manual of Palaeartic Birds" (1902) is a statement that it so nearly resembles *A. spipoletta* as to have been included, in error, as a European bird.

A PROPOSED CENSUS OF THE COMMON HERON (*Ardea cinerea*).—Such a bird as this, large in size and sedentary in habits, affords the possibility of some success attending an attempt to number the individuals in a limited area. A proposal is being mooted to undertake this enumeration in Scotland, where the location of the Heronries, which are widely distributed over the mainland, is pretty accurately known at present. This wide distribution may, however, prove a serious difficulty in the attainment of accuracy or completeness of returns. The numbers of several species of British birds are known, but these are mostly inhabitants of restricted areas or individually scarce, or where the species may be called common, *e.g.*, the Gannet, its occurrence is concentrated (at any rate at the breeding season) at a few well-known stations.

PHOTOGRAPHY.

By C. E. KENNETH MEES, D.Sc.

THE MICROSCOPIC STUDY OF DRY PLATES.—Dr. W. Scheffer, of the University of Berlin, in his lecture at the Royal Photographic Society on December 20th, described the investigations which he has made on the effect of exposure and development upon the individual grains of a gelatino-bromide emulsion. He has designed for his work a very complete experimental equipment, and his photographs are all taken at a magnification of two thousand diameters, much higher than has been used by previous workers in the subject. Photographs taken of grains during the process of development show that the grains are of two kinds, which Dr. Scheffer distinguishes as "original grains" and "nourishing grains." The original grains have filaments projected from them, either during exposure or at the commencement of development, and Dr. Scheffer concludes, from his later observations, that grains showing these filaments remain unaltered during the progress of development, and become covered by the metallic silver which is deposited upon them, this metallic silver being derived from the solution of the "nourishing grains," which disappear during development. When a plate is under-exposed there are few original grains present, and with over-exposure many original grains and few nourishing grains, a fact to which Dr. Scheffer ascribes "the lack of density produced by over-exposure." This seems to require re-consideration, because ordinary over-exposure does *not* produce lack of density; the thinness which most amateurs assign to over-exposure is due to under-development; if an over-exposed plate be developed for the normal time, it will be extremely dense all over. Possibly, however, Dr. Scheffer intended the reversal period by "over-exposure." The connection of these observations with the known facts as to the chemical dynamics of development will require a great deal of work. It is not at all obvious, for instance, that a steady growth of original grains and diminution of nourishing grains would be in harmony with Hurter's "Law of the Constancy of Density Ratios," which is the photographic equivalent of the mass-law.

Moreover, the statement that there are silver bromide grains in the film of a plate which are unaltered in development and which can survive fixation, should be capable of confirmation by chemical experiments on plates in the mass, and the amount of such grains should be readily ascertainable if developed and fixed plates are treated with a solvent of silver which is incapable of affecting silver bromide. Dr. Scheffer showed an experiment in which this was done, but this would require confirmation by quantitative measurement on masses of developed film sufficient for the purposes of ordinary chemical analysis.

If the quantity of these unattackable grains varies with the exposure it would seem probable that the amount of metallic silver required to produce a given light absorption would vary with the exposure also, and it is known that such variation must be very small if it occurs at all.

A most interesting experiment of Dr. Scheffer's would seem to suggest that the "filaments" can scarcely be produced during exposure. A small quantity of emulsion was placed on a slide and a most powerful beam of light passed through it by a Zeiss projection apparatus and microscope, the image being projected on to a screen.

Under these conditions the grains could actually be observed to decompose under the action of light, shooting out the "filaments" or clouds of nebulous matter, and going black with growths, apparently of metallic silver, upon them. The amount of light required to produce this effect is very great, however, and there seems to be every reason for doubt as to whether any actual decomposition of the grain is produced by ordinary exposures.

Dr. Scheffer also described the investigations which he had made as to the distribution of the image in the film of the ordinary dry plate. The great difficulty in such work is the preparation of sufficiently thin sections, since for first-class results the sections should not be thicker than $\frac{1}{2}\mu$ ($\frac{1}{2000}$th mm). By the aid of a special microtome of his own construction, Dr. Scheffer has been able to attain to most excellent results, and one photograph, showing not only the Zenker's laminae in a Lippmann plate, but the actual grains composing them, was a marvellous testimony to the perfection of Dr. Scheffer's methods.

Most of the results obtained from sections confirm those of previous investigators, but the studies of the action of various "reducers" are of special interest, and make very clear the known differences between the various oxidising agents employed to reduce the density of photographic negatives.

DEVELOPMENT WITH HYDROQUINONE. — The chemical reactions involved in development are generally complicated, and the oxidation products of the organic developers are especially obscure.

One of the simplest of the organic developers is, of course, hydroquinone, which is oxidised to quinone by silver bromide. Using the ordinary nomenclature, the reaction will be

$$C_6H_4(OH)_2 + 2AgBr + 2NaOH \rightarrow C_6H_4O_2 + 2Ag + 2NaBr + 2H_2O,$$

one molecule of hydroquinone producing two atoms of silver.

It has been shown that this reaction is reversible, quinone and soluble bromide having the power to oxidise a silver image to silver bromide. So that quinone and a soluble bromide will act as a photographic reducer (of density) as has recently been pointed out by MM. Lumière and Seyewetz.

But the simple equation given above does not by any means express the whole of the reactions taking place in a hydroquinone developer containing alkali and sulphate.

Quinone reacts with sulphite, oxidising it to Dithionate and being reduced to Hydroquinone thus:—

$$Na_2SO_3 + C_6H_4O_2 + 2H_2O = Na_2S_2O_6 + 2NaOH + C_6H_4(OH)_2$$

Moreover, the addition of an alkali to quinone reduces some of it to hydroquinone, apparently being oxidised to peroxide, since the ether extract gives the characteristic blue colour with acid bichromates. So that both the sulphite and the alkali regenerate the reducing agent from its oxidation product, and the development reaction becomes far more complicated than would at first appear.

PHYSICS.

By W. D. Eggar, M.A.

WAVES *VERSUS* RAYS.—A good many years ago Professor C. V. Boys took a series of photographs of flying bullets. In these a prominent feature was the wave from the bow of the bullet, as from the bow of a steamer. It was a wave of compressed air, made [illegible]taneously visible to the eye of the camera by the spark which took the photograph. In fact, it was a wave of sound. Fol[illegible] up this discovery, Professor R. W. Wood took a series of photographs of sound waves, issuing from a central point. The sound was that of an electric spark, and the photographs were taken by the light of another spark, following close upon the heels of the noisy spark. The [illegible] between the two sparks could not be regulated with [illegible] accuracy, but a large number of photographs were taken, which are published in [illegible] form of lantern slides, and appear [illegible] Wood's "Physica[illegible] [illegible]. They illustrate many of the [illegible] features of wave [illegible] are exceedingly useful in explaining the wave-theory [illegible]. In a paper read to the Physical Society on "Unspe[illegible] [illegible] Light and the Theory of the Rainbow," Mr. W. [illegible] alludes to the tendency at the present time to [illegible] teaching of Optics on the conception of the wave, rath[illegible] that of the ray. This tendency was further exemplified [illegible] annual meeting of the Public School Science Masters' Association, at which Mr. J. Talbot gave a demonstration of his use [illegible] the ripple-tank. This is a large flat glass tank with water in it to a depth of about half an inch. It is supported at the height of an ordinary table above the ground on which is placed an arc light, screened from the class. A translucent screen tilted above the tank on the side of the class receives the shadows of the ripples made in the surface of the water. The velocity of the ripples can be altered by altering the depth of the water, and this can be done by flat glass plates. Hence, many of the features of reflection and refraction can be demonstrated by the medium of surface ripples. The method forms a most useful addition to the equipment of a teacher of Optics. At the same meeting, Mr. C. E. Mott exhibited his apparatus for teaching Optics by the method of rays. In place of the usual pins employed in elementary practical Optics, Mr. Mott uses a beam of light coming through a pair of narrow slits, fixed at the ends of a groove cut in a block of wood. The conception of rays is, in the opinion of some, the natural introduction to the subject, and if it be right to follow historical order in the presentation of physical knowledge, rays would undoubtedly come before waves. However, as the protagonists agreed, the two methods are supplementary rather than antagonistic; and it must be borne in mind that the teacher of science has sometimes as his aim the stimulation of interest in physical phenomena, at other times the training of the youthful mind in methods of precision.

THE RADIO-BALANCE.—In the December number of the *Proceedings of the Physical Society* there is an important paper by Professor Callendar describing his radio-balance. This instrument is devised for the absolute measurement of the heat of radiation, and is specially applicable for that of Radium and its emanation. The heat imparted by radiation to a small copper disc or cup is directly compensated by the heat absorption due to a Peltier effect created in an iron-constantan thermo-couple connected to the disc, and to a variable source of electric current. The Peltier co-efficient and the value of the compensating current being accurately determined, the heat of radiation can be measured with considerable accuracy, when an exact balance between the two effects is obtained.

ZOÖLOGY.

By Professor J. Arthur Thomson.

NON-DIGESTIBILITY OF FAT BY PROTOZOA.— W. Staniewicz calls attention to a curious point, that the Protozoa have never learned to digest fat. All Metazoa have this power, but Protozoa have not. Experiments with Paramoecium, Stentor, and some other common Infusorians show that fat may be ingested, but it is not digested. It is not a natural part of a Protozoon's food. The fat sometimes found in natural conditions within the cell of a Protozoon seems to be due to the transformation of proteids or carbohydrates.

MUDDY TASTE IN FRESHWATER FISHES.—It is well known that carp and tench and eels and some other freshwater fishes are apt to be tainted with a peculiarly disagreeable taste, which someti[illegible] them almost uneatable. The taste is called "[illegible]" but Louis Léger's experiments have shown that it [illegible]ctly due to the mud.

The Stonewort (*Chara*), w[illegible] a curious odour, has been blamed, but Léger has [illegible] hat the "muddy" taste may occur in fishes fro[illegible] without any stonewort. Following the method of [illegible] he has traced the mischief to Oscillarias, those cur[illegible]de Algae, which are common in fresh waters. The[illegible]ectly or indirectly used by the fishes as food, and it [illegible] "essence" that saturates through the fish-body. Th[illegible] strongest in the glandular parts of the skin and in th[illegible]. Carnivorous fishes are less liable to be tainted, but [illegible]out do not escape.

A NEW CO[illegible]NSAL TURBELLARIAN.—Professor Edwin Lint[illegible]nd in the ribbed mussel (*Modiolus plicatulu*[illegible] at Woods Hole an abundant occurrence of a commen[illegible] Rhabdocoele Turbellarian, belonging to the genus *Graffil*[illegible] to a closely-related genus. It is interesting in many [illegible], e.g., in containing ciliated young, most of which were [illegible]*cos* inside a thin capsular envelope. The young are not [illegible]ted until the reproductive powers of the mother are ex[illegible]ted, when they make their way through the ruptured [illegible]-wall. Another interesting peculiarity is that the adults, [illegible]ich rarely reach 2mm. in length, move by a series of zig-zags, a mode of progression which affords constant change of position within the limited area of the host.

DO BLOW-FLY LARVAE RESPOND TO GRAVITY?—S. O. Mast has investigated Professor Jacques Loeb's statement that blow-fly larvae "when placed under the surface of the water, do not swim upwards and so avoid death, but swim downwards." It is found, however, that blow-fly larvae do not react to gravity, either in water or out of it. In air they may be found to crawl nearly straight upwards on objects, but experiments show that this has no relation to gravity. In water they sink to the bottom or float at the top according to the amount of gas they contain, and there is no evidence whatever indicating that they can swim.

PROCESSION CATERPILLARS.—A month or two ago we described observations on the habits of the Procession Caterpillar, *Cnethocampus pinivora*, made at Arcachon by Mr. T. G. Edwards in the Spring of 1909. An account of additional observations and experiments made in the following Spring is now published by Mr. H. H. Brindley. Strangely enough, the greater number of the processions seen by Mr. Brindley were met, not within the forest itself, but on a broad road (over which there was constant traffic) leading towards it. The road was bordered by villas, in many of the gardens of which there were pine trees. Many nests containing living larvae were found on the young pine saplings in the forest, and in all cases the branches near the nest were thickly matted with the threads secreted by the larvae. Very few threads were found on the branches at a lower level, or on the trunk, and of these none reached the ground, so that the threads gave no evidence that the larvae were in the habit of leaving the nest and returning to it. A series of experiments with the thread showed that it has no great importance in the formation of the procession, or even in keeping it together. Head to tail contact seems the important factor, and when that is broken, the detached portion of the procession joins on again, apparently by sight, if the distance is not great. The thread forms the nest in the tree, and the cocoon in the pupa state, but it is not clear why it should continue to be formed when the larva is away from the nest, unless it is to be regarded as a mere secretion. Mr. Brindley made an interesting series of experiments to test the permanency of the leadership. In small processions, each individual caterpillar was dusted with a powder of a different colour, and the procession was interrupted. In fifty per cent. of cases the same leader took the head of the procession, whether mass-formation was natural or artificial; the leader for the time being undoubtedly determining the behaviour of the procession, since contact is always maintained. The leader always takes the initiative in mass-formation and very frequently in burrowing.

The observer did not experience any irritation on handling the caterpillars, and he believes, with his collaborator, that the degree of sensibility to the glandular hairs varies with the individual.

YAWNING IN FISHES.—Mr. Richard Elmhirst, Superintendent of the Millport Marine Biological Station, has made some very interesting observations on Yawning in Fishes. He has watched it in cod, saithe, cobbler, plaice, and some others. He describes the wide opening of the mouth, the slow expansion of the buccal cavity, the erection of the gill-arches, and then a rapid expulsion of the indrawn water, mostly from the mouth, partly through the gill-slits. This is often accompanied by a distinct heaving of the pectoral region and erection of the pectoral fins, and is quite different from the rapid movement of the gill-cover and jaws when the fish dislodges a bit of seaweed from its gills. "From numerous observations, I am led to think that this action of fishes is a real yawn, and serves the true physiological purpose of a yawn, *i.e.*, flushing the brain with blood during periods of sluggishness. The conditions conducive to yawning are a slight increase in the temperature of the water, and, I suppose, the accompanying diminution of oxygen."

A NEW KIND OF SENSE ORGAN.—As anatomical analysis becomes more and more minute there is a continual discovery of new intricacies. A good illustration is to be found in an investigation which Dr. K. W. Dammermann has recently been engaged in, concerning the saccus vasculosus, a dependence of the brain peculiar to fishes. It will be remembered that there is a remarkable downgrowth, or infundibulum, from the tween-brain or region of the optic thalami (the part of the brain that also gives origin to the pineal body as a dorsal upgrowth). This infundibulum bears the very interesting pituitary body, but it also gives off a posterior diverticulum called the saccus vasculosus. In many fishes this extends backwards and lies, along with the pituitary body, in a pit of the skull called the sella turcica. It has been usually regarded as a glandular structure, but Dammermann has proved up to the hilt, what a few have suspected, that it is a sensory organ with somewhat striking sense-cells. In an ingenious argument he suggests that it may enable the fish to test the degree of oxygenation in the water, and thus to seek out the depth physiologically most comfortable. He proposes to call it a "Benthic" or Depth-Organ.

EVOLUTION OF REPTILIAN ARMATURE.—Georg Stehli has been studying the development of scales (in the wide sense) in various reptiles, and comparing recent with extinct forms. He is strongly of the view, also held by Hase and Otto, that the scales had primitively a segmental arrangement, and that each horny scale belonged primitively to an underlying bony scale. His theory is that the evolution of reptilian armour has passed through four stages. First, there was the primitive stage (which must, of course, have had a long evolution behind it) of strictly segmental arrangement of horny scales with bony scales beneath them. In some cases doubling gave rise to two rings of scales for each segment. Secondly, the bony scale broke up into a mosaic of little plates, as seen to-day in Scincoid lizards. Thirdly, the bony scale disappeared. Fourthly, the horny scales multiplied and lost their segmental arrangement.

A QUAINT STRUCTURAL ANALOGY.—One might spend a pleasant life-time in admiring organic adaptations. One of the last we have read about concerns the "snow-shoes" of the North-American ruffed grouse (*Bonasa umbellata*). According to Dr. Austin Hobart Clark, these "snow-shoes" develop in winter as two rows of "scutes" on each side of each toe, and they increase the area of the foot by as much again. Thus the bird treads safely on the lightly-compacted snow. It might be interesting to test experimentally whether the stimulus of wet feet at some other season than winter would induce the extra integumentary growth. Dr. Clark points out that a figure of the ruffed grouse's toe is very much the same as a figure of the arm of some of the Crinoids from deeper waters. Two rows of supplementary plates occur on each side of the median row, and the meaning of the adaptation is to increase the receptive surface on which the shower of minute dead organisms is caught. Convergent adaptation in two creatures almost literally as far as the poles apart!

HAD CETACEANS A TWOFOLD ORIGIN?—It has been repeatedly suggested that the toothed whales are not very nearly related to the baleen whales, and Professor Kukenthal, in particular, has argued in support of a "diphyletic origin." Dr. Stefan Sterling, a worker in Kükenthal's Institute, has recently gone carefully into the musculature of the fore-limb, and finds that in respect to this the toothed whales and baleen whales are not very closely related. Their resemblance is one of convergence; that is t[illegible] [illegible]ppers are independent adaptations to similar condition[illegible] [illegible]othed whales diverge further from the typical Mam[illegible] [illegible] must have had an earlier [illegible]igin than the baleen [illegible]. Thus anatomy illumines evolution. It is interesti[illegible] that the flipper type of limb must have been evolve[illegible] [illegible] times independently,—in Ichthyosaurs, in post-Tr[illegible] Plesiosaurs, in Cetacea (twice[illegible]) Sirenia, and in Pinn[illegible]ia.

REVIEWS.

AËRONAUTICS.

The Problem of Flight.—By HERBERT CHATLEY, B.Sc. 131 pages. 60 illustrations. 9-in. × 6-in.

(Charles Griffin & Co. Price 10/6 net.)

This book, which bears the somewhat ambitious title of a "Textbook of Aërial Engineering," is not one which it is easy to review. The first edition was written some months before Farman, in January, 1908, succeeded in making the first circular kilometre flight in Europe. Owing to the author's absence in China, the present edition is admittedly not up to date, although numerous alterations and additions have been made to the text, and some of the original rather crude illustrations have now been replaced by more accurate photographic reproductions of various aeroplanes.

There is, however, no mention of the well-known Farman or Blériot machines, nor does the victorious Gnome engine receive any mention, and none of the recent work of the English constructors is described.

On the other hand this edition is not much blemished by misprints, though there are a few minor errors, such as on page 48b "Driwiski" for "Drzewiecki," and "Voison" for "Voisin."

Chapter I. deals with general considerations; Chapter II. with essential principles. In Chapter III. when discussing propellers, the author states (in effect) that the total projected blade area should approach very nearly to the disc area, provided the blades are not sufficiently near to cause interference; this does not seem to be very conclusive.

In Chapter IV. three methods of starting aëroplanes are given, but no reference is made to the Wright Bros.' pylon and falling weight device.

Chapter V. on "Ornithopters," is good, but does not command much interest at the present time; the author seems to have a particular penchant for the Helicopter, and devotes a good deal of space to this type throughout the book.

In Chapter VII. on "Form and Fittings of Aerial Vessels," the author states that "corrugated aluminium for helices and aeroplanes has been found to be very efficient," though it has not been used by any successful machine at the present date.

Some of the appendices are interesting, and are perhaps the most valuable portion of this book. In appendix H. the author discusses landing problems, but apparently has some idea that the aëroplane always meets the ground at its gliding angle; the operation of the "vol plané" does not seem known to him.

The bibliography at the end is not at all complete, nor is the list of aëronautical societies and clubs up to date. On the whole, however, the book gives plenty of food for thought, but the author endeavours to cover too much ground, and has a fatal tendency to indulge in mathematical jerry-building; edifices of most elaborate formulae are piled up on (in many cases) extremely slender foundations, and, as a result, are naturally neither of a permanent nor useful character.

There is no doubt that Mr. Chatley is an able mathematician, and if he will only alloy his theories with a greater number of practical facts, he may then succeed in producing something of value to the aëronautical engineer.

CHEMISTRY.

Spark Spectra of the Metals.—By C. E. GISSING, F.R.[illegible] 21+vii. pages. 10 plates. 11¼-in. × 8¾-in.

(London: Baillière. Price 7/6 net.)

The method of spectrum analysis is now so widely used to ascertain the composition of unknown bodies that this book of Admiral Gissing, which embodies an enormous amount of work, should be welcomed in many directions. It gives a brief description of the prism spectroscope and of the methods of obtaining spark spectra and recording them by photography, but its chief value will be as a work of reference. For since it gives photographic enlargements of the spectra of fifty different metals, alloys and gases, it will be a simple matter to ascertain, by comparison of the spectra and measurement of the wave lengths of the lines, the constituents of any mineral or mineral ore under examination. The photographs are excellently reproduced and notes are given to call attention to the most characteristic lines in each case.

Cambridge County Geographies—Fifeshire.—By E. S. VALENTINE, M.A. 187 pages. 64 illustrations. 4 Maps. 7¼-in. × 5¼-in.

(Cambridge University Press. Price 1/6 net.)

The Scottish series of Cambridge County Geographies, so admirably begun with the volume on Lanarkshire, is well continued in the little book under review. By virtue of its position, the ancient kingdom of Fife—a peninsula jutting into the North Sea between the Firths of Tay and Forth, and separated from the rest of Scotland by the Ochil Hills, lends itself specially to treatment as a geographical unit. The unique geological phenomena found along its shores, its ancient history, its abundant mineral resources, and last, but not least, its claim to possess the Mecca of golfers, give Fifeshire special prominence amongst Scottish counties. Whilst largely an agricultural county, weaving, fishing, and mining particularly, employ a large proportion of its inhabitants. Dunfermline is the chief seat of table-linen manufacture in the world, and Kirkcaldy is almost equally famous for floorcloth and linoleum. Coal-mining has so progressed of late years that Fifeshire, from the third in 1899, had sprung to the first place among Scottish counties in 1906, in the quantity of coal shipped from its ports. In style, get-up and readability this book upholds the high character of this series; and Mr. Valentine has worthily maintained the standard set up by the initial volume on Lanarkshire.

An Elementary Treatise on Co-ordinate Geometry of Three Dimensions.—By R. J. T. BELL. 355 pages. 9-in. × 6-in.

(Macmillan & Co. Price 10/- net.)

The author is Lecturer in Mathematics at Glasgow University, and has embodied in this book the course of his lectures in solid geometry. After preliminary matter the book deals chiefly with the Conicoids, but contains also chapters on Ruled Surfaces, Curvature, and Geodesics. It has copious examples, and might therefore be [illegible] supplement a course of lectures; but we do not thi[illegible] student would find it an easy introduction to the sub[illegible] the author has not the qualities [illegible] a good guide: he [illegible] turns round to survey the ground already covered, [illegible] to point out the path by which the climb is to b[illegible]ed. The different subjects are not made complete [illegible]mselves, nor is the relative importance of differe[illegible]ms or methods suggested. For instance, the Ellipso[illegible]duced on page 83, but instead of being treated with [illegible] respect, the form of its surface is dismissed with a [illegible]ce to an example in small print on page 9. The bo[illegible]ll printed, but we are disappointed at the paucity of [illegible]tions which, with geometrical methods, might be used [illegible]nforce the analytical reasoning which the author alo[illegible]s; the chapters on the sphere and cone contain n[illegible] at all, and a student will find no suggestions for draw[illegible]phere or representing points on its surface.

GEOLOGY.

The [illegible]tham and the Ancaster Gap, a Study of River Act[illegible].—By F. M. Burton, F.G.S., F.L.S. 31 pages. $4\frac{1}{2}$-in. × 7-in.

(London:—A. Brown & Sons. 1/- net.)

[illegible]e Winding Course of the River Wye.—By T. S. Ellis. 10 pages. $5\frac{1}{2}$-in. × $8\frac{1}{2}$-in.

(Gloucester:—John Bellows. 1/- net.)

In Mr Burton's interesting booklet the theory of river origin we owe to the genius of Professor W. M. Davis is applied with signal success to the origin and history of the Witham and adjacent rivers, as it was also applied in the author's earlier brochure on the River Trent. The Witham is a remarkable river, which, rising near Oakham, first flows northward past Grantham to Lincoln, and then makes an abrupt turn to the south-east, entering the Wash near Boston. Excluding the very recent lower portion from Lincoln to Boston, Mr. Burton divides the river into three parts,—a tributary stream from its source to Grantham; a relic of an original transverse river (supposed to be the primeval Devon) from Grantham to Barkston; and again a tributary stream from Barkston to Lincoln. The original stream, the Devon, flowing east, cut out the Ancaster Gap, after which it was captured by the Trent, bringing the modern Witham into existence. There were several minor vicissitudes, well worked out by the author, before the Witham assumed its actual present course. The pamphlet would have been easier reading if a map illustrating the history of the river system had been included. Mr. Ellis, however, will have nothing of Professor Davis and consequent, subsequent or obsequent streams. His theory of river origin seems to be that of the evolution of principal channels out of a network of streams occasioned by the original irregularities of a land-surface newly arisen from the sea. He finds illustrations of the process in the water-channels on a gravelled or macadamized slope. The sinuosities of the Wye, for instance, are regarded as relics of an original network of channels. Mr. Ellis rejects the principle of stream capture, on the ground that he is unable to conceive of a stream working headwards and thus extending its valley backwards. He finds special difficulty in the case of valleys with low flat divides between streams falling in opposite directions, and believes that these valleys have always been excavated by the continuous flow of a body of water in one direction. Whilst some of these valleys may have been cut in this way as a stage in the development of a river system, the divides may have been smoothed by glaciers or by glacial lake overflows; and it must be remembered that low flat divides are characteristic of mature and ancient topographies. The paper is illustrated by a map of the Severn-Wye river system.

PHOTOGRAPHY.

Photography in Colours.—By George Lindsay Johnson, M.A., M.D., B.S., F.R.C.S. 143 pages, with 8 plates in colour. $7\frac{1}{4}$-in. × 5-in.

(Ward & Co. Price 3/-.)

The author states that he has separated Colour Photography from Photographic Optics when revising his work on the latter subject, and we cannot but feel that the separation is an advantage; there was, indeed, no reason for ever including two such distinct subjects within the covers of one text-book.

The present volume is, on the whole, a considerable advance on the treatment of the subject in the earlier work; the author has collected together the information which has been published by other workers, and has appended his own opinions to their conclusions.

This method occasionally leads to remarkable results, as when a solution of "Xyline red" is stated to be a nearly pure blue in colour: but, on the whole, the book is free from serious mistakes. On the screen plate processes of colour photography the book is very complete, but the short chapter on other processes is practically useless; it is far too scrappy and brief in its treatment. Incidentally we do not think that F. E. Ives ever claimed to have discovered "the principle of three colours being used to reproduce all colours." Ives invariably claims that the originator of the true theory of colour photography was Clerk Maxwell. We note with regret that the author prints his spectrum diagrams with the red to the left.

NOTICES.

WEBSTER'S NEW INTERNATIONAL DICTIONARY.—We have before us the details of the new dictionary which Messrs. Bell & Sons are publishing. As a matter of fact it is really a new work, for there are four hundred thousand references as against one hundred and seventy thousand in the previous dictionary which bore the same name. Very special attention has been given to the many new words which science has introduced into our modern vocabulary. Although there are two thousand seven hundred pages, and six thousand illustrations, the whole of these are contained in one volume, which is issued at a reasonable price. The dictionary is likely to meet the requirements of many of our readers, who can obtain all particulars on filling up and sending in the special coupon to be found on page iii of this issue.

CATALOGUES.—Among the many catalogues which we have received is one of lantern slides sent by Messrs. Flatters and Garnett, and we would call special attention to the photographs illustrating British Plant Associations, by Mr. W. B. Crump, whose ecological work is well known. Of special scientific interest also are the photomicrographs by Mr. W. T. Haydon, illustrating the reproduction and development of *Pinus sylvestris*.

As usual, the classified list of second-hand instruments which Mr. C. Baker has for sale or hire, is useful and exhaustive, seeing that it runs to eighty-two pages.

From Messrs. R. & J. Beck, Ltd., comes a special new catalogue of physical apparatus. Among some of the more important pieces are optical benches for the testing of photographic lenses as well as those which are used for spectacles. There are also some glass troughs of useful and various shapes which can be adapted to many purposes.

A MICROSCOPIC EXHIBITION.—Messrs. Watson and Sons, Ltd., 313, High Holborn, have sent us particulars of an Exhibition of Microscopic Objects which they are holding to enable microscopists to see for themselves the great diversity of objects which they offer.

In order that the whole of the contents of their cabinets may be easily examined, different subjects are set out week by week so as to be readily glanced at and subsequently examined microscopically.

Two of these Exhibitions have already been held and the current one from the 30th of January to the 8th of February, is of Botanical Subjects, Fungi, Algae and so on.

Future dates and subjects are:—

February 13th to 22nd, Geological and Entomological Specimens, Objects for Polariscope.

February 22nd to March 8th, Mounted Pond Life, Marine and Zoölogical Specimens.

Knowledge.

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

A Monthly Record of Science.

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

MARCH, 1911.

X-RAYS.

By REGINALD MORTON, M.D.

(*Continued from Volume XXXIII, page 199.*)

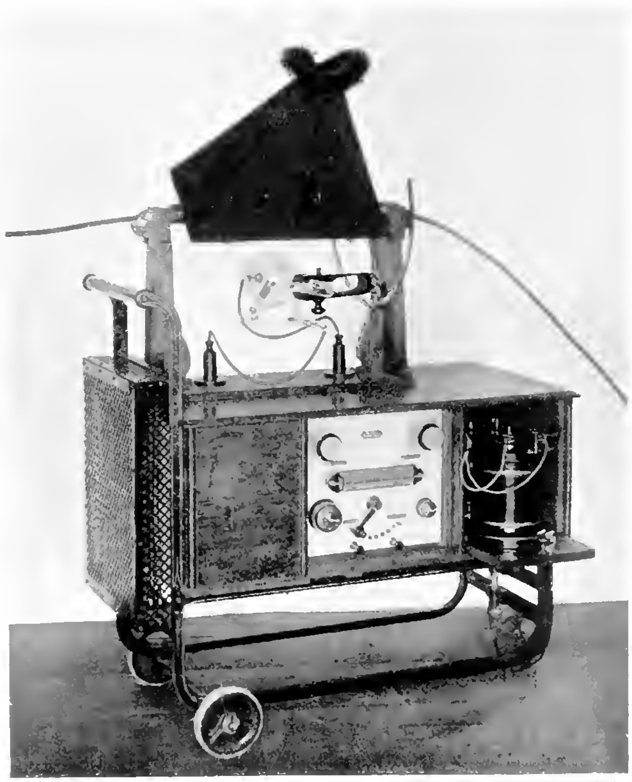
In the course of an article in a previous number, the development of some of the various parts that go to make up a modern X-ray equipment was briefly described; of those that remain to be dealt with, none have a greater importance than the interrupter, or "break" as it is generally called. As its name indicates, its function is to interrupt or break the flow of current through the primary coil of the inductorium. A sudden interruption is essential for the working of the coil, and the more sudden and complete it is the better is the discharge from the coil. Up to the time of Roentgen's discovery breaks were of a simple and not very efficient form; they were only used in circuit with batteries of low voltage, and as the induction coils were as a rule small in size and giving short spark length they answered well enough.

The demand for greater discharges to excite heavier and stronger tubes soon made it evident that the interrupter would have to be modified, especially as it was desired to make use of the comparatively high pressure currents from the street mains. The platinum hammer break (see Figure 2) was one of the first, and though it is seldom used now for heavy work, and mostly on portable apparatus, in its most modern form it can be made to give very good results. It requires care in adjustment and manipulation, but is practically the only kind that can be used in military service in the field.

A disadvantage of this form is the flashing that takes place between the platinum points every time the current is broken; this is troublesome when it is desired to make use of the fluorescent screen in a dark room.

It was found that when the break was so modified that one of the points was replaced by a dish of mercury, the spark from the coil was intensified. In one of the earliest types a copper wire was made to dip in and out of the mercury by the action of a small electric motor, and a number of these are in use, for X-ray treatment especially. (See Figure 4.)

Following on this we have the mercury jet breaks, which were a great improvement, in that they gave a much higher rate of interruption for the same quality of discharge from the coil. In these a small jet of mercury is made to impinge upon a copper

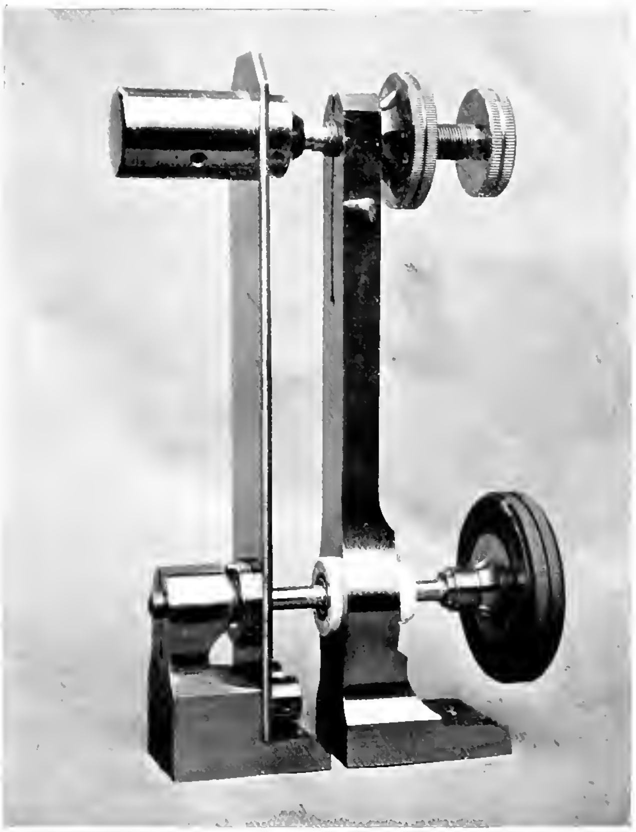


By the courtesy of *The Sanitas Electrical Co.*

FIGURE 1. An X-Ray Cable-Testing Outfit.

blade or blades. It is immaterial whether the jet revolves or whether the copper teeth revolve around the jet, the result is the same. The mechanism is enclosed in a glass or iron vessel, which contains a quantity of mercury at the bottom, and then filled up with spirit or paraffin oil. The break thus taking place under the surface of the fluid is all the more sudden and complete, and this type of mercury break has been, and is, very popular. The great disadvantage is the large quantity of mercury required (twenty to thirty pounds in some) and the rapidity with which the latter becomes emulsified and useless for the time being. Most of the mercury can be recovered, but the process is very messy. (See Figure 3.)

Owing to this difficulty of cleaning, efforts were made to find some gaseous medium to replace the liquid in common use, and it was found that ordinary house gas was all that could be desired: and it may be said that any mercury break designed for the use of liquid will work equally well, or even better, if the gas is used instead. The case has, of course, to be made tightly-fitting so as not to allow free escape of the gas. Used in this way the mercury does not become emulsified, only a small quantity is required, and the small amount of black mercury compound that gradually forms need only be removed at long intervals.



By the courtesy of *Messrs. Newton & Co.*

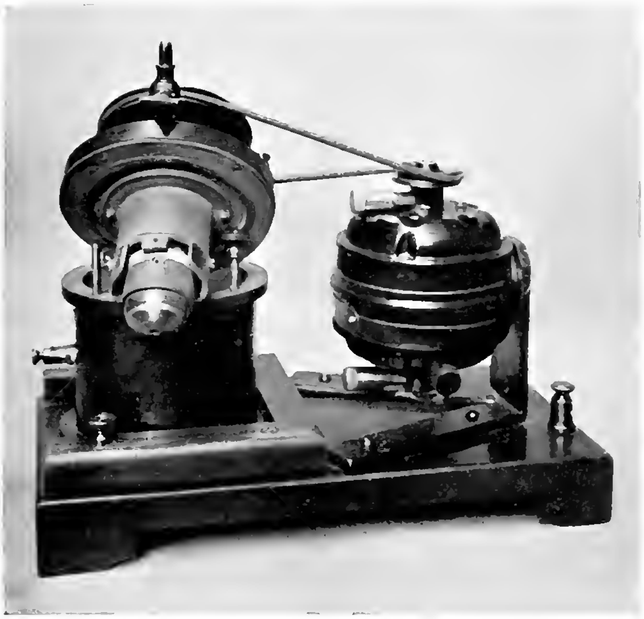
Figure 2. A Platinum Break.

The most recent development of the mercury break is a more or less radical departure from the jet type we have been considering, but the change is a very important one, and the system upon which they work is one that is likely to prevail. The principle involved is an old one, though its application to interrupters is quite new. It is well known that if we fill a hollow sphere with liquids of different densities, and then rotate the sphere rapidly, the various liquids will tend to arrange themselves around the equator of the sphere with the heaviest liquid against the wall and the lightest liquid nearest the centre of rotation. Applying this principle to an interrupter, the hollow sphere is flattened at the poles and the equator is bulged out. This form is found to give the best results, as might be supposed. (See Figure 5.) Into this jar is placed some mercury and paraffin oil, and the whole is mounted upon the end of the shaft of an electric motor, which is placed vertically. As the latter is set in motion the jar turns with it, and the mercury, by virtue of its greater weight, at once takes up its position at the widest part. Its rate of rotation is a little less than that of the jar, which is made of cast iron, both for its strength and its resistance to the action of mercury. There are several forms of interrupter working on this principle, but the above arrangement forms the basis of them all. In one of them, a fibre disc with a metal segment, and about the size of a five-shilling piece, is mounted so that its edge engages the whirling band of mercury. This causes the disc to rotate rapidly, and as the metal segment touches the mercury the circuit is completed, to be suddenly and completely broken when it leaves.

The "make" and "break" in other modifications of this type need not be described in detail; they are by far the most efficient of the mercury breaks, and the mercury is not emulsified and used up anything like so rapidly. Electrolytic breaks are not so much used now as they were some time ago. These work on an entirely different principle and are the simplest in construction of all of them. They require a great deal of current, and the effect on the X-ray tubes is rather severe, but many radiologists prefer them to any other form. Their action is fully explained in most text books on electricity, but is too technical for an article of this kind.

When we consider the remarkable property of the X-rays in readily passing through substances that are quite opaque to ordinary light it would seem that such ought to be of the greatest use under many and diverse conditions. In the early days of their discovery many extravagant predictions were made as to their probable value and these were treated more or less seriously. As a matter of fact, if we take away their application in medical and surgical work, so little remains that the demand for the necessary apparatus would be so small as to be unworthy of the serious attention of any manufacturer, except in the fulfilment of a special order.

It will be thus easily understood how difficult it is, when treating of the uses of the X-rays, to avoid reference to medical matters. Their limited use in other directions is due to several causes, and the chief one is that the X-ray image is a silhouette and not a photograph, as it is sometimes erroneously termed. The property of arresting the passage of the X-rays



By the courtesy of *Messrs. Newton & Co.*

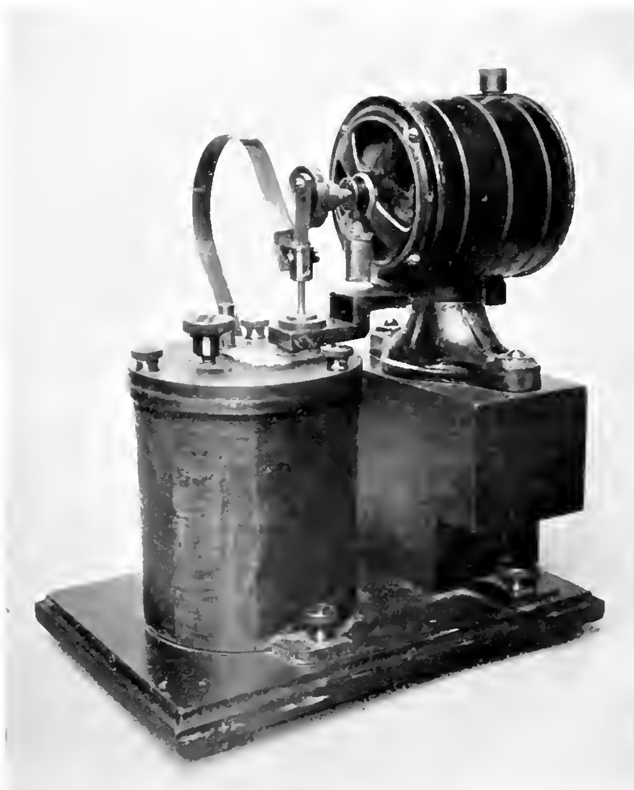
FIGURE 3. A Jet Break.

and thus casting a shadow is purely a question of the atomic weight of the elements that make up any substance. Speaking generally, substances of vegetable and animal origin, except the bones, are very transparent. With the exception of aluminium, all the metals in common use are more or less uniformly opaque. Calcium having an intermediate atomic weight is semi-transparent, and as lime salts enter very largely into the structure of most living organisms, the X-rays are very valuable in studying their normal structure as well as tracing departures from the normal, whether from disease or accident. Any inequalities in thickness are registered on the screen or plate, and so accurately is this done under favourable conditions that the details of structure can often be made out: a good radiograph of the hand or foot shows this very well.

Some very interesting discoveries have been made in this way regarding the internal structure of shells, and the Rays have been used in examining oysters for the presence of pearls. If no pearls are present the oyster is returned to the sea, which is presumably an advantage to the oyster. In a like manner electrical cables are examined (see Figure 1), both for the continuity of the conductor as well as to see that it maintains its proper relation to the other members of the system. The modern electric cable is in many instances a very highly specialised structure, that has to stand very severe strains both mechanical and electrical, and, as an apparently small fault may give rise to very serious trouble, the final inspection has to be carried out with the greatest care before it is passed as fit for service.

With regard to the medical and surgical uses of the X-rays, most people are inclined to think that the examination of fractures and the detection of foreign bodies within the hum[illegible]nism constitute the main field of their usef[illegible] These are, of course, very important applic[illegible]nd ones that count for much in hospital pract[illegible]icularly, but they do not by any means constitu[illegible]hole. An ordinary simple fracture occurring [illegible]ft of a long bone such as in the middle of th[illegible]r arm, can be dealt with quite satisfactori[illegible]hether examined by the X-rays or not: but the [illegible]eon who attempts to deal with a fracture close t[illegible]or involving a joint, without having it properly examined by this method, takes a risk to his patient, as well as to his own reputation, that is not justifiable. An instance of this is shown in the accompanying radiograph (see Figure 6): this injured wrist was declared to be a severe sprain and treated as such. Fortunately the patient decided to come to the hospital, where it was X-rayed as a matter of routine. This shows that the bone is not only broken in at least three fragments, but that one of the lines of fracture enters the wrist joint. The fact that there was no displacement of the fragments led to the erroneous diagnosis being made, and had this been treated in the ordinary way a stiff wrist joint would have resulted almost certainly.

In the early days of the X-rays their use was almost entirely confined to strictly surgical cases; nowadays the method is used almost as much for the investigation of medical cases, such as disease of the respiratory organs, the heart and great blood vessels,

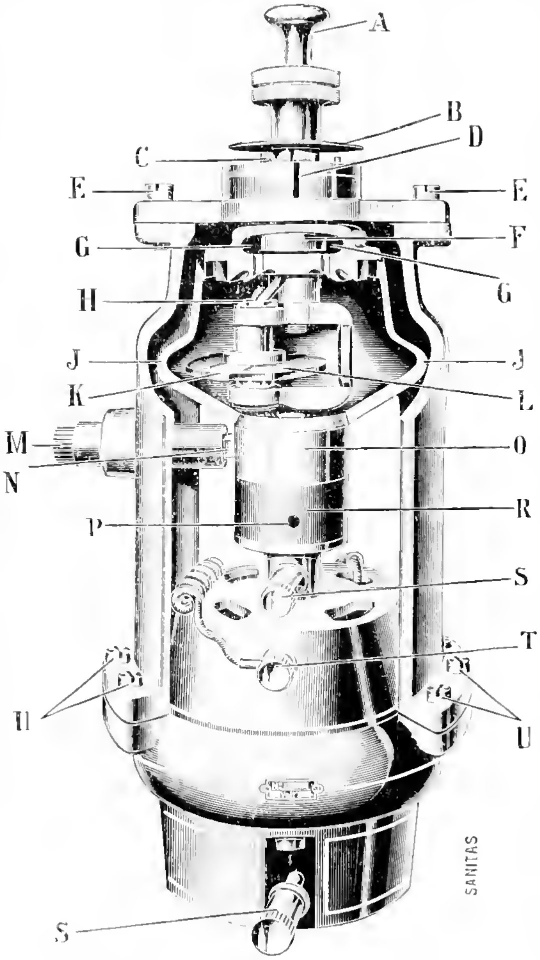


By the courtesy of *Messrs. Newton & Co.*

FIGURE 4. A Dipper Break.

tumours, and obstructions in the digestive system. The latter is a comparatively recent development, and is one that is of great interest. The method consists of giving jelly or other food containing a large amount of a bismuth compound that is quite harmless. The bismuth being opaque to the X-rays the progress of the food can be watched in its progress along the digestive canal, and at times the information gained is very valuable. There is a great danger, however, in misinterpreting the appearances, because similar shadows may be made by very different conditions: in no instance is the opinion of an expert more necessary than in this.

By means of very powerful apparatus more or less instantaneous radiographs can be made of the heart when the X-ray tube is placed no less than two metres from the plate, as shown in the illustration accompanying the first part of this article. Owing to the great distance of the tube, the size of the shadow of the heart is very nearly the same as that of the heart itself, and it is the best method at our disposal for accurately determining the dimensions of that organ. Changes in these dimensions can be detected by making examinations at intervals. This by no means exhausts the list of applications of the X-rays in the diagnosis of disorders of mankind, but enough has been said to show how much progress has been made, and the science is by no means at a standstill. Improvements in methods and in personal skill are being introduced every day, and scarcely a month passes that does not give us something new in the way of improved appliances.



By the courtesy of The Sanitas Electrical Co.

FIGURE 5. A Sanax Break in Section.

It was comparatively soon after the discovery of the X-rays that some investigators began to employ the radiation for purposes of treatment. They were led to do this from the good results that were being obtained with the ultra-violet rays, and from the fact that many X-ray workers had begun to suffer from a form of dermatitis, which was rightly attributed to the influence of the X-rays themselves. It was at this stage that the foundations were laid for the immense amount of suffering that has been endured by many of the pioneers of X-ray work, many of whom still continue to suffer in one way or other, in spite of the fact that they have taken every possible precaution since the first attack of the dermatitis. The danger from these rays is only incurred by those who are working with them more or less continuously: there is not the slightest danger to any one who undergoes an examination or a course of treatment by the X-rays, so long as the work is done by one who is a recognised expert in such matters.

It may be taken as an axiom that any agent that is capable of doing so much harm as this can also be made to do a great deal of good, if only its powers are properly controlled and directed into the right channels. The great trouble in administering these rays therapeutically was that of knowing how large or how small a dose was being given, and even at the present time the methods at our disposal are not anything like so simple and scientific as that of giving ordinary drugs. We have no satisfactory method of ascertaining the exact strength of radiation the patient is getting at any given moment: our methods will only tell us how much has been given, and that rather crudely. The means mostly employed are sufficiently accurate in the hands of one who has had a considerable experience of the work, and who has become more or less familiar with the vagaries of the X-ray tube. The day is not yet that the novice can dip into this work without running considerable risk.

When the platino-cyanide of barium is exposed for a certain time to the influence of the X-rays it turns from its usual greenish-yellow tint to that of a light orange. This material is spread upon stiff paper and cut into small circular pastilles. The X-ray tube is enclosed in a ray-proof shield, from which the rays can escape only by an opening made for the purpose, the size and shape of which can be altered to suit any ordinary conditions. The pastille is held in a clip exactly half the distance between the source of the rays and the area to be treated, and is so arranged that it can be removed for examination from time to time. With each set of pastilles is supplied a standard tint, to which the pastille must change before the ordinary full dose is given. This is, in outline, the method in use at the present time by the majority of radiologists. It is, admittedly, a crude one when judged by other standards of measurement, but in the hands of the expert it gives very good results. The arrangement is shown on page 498 of the previous article ("KNOWLEDGE," Volume XXXIII, December, 1910).

With regard to the conditions that are benefited by this form of treatment, it may be said that the more superficial is the disorder the more likely is it to be favourably influenced: this is only another way of saying that the method finds its greatest field of usefulness in the treatment of the diseases of the skin, and the results that have been obtained are at times quite remarkable. It is a very fortunate thing that it is among those conditions that are, as a rule, very resistent to all ordinary methods of treatment, that some of the greatest successes have been made.

Of course, X-ray treatment is not confined to cutaneous disorders: their field of usefulness is a very wide one, but this is scarcely the place to enlarge upon this side of the question. It is, in fact, a pity that so much has been said upon the medical aspect of the question but, for reasons that are obvious, its avoidance is a matter of some difficulty.

Before closing this article it may be of interest to indulge in a little speculation as regards future developments. While we have seen that improvements in the electrical appliances have been going on from the very beginning, and show little sign of any falling off in this gradual but steady improvement, the X-ray tube itself has undergone no radical change since the invention of the focus tube by Professor Herbert Jackson.

It is quite true that the X-ray tube of the present day is a great improvement on the original Jackson tube: it is larger in size, more steady in action, and more capable of withstandin[illegible]ous and severe stresses to which it is subject[illegible] also provided with a means of regulating its v[illegible]ut it remains in p[illegible] it always was, [illegible] as its improv[illegible] been it has not [illegible] with the develop[illegible] the electrical sid[illegible] the X-ray equipme[illegible] modern coil can [illegible] pletely wreck any X-ray tube in a few seconds if desired. Our greatest want now is a tube that is steady in action and in vacuum, that will give out a certain quality of radiation as required, and no other, and continue to give this no matter how great power is applied to it within the limit of reasonable requirements. With a view of meeting some of the conditions it has been suggested to make the bulbs of quartz instead of glass, but so far no one seems to have attacked the problem seriously. Quartz is much more transparent to the X-rays than any form of glass, it is independent of any changes of temperature, and will stand any amount of rough usage within reasonable limits. It certainly should be well worth giving a thorough trial, if only for the advantages already mentioned. But even with these advantages it could not be said that the X-ray tube was in the nature of a perfectly satisfactory instrument. In the present state of our knowledge it is very difficult to see how the X-ray tube can be radically improved upon. We can only wait patiently; and for all we know some means of getting our X-rays may be discovered that is much more simple and reliable, and entirely different from the methods we use at present.

FIGURE 6. A fracture of the lower end of the radius involving the wrist joint.

This injury could not have been accurately diagnosed except with the assistance of the X-rays.

THE ROYAL INSTITUTION

A GENERAL Monthly Meeting of the Members of the Royal Institution was held on the afternoon of February 6th, The Duke of Northumberland, President, in the chair. Mr. and Mrs. Alfred Carpmael, Dr. W. S. Colman, Mr. Guy Ellis, Mrs. E. B. Fielden, Dr. A. H. Levy, Mr. Basil Mott, Mr. A. F. C. Pollard, and Dr. N. Raw were elected Members. The Treasurer reported that he had received £1,200, part of the legacy to the Royal Institution of the late Miss Wolfe, and £62 10s., a portion of the legacy of the late Mr. C. E. Layton. The special thanks of the members were returned to Dr. J. Y. Buchanan for his donation of £100 to the fund for the Promotion of Experimental Research at Low Temperatures. The Institution has recently received a gift of £1,000 from Dr. Muller.

HOW YOUNG BIRDS LEARN TO SING.

By G. W. BULMAN, M.A., B.Sc.

THE question of how a young bird learns the peculiar song of its own species is an interesting one, although the subject does not seem to have much engaged the attention of Naturalists. Walking from Hexham to Corbridge in Northumberland early last August, I had the pleasure of listening to the singing lesson of a young yellow hammer. One bird, the pupil, with slightly weaker and less decided song, was answering another which sang in a clearer and more finished style. There was no mistaking the fact that the first song came from the more accomplished songster, and it was hard to resist the conviction that the other was an imitation. It seemed, in fact, a young bird learning to sing. Several times the instructor gave the complete song—"A very, very little bit of bread and NO cheese"—and the pupil replied also with every note. There was no hurry, and always a quite perceptible pause between the songs. Then some three times in succession the teacher gave the song without the final note. And the pupil duly replied with a song one note short. Then the instructor went back to the complete version, but so long as I listened it was answered by the incomplete song.

This incident recalls some observations on the subject made some years ago. August is a specially favourable time for listening to the yellow hammer's song. Then it seems to come out with a clearness and beauty peculiar to the season. Whether this is due to the silence of the louder songsters, or whether the yellow hammer's song really improves by practice as the year advances, is perhaps uncertain. And in listening to this August songster I had often thought there must be two similar but distinct bird songs, and tried to make out to which of the buntings the other could belong. The one song was rapid, clear, and distinct, the other slow and frequently omitting the proper ending. But listening carefully one afternoon I convinced myself that the former was that of the old bird, and the latter that of the young one learning to sing. First of all came the quick, clear, decided song, and then, after a few seconds, the slow, hesitating, and often stopping short imitation. These were given in regular alternation for a long time. As I listened to them, it was impossible to resist the conviction that it was a young bird receiving its singing lesson. A somewhat similar account of a young bird learning to sing was recorded some years ago in the pages of a natural history periodical known as the *Field Club*, now no longer extant. Personally I have not met with any evidence that any other species learn their songs in this way. Nor have I come across the records of any other observers who have heard similar singing lessons, except the above-mentioned case, which, I believe, also referred to the yellow hammer. Young robins, song thrushes, and blackbirds, which I have heard making their early efforts, have always been singing alone.

Many years ago the Hon. Daines Barrington made some interesting experiments. He reared young linnets under skylarks, woodlarks and titlarks, and found that in each case they learned the song of their foster-parent instead of their own. He concluded, therefore, that the song of a bird is no more innate than language is in man. And more recently the experiment of rearing Baltimore orioles altogether apart from their parents has been tried. Two which were thus reared in a fourth floor flat in Boston, developed a song of their own, different from the proper song of the species. Other nestlings afterwards reared in the company of these two also learned the new song. Mr. Hudson, again, notes the case of the oven bird, the young of which apparently learn by imitating their parents while still in the nest. The old birds, it appears, sing a sort of duet together, and according to the above naturalist, "the young birds, when only partially fledged, are constantly heard in the nest or oven, apparently practising these duets in the intervals when the parents are absent."

The direct imitation explanation of bird-song is strengthened by the fact that in many birds the imitative faculty seems to be strong. Putting aside the familiar cases of our own starling and the American mocking bird, the following examples of imitation in birds not usually mimics may be cited. On one occasion I heard a blackbird crow like a cock. And I find that Yarrell records the fact that it is occasionally known to do so. On another occasion I heard a robin imitate the song thrush. Again, on one occasion only, I heard a skylark twist the song of a chaffinch into its own more copious melody. I incline, however, to think that this may have been unconscious imitation.

There are birds, however, like the cuckoo, which apparently cannot learn by imitation, whose song must be supposed to be innate. And the case of *Rhynchotus rufescens* cited by Mr. Hudson is of similar import. A young bird of this species was taken from the nest when just breaking the shell. It was reared where it had no chance of hearing the song of its species. Yet long before it was full grown it would retire to a dark corner of the room, and give its characteristic evening song in great perfection.

A NEW SPECTROSCOPE AND SPECTROGRAPH.

By R. A. HOUSTOUN, M.A., Ph.D., D.Sc.

(Natural Philosophy Department, University of Glasgow.)

THE type of spectroscope for general use in physical or chemical laboratories is now pretty well fixed. There is a telescope and collimator, both with achromatic glass lenses, the collimator being fixed, and the telescope moving round a divided circle. If the spectrum is to be photographed, the eyepiece end of the telescope is replaced by a box carrying a photographic plate at its end. With an instrument of this kind work can be done in the visible spectrum and in the ultra-violet to about $330\mu\mu$; if we wish to go further, quartz lenses and a quartz prism must be used. Quartz lenses and a quartz prism will also carry us considerably further into the infra-red than glass. But the quartz prism in general use, the Cornu double prism, gives a sharp image only when set at minimum deviation, and the focal length of a quartz lens varies so rapidly with the wave-length that the photographic plate must be set with its surface at an angle of about 21° to the axis of the camera. The focussing of the plate may thus be a lengthy process. On account of these complications and the cost of the special apparatus involved, the experimenter of moderate means and limited experience usually avoids the ultra-violet and infra-red.

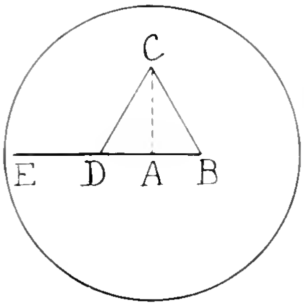


FIGURE 1.

The object of this short paper is to describe a cheap and simple form of spectroscope of radically different design, which is eminently suited for the amateur who wishes to work in these regions, and which is also suitable for the visible spectrum. It does not appear to be known in this country, although frequently used in research work in America. In this instrument the lenses are replaced by mirrors, and the Wadsworth mirror-prism combination is used. The Wadsworth mirror-prism combination consists of a prism and mirror mounted together on the prism table, with the plane of the mirror and the plane that bisects the refracting angle of the prism both meeting in the axis of rotation of the prism table. The diagram (see Figure 1) illustrates a special case of the arrangement: ED and CA are respectively the traces of the two planes referred to, and they both meet in A, the point through which the axis of rotation of the table passes.

Now consider any ray FGHJK (see Figure 2) passing through the prism at minimum deviation, and being reflected by the mirror. Its path through the prism, GH, is parallel to the base of the prism, DB, and JK is parallel to FG. From A draw AP, AN and AM perpendicular respectively to FG, HJ and JM. Then by symmetry AP=AN, and by equal triangles AM=AN. Consequently AP=AM. Suppose that the ray FP is white light; the colour in this ray that suffers minimum deviation emerges along JK after passing through the system. Rotate the prism and mirror through the same small angle, keeping the direction FP fixed. Then AP and AM are fixed, and consequently JK is fixed. A different colour now suffers minimum deviation, but emerges along the same straight line JK.

Suppose now that the single ray FP is replaced by a beam of parallel rays and that the prism table is rotated; each colour in turn, as it suffers minimum deviation, is undeviated and at the same time suffers the same constant parallel displacement.

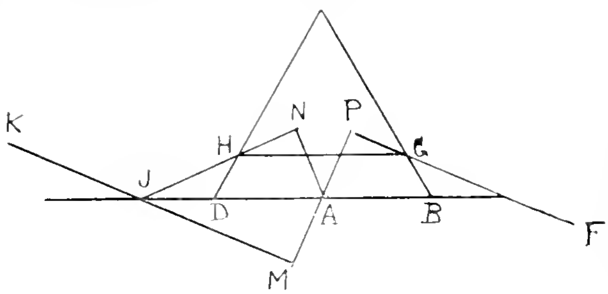


FIGURE 2.

The next diagram (see Figure 3) shows how these properties are taken advantage of. ABCD is a solidly-made box, the lid of which has been removed and into which we are looking vertically down. S is a slit attached to a piece of brass tubing which slides in a short piece of tube fixed in the side of the box. The light from the slit is rendered parallel by

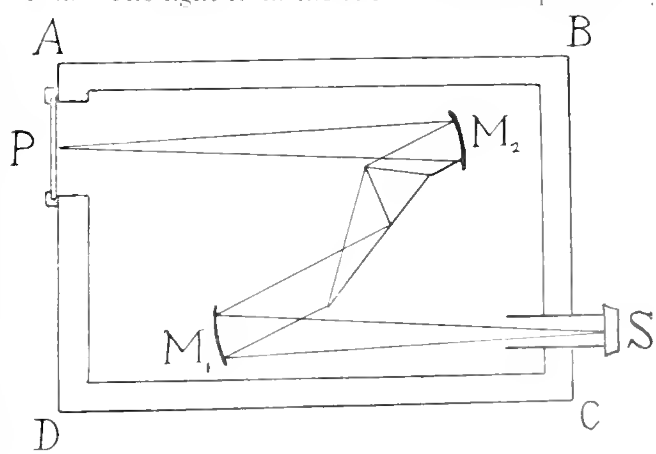


FIGURE 3.

the concave mirror M_1. It is then acted on by the mirror-prism combination, falls on the other concave mirror M_2, and is brought to a focus on the photographic plate at P. The concave mirrors are placed at their calculated distances and any necessary adjustment is then done by sliding in or out the slit until the image of the latter, when illuminated with Na. light, is perfectly sharp on the ground glass plate. Then, since the focal length of a mirror is independent of the colour of the light, all the spectrum is in focus away into the ultra-violet.

Suppose that a quartz prism is being used and that the photographic plate is replaced by a fixed eyepiece with crosswires. Then, if the mirror M_2 is adjusted so that the Na. lines coincide with the crosswires when they are at minimum deviation, and the prism table be rotated, every line comes into minimum deviation as it reaches the crosswires. That is, we obtain maximum definition automatically. The same holds if we are examining the infra-red with a linear thermopile. The thermopile remains fixed and we move the spectrum across it and every line as it reaches it moves into perfect focus, a pleasant contrast to the quartz spectroscope where, for every wave-length, we have to adjust both for minimum deviation and the correct distance of the thermopile from the lens.

Other advantages of this mirror spectroscope are its compact form and the absence of diffuse light. When light falls on a lens, eight per cent. is reflected back; here the light not used is absorbed by the mirror. Also, there are no tubes to reflect light at grazing incidence. The instrument may also be used as a monochromatic illuminator.

For the mirrors I have used plate glass and cheap concave lenses silvered. As it is the outside surface of the silver that is used, it is better to send the glass to an optical firm to be silvered. In calculating the position of M_1 and M_2 allowance must be made for the obliquity of the incidence. The correct distance between S and M_1 or P and M_2 is not $r/2$ but $\frac{r \cos \phi}{2}$ where ϕ is the angle between the incident beam of light and the normal to the mirror.

The disadvantage of silver mirrors is that they reflect light at 310 $\mu\mu$ very poorly. Consequently, that part of the spectrum is usually wanting, although the region beyond comes out well enough. Spiegel magnalium mirrors, however, reflect well to the very end of the spectrum; I have no experience of them, but, according to the tables, if they are used, the spectrum should be everywhere as bright as with quartz lenses.

A NATIVE IN MOURNING FOR A DOG.

By the courtesy of Mr. Frederick Bonney we are enabled to publish the accompanying photograph of an old native woman of Australia who is shown in "half-mourning" (num-muyn-ka). Mourning consists of covering the head with plaster, and in half-mourning a broad band of the latter is put over the head from front to back. The remains of this are seen in the picture, the special interest of which is that the signs of sorrow were put on, not owing to the loss of a human relative, but on account of the death of a favourite dog.

After the period of mourning is over, the plaster must not be removed, but allowed to crumble away. Incidentally it may be said that the bag which the woman is netting is one that is usually carried suspended between the shoulders, the ends being tied under the chin. In such a bag, the women carry about small possessions or an infant if they are moving about with one.

The photograph was taken in April, 1881, at Momba, River Darling, New South Wales.

From a photograph *by Frederick Bonney.*

An Aboriginal Woman of Australia netting a bag.

The plaster on her head is the remains of half-mourning after the death of her dog.

SCIENCE IN EVERY-DAY LI[illegible]

By Rev. H. N. HUTCHINSON, B.A., F.G.S., F.Z.S.

"Knowledge grows, but wisdom lingers." These weighty words of the late Lord Tennyson are, perhaps, just as true now as when they were penned, over fifty years ago. Scientific knowledge has indeed advanced by leaps and bounds in that short space of time. The chemist, the astronomer, the student of physics, geology, or of biology, all stand now on a different foundation, and by the help of modern instruments and the wonderful results obtained by methods of precision, they are privileged to see a little further into the mysteries of the truly marvellous Kosmos in which we live, and to read, however imperfectly, some of the riddles of Nature. But when we ask whether the civilised races of mankind have made an equal progress in wisdom, we are obliged sorrowfully to confess that the answer must be in the negative. Were we truly wise we should endeavour seriously to apply some of all this scientific knowledge to the practical problems of every-day life. We ignore the teaching of Science as far as it touches our habits and ways of life. We do not think scientifically. A few individuals here and there may do so, but, as a nation, we certainly do not, and the consequences of this neglect are of a serious nature. In spite of the warnings of kindly Nature and the advice often offered, freely and with goodwill, by those who know and realize the importance of obeying her laws, and following her wise councils, we continue in our own foolish way; perversely making paths of our own that are dangerous, nay, even forbidden; doing some things in ways that are quite wrong, and others that ought not to be done at all. As the prophets of Israel solemnly warned the people of their day of moral evils, and of unrighteous ways, so men of science, in the twentieth century, may well take upon themselves some portion, at least, of the seer's duty, and speak in no uncertain tones of the misery and waste and suffering that follow from disobedience of Natural Law. Such warnings might well be graven deep on tablets of stone, and brought down from the sacred mountain of knowledge to the plains below, to be set up in the eyes of the people. We surely cannot dispense with the aid of Science: at every step we need her help—at our peril do we neglect her wise counsel. She is Athene to the modern Ulysses. When we enter the world, Science, in the person of a medical practitioner, stands by to help our arrival, and when we seem likely to leave it he is also there, in case he may possibly be able to keep death away, or at least to help us in our last moments. One may go a step further and say, that if the laws of heredity were considered in the making of matrimonial alliances, the health of the races could be vastly improved, and much quite unnecessary suffering avoided. The time will come when the science of Eugenics will take its proper place.

In the following pages, the writer begs humbly to offer a few thoughts and sugge[illegible] those who will accept them, in the hope th[illegible] [illegible]ay be of some service in a good cause. [illegible] offered more especially to women—and [illegible] the readers of "Knowledge" are not all [illegible]ause they refer largely to domestic matters, a[illegible] the house, woman is rightly supreme. She it is [illegible] is responsible for order, cleanliness, comfort and th[illegible] supply of food, light, air, and other things so truly vital to a proper healthy existence. There is hardly any limit to her power in this domain: in her hands lie the man's peace and perhaps his very life.

The first thing to consider is the house we live in, and its environment. Nobody would willingly choose an unhealthy place to live in, but supposing that circumstances compel us to dwell in such a district, we can at least see to it that our homes are not insanitary. It is a good plan, in these cases, to call in the aid of a professional expert, a sanitary engineer or an architect. All who study these matters are aware of the fact that houses have been built in situations where good health is hardly possible, except perhaps to a few exceptionally strong men and women, places where damp prevails, bringing with it lung troubles, rheumatism and a lowered vitality. In these places the death-rate is a high one. For example, the situations of our two chief Universities are bad—they would never have been chosen by their pious founders had they known something of the Science of Sanitation. It is to be hoped that, in the good days to come, the building of dwelling houses on such sites will be strictly forbidden, and on those which may be moderately unhealthy, only such houses should be allowed as are built on arches, as recommended by the late Dr. B. W. Richardson. This simple plan would keep out damp to a large extent. It is sad to think how many valuable lives are lost, or at least partly ruined, by neglect of these simple precautions, which even a slight knowledge of science would suggest. The writer has frequently seen country houses surrounded by so many trees at a short distance as to render them decidedly dark and unhealthy. Now darkness in a house is a thing to be carefully avoided. It is bad for the mind, because darkness is depressing, and all depressing influences should be avoided. It is bad hygienically, because evil germs flourish in darkness, while sunlight kills them.

Labour-saving appliances should be welcome in these days, when good servants are not easy to obtain (and are inclined to leave us after a year or two). But there is one plan which the present writer has often strongly advocated which, perhaps, more than any other, would save labour, and that is the provision of hot and cold water in every bedroom, together with a waste pipe of proper width to take away water which has been used, and other things. This idea is not new, for it is being carried out in some of the best and most up-to-date hotels, where labour-saving is most important.

Doubtless builders might object to the extra expense, but as soon as the public demand such a change it will be made. The only delay will be in educating people to make the demand. Linoleum might be used to a greater extent: most houses have too many carpets, curtains and other hangings which collect dust. On entering the house dirty boots bringing in mud might be changed for slippers.

The writer does not propose in these articles to discuss the action (or inaction) of corporate bodies, a subject on which much might be said, but it may suffice to point out the importance of scientific knowledge to our local rulers. The more they know of science, the fewer mistakes will they make. In spite of frequent warnings in the daily press, few people realize the dangers lurking in water and milk, two of the prime necessaries of life. The public are in the habit of drinking water anywhere and everywhere, without making any enquiries as to its purity and origin. A very good rule would be to refuse to drink the water provided in hotels, restaurants, or lodgings unless guaranteed to be effectively filtered. There are good filters to be obtained which will effectually stop all bacteria, if kept clean and in good working order, such as the "Pasteur" (which has been subjected by expert bacteriologists to severe tests). Perhaps a safer plan would be to boil all the drinking water, and charge it with carbonic acid in large gasogenes made for the purpose. This would make it pleasant and sparkling. When travelling abroad, it is still more important to avoid the drinking water, and to drink only wine or beer, or mineral waters of guaranteed quality. With regard to milk, it may be safely said that the danger is still greater; and one is glad to observe that more attention is now paid to this subject, both by the general public and by sanitary authorities, for it is a most serious question. Tuberculosis in children is frequently due to milk from a tuberculous cow. Diphtheria, scarlet fever, typhoid, may often be traced to a similar source. Consequently it is most important that both dairymen and farmers should take every reasonable precaution to keep the milk clean and pure, for it is a most favourable soil for harmful bacteria. Also milk, when it reaches the house, should be kept in a cool place, away from the sun, and it is a good plan to cover the basin containing it with muslin (fixed on a wooden hoop), to keep out flies and dust. Dairymen mostly adopt this practice now, and housekeepers should follow their example. Most farmers are not sufficiently careful about the condition of the cow-house and its surroundings. Any sort of refuse carelessly left near these places may be a real source of danger, on account of the flies that breed on refuse heaps. Milkers must keep their hands clean, and milk-pails must be scalded with pure water. Sir James Crichton-Browne and others have spoken plainly to the public on the danger of flies, and it is greatly to be hoped that these warnings will be heeded. Some of the London streets might be washed and brushed very much more than they are. Where there is much traffic, one often sees horse manure lying about in large quantities. Flies are attracted to it, and when dried by the sun and air it is carried about like dust, enters shops where food is sold, and contaminates it. This is a matter in which doctors and public men may do good service to their fellow-citizens, by writing to the newspapers and bringing pressure to bear on local authorities. The power of the press is enormous, and consequently the education of our very unscientific public, in these days, is largely in the hands of the journalists; on them rests a heavy responsibility. One is glad to see a popular newspaper, such as the *Daily Mail*, devoting some of its space to matters of this kind, for in so doing it renders the nation a service of untold value.

It cannot be denied that a great deal of food is wasted, not by any one class of people, but in houses of all classes. Waste of any kind is unscientific, and quite wrong economically. One of the triumphs of modern science is the way in which bye-products, or so-called "waste," in manufacturing processes, have been turned to account and made a source of increased profit. Even the refuse from our houses can be converted into "producer gas," and supply gas engines for working machines, or for making electricity. What can be accomplished on a large scale can also be carried out on a small one, and, probably, more effectively. A great deal of teaching is wanted to bring home to the minds of women the full meaning of all this waste.

It is true that much care and supervision is needed in order to prevent waste, but the lady of the house (or housekeeper, as the case may be) should regard this as an imperative duty. Where coal fires are used (and these are quite wrong scientifically, as will be shown later) a good deal of valuable coal is wasted by servants, who are too careless or indolent to separate the white ashes from the unburnt coal, and so both alike are thrown into the dust-bin, to mix with organic refuse, such as cabbage leaves, and so on. To anybody who regards this question scientifically, it is quite clear that the organic matter and the inorganic matter should be strictly kept apart from the beginning. In the country, cottagers set a good example in this matter by putting coal ashes on to flower-beds, or some other part of the garden, and keeping the waste food-stuffs to feed a pig or chickens. Now it may be troublesome for town-folk to make this separation, but it would be well worth while to do it, and so to increase the national wealth and welfare. There should be two dustbins, one for coal ash (*i.e.*, real ash, not lumps of coal), pieces of china, wood, iron, paper and other such refuse; the other for food-stuffs. The lady of the house should give instructions to her servants to use a sieve for separating the coal ashes from unburnt coal, the former to be thrown away (which seems a pity, for they contain potash, soda, lime and iron silica, and so on, all of which can be used by plants; in country houses these should be put on one side for the garden). The latter should be used for making up the fire. The other bin may be used for organic refuse such as cabbage leaves and stalks, lettuce leaves, potato peelings and pieces of unused vegetables (tea leaves are often kept for use in sweeping floors), bones, after being used for soups, bits of meat. Bread and toast should never be thrown away, as they often are, even in the streets of the poor. All these things are to be regarded as valuable bye-products of the house. Some means ought to be devised for regularly collecting this matter from house to house; attempts in this direction are being made here and there by the Salvation Army and certain Sisters of Mercy. We presume that soup is made of this material, but a far better plan would be to use it for pig-feeding, in which way it would be more completely used and converted into bacon (which, at present, commands a high price).

The keeping of pigs by country labourers, farmers and others would thus be encouraged. The local authorities in towns, who at present take away all the house refuse, would be extremely glad to see such a change as this, for their carts would only be required to take away the inorganic matter, and thus much trouble and expense would be avoided, and that would mean a saving in rates (which in most places are rapidly rising). On the other hand, municipal piggeries might be worth considering.

Ladies might well devote more attention to the subject of food and diet. Our health depends partly on the food we eat, and the way it is kept and prepared. It may safely be stated that the hygiene of the larder and scullery in most houses is somewhat neglected. Meat guards might be used much more extensively. Rats and mice should be ruthlessly exterminated, as well as cockroaches and flies. Tinned meats should be avoided, especially tinned lobsters, oysters, shrimp paste, and so on. Even tinned fruits are not quite safe. Meats are now often done up in glasses, but air occasionally finds its way into these, causing decomposition. Ladies who do not study the hygiene of food would be surprised if they knew of the dangers that lurk in tinned foods. A good plan would be to give a general order to the cook that no such preparations be allowed to enter the house. Raw oysters are by no means safe—they should be cooked, and so should escallops and mussels; the latter are very wholesome and nourishing. Wholemeal bread is far preferable to the ordinary white kind, which unfortunately lacks some of the most important constituents of the wheat grains.

Steam cookers both for meat and vegetables should be used: in this way valuable salts and juices are retained, which by ordinary methods are lost.

The adulteration of food is a subject on which much instruction is wanted. More public analysts and public inspectors are greatly needed. Magistrates should inflict severe sentences in those cases where the evil-doers are brought to justice. In all our large towns a great deal of dis[illegible]t is sold to the poor, especially in the form [illegible]. Vegetarians avoid these dangers, and they [illegible]xample; but those who do not wish to ab[illegible]iet of flesh might well take less of it, and pa[illegible]tention to fruits, vegetables, milk and chees[illegible]re quite sufficient to keep us in health. W[illegible]d then hear less about ptomaine poisoning, [illegible]hich is frequently connected with the eating [illegible] pies. Fruits might be used by all classes a great [illegible]re. Every country in the world can send its fr[illegible] to Great Britain and Ireland free of any tax. This is a great national blessing, and one which is hardly appreciated as it ought to be. Young people might be encouraged by their parents to eat apples, oranges, grapes, nuts, figs, raisins, dates, plums, currants, and so on, and at the same time to consume less of pastry, sweets, pickles and sauces. Parents may reply that many fruits are expensive. To this we may say, apples and oranges can be obtained cheaply by buying in large quantities, especially from the stores. The very finest apples, for example, can be purchased at about 1¼d. each by buying a large box containing about one hundred and twenty. The same with oranges. The fruit may easily be stored on wooden shelves in a wine cellar, and the riper ones picked out for present consumption, leaving the rest to ripen gradually for a month or two. They do far more good to the young people than medicines. Their use tends to keep down doctor's bills. Unfortunately, the less educated portion of the public still puts great faith in patent medicines and patent foods, and their credulity is incomprehensible: lying advertisements, and the promises held out therein, are accepted with a faith that is simply amazing. Nothing but education can stop this growing evil, for no Government has the courage to warn foolish people in such matters! Much might be said about the excessive use of stimulants, narcotics and drugs, but it is impossible to deal adequately with the subject here. Suffice it to say, that for most people the less alcohol they consume the better. Many old people have attributed their long lives to total abstinence. Even the doctors are much less in favour of alcohol than in former times. But with regard to tea and coffee much might be said; only we fear the ladies will not thank us for saying that the excessive use of tea (and coffee) by all classes is really a grave danger! It is taken far too strong and too frequently, and it should be poured off into another vessel after standing three or four minutes. Medical men are beginning to realize the magnitude of this evil. On all sides we hear of people suffering from "nerves," and yet they continue drinking large quantities of tea. When to these habits they add want of exercise, excessive eating (often of over-rich food, highly spiced with sauces), and somewhat idle habits, what wonder is it that they become depressed, morbid and unhappy? When the mind is left uncultivated by the very best literature and art, the effects are still worse.

(To be continued).

BIRD LIFE ON THE CAERNARVON COAST. MARITIME HABITS OF THE LAPWING, RESEMBLING THOSE OF THE RINGED PLOVER.

By A. R. HORWOOD

(Leicester Museum).

WHEN staying for a few weeks on the Caernarvonshire coast at Criccieth, and engaged in the study of the habits of the different shore-birds and those frequenting the mouths of estuaries, I came across the nest of a Lapwing (*Vanellus vulgaris*) containing five eggs, which were generally unlike the ordinary type of plover's egg, in being both shorter and broader. All the eggs were similar in shape, and the coloration and markings were normal, but of course the number (five) was unusual.

Likewise the nest was quite characteristic, though more carefully constructed than is often the case in inland stations, consisting of more ample material, being composed of dried bents. It was placed at the edge of the coarse grasses, *Festuca*, *Agropyron*, and so on, fringing the sandy beach. This was not more than a dozen yards from high-water mark. Between the line of vegetation and the sea there were patches of shingle. Amongst the pebbles forming the shingle, the Lesser Tern breeds; and among the fine and sandy stretches removed some distance from the beat of the surf the Ringed Plover nests, whilst lower down still, in coarser sand and shell fragments, quite close to the water's edge, nests of the Oyster Catcher could be found. Indeed these three species (all of different genera) form a more or less constant avian association characteristic of low-lying littoral flats, especially along the western coasts of the British Isles.

When discovered, the Lapwing's eggs were warm, indicating that the bird had but just left the nest. Here it might be urged that the eggs were warm owing to the heat of the sun, and that the Lapwing is in the habit of leaving her eggs for the sun to hatch, but this would not obtain in this instance, as the day was dull, if not chilly, and, moreover, we do not credit this belief. No bird at least had risen up from this bit of coast, upon which I had been reconnoitring for some time, having beached the boat by which I had approached it. And for a considerable period I had been experimenting in the search for nests of the Ringed Plover, Lesser Tern, and Oyster Catcher, a good lesson in bird habits.

Now it is well known that the Ringed Plover does *not* get up and fly away at once, or circle round and round an intruder upon the approach of a human being to the vicinity of its nest. But, on the other hand, it simply leaves the nest unobserved (if possible), effecting this by running in and out of the piled-up masses of parti-coloured shingle which in plumage it closely resembles. Then, having removed to some distance, it may be noticed perched upon one of the rolled pebbles which strew the beach in great profusion. This manoeuvre may be followed easily and closely by one conversant with the habits of these birds, and is most marked, contrasting as it does in so noticeable a manner with the habits of the Lesser Tern.

Likewise, inland, the habit of the Lapwing when its nest is approached by a person—even some distance away, it may be, from the actual whereabouts of the nest—is totally different. For on first observing the intruder it quietly runs unseen for some little distance, then as quickly and stealthily takes wing, and, circling at first round and round the intruder, it repeatedly tries to inveigle him further and further away from its nest by sweeping backwards and forwards at a point and in a direction as far as possible removed from the nest; and now, appearing above the top of some hedge close by, it undoubtedly endeavours, by its anxious noise and vigorous flights to and fro, to try and decoy the enemy away.

Not so, however, when nesting along the sea-coast, for here it has undoubtedly habits similar to those of its somewhat near relative, the Ringed Plover; and, instead of getting up some distance from the nest, it runs along, remaining, like the Ringed Plover, at a distance amongst the shingle until the danger is past. This, moreover, is easily accomplished amongst the bushy grasses at the edge of which it nests. Though *several* nests were found in the same locality under similar conditions, no birds were seen.

Somewhat exercised in mind as to how to account for this evident change of habit of the Lapwing when nesting on the sea-coast, as compared with its well-known and curious behaviour when breeding inland, and nesting on pasture or ploughed land, and not knowing whether or not my experience was unique, upon my return to Shropshire, where I was then living, I mentioned this interesting habit of the Lapwing to Mr. H. E. Forrest, of Shrewsbury, who was then, as now, particularly interested in the fauna of North Wales (of which his recent work is perhaps a summary). I was naturally surprised but delighted to find that he was able to bear out my experience, when I related the circumstance to him, though he had not, until I pointed out the resemblance in habit between the Lapwing and the Ringed Plover, noticed that this was the case. Mr. Forrest wrote me as follows: "I was struck by your remarks as to the behaviour of Peewits nesting by the sea. Though I hardly noticed it at the time, I should say, is of long stan[illegible] It is a curious fact that the Ringed Plover's t[illegible] identical along the sea-coast. Is this me[illegible]lence, or were the habits of the Lapwing o[illegible] like those of the Ringed Plover, and has it [illegible]s breeding habits when nesting inland? I[illegible]y habits

From a Photograph by E. B. Miles *[illegible] Drawing by W. [illegible] G. Montgomery.*

Lapwing, Ringed Plover, Oyster Tern and Little Tern, nesting together.

now remember that they leave the nest quite unobserved, and do not fly around in the way we always see them inland."

It seems probable, from the uniform shape of the five eggs found, that the Lapwing nests habitually in the same situation at the locality named, and that the habit it has acquired, or exhibits, perhaps we and generally conspicuous appearance rather suggest that once it was generally a frequenter of marshy tracts or areas not given over to cultivation, and indeed we must remember that it is only of comparatively recent years that cultivation has been general in the way that it is now carried on. At least the case is interesting.

ANNOUNCEMENTS.

THE PHYSICAL SOCIETY OF LONDON.—We are informed that owing to an alteration in the publications, papers read before the Physical Society of London in future will appear in general only in the *Proceedings* of the Society and not in the *Philosophical Magazine*. The *Proceedings* and other publications are now obtainable by the public from the publishers to the Society, The Electrician Printing and Publishing Company, Ltd., 1, 2 and 3, Salisbury Court, Fleet Street, London, E.C.

THE BRITISH ASSOCIATION.—For the meeting of the British Association for the Advancement of Science, which is to take place this year at Portsmouth, on August 30th, and following days, under the presidency of Professor Sir William Ramsay, K.C.B., F.R.S., the following presidents have been appointed to the various sections: Mathematical and Physical Science, Professor H. H. Turner, D.Sc., F.R.S.; Chemistry, Professor J. Walker, D.Sc., F.R.S.; Geology, A. Harker, M.A., F.R.S.; Zoölogy, Professor D'Arcy W. Thompson, C.B.; Geography, Col. C. F. Close, R.E., C.M.G.; Economic Science and Statistics, Hon. W. Pember Reeves; Engineering, Professor J. H. Biles, LL.D.; Anthropology, Dr. W. H. R. Rivers, F.R.S.; Physiology, Professor J. S. Macdonald; Botany, Professor F. E. Weiss, D.Sc., with W. Bateson, F.R.S., as chairman of the sub-section of Agriculture; Educational Science, Right Rev. J. E. C. Welldon, D.D.

NOTES UPON THE FUNDAMENTAL SYSTEM OF STARS.

By F. A. BELLAMY, Hon. M.A., F.R.A.S.

Of all the branches into which astronomical work may be divided there is none of greater importance, none to which more time has been devoted at the observatories during the past two hundred and fifty years, and none that has proved so useful in our daily life, as meridional or star-catalogue work. Some hundreds of star-catalogues exist, small or great, and the aim of all has been to re-observe the brighter stars and obtain improved positions, and to observe and determine the positions of other and fainter stars: the object being to fix or ascertain a large number of points of reference in the sky, much as geographers do upon the earth.

The object of these notes is to draw attention to perhaps the most important piece of work ever undertaken in this branch, and to place before our readers a general summary of the proceedings which led to its being started, and of the present condition or progress already made.

Some remarks will be made upon the scheme proposed, the pecuniary and other help received by the Dudley Observatory, the erection of a southern observatory, the inauguration of the work there, also attention will be called to future proposals and ultimate aims; and, finally, a translation from the Spanish of an important paper by Professor R. H. Tucker, dealing with the actual details of the work and its progress at San Luiz, in Argentina, up to last July, will be appended.

The success of the great scheme depends upon three sources: Professor Boss, who has initiated, planned, and is naturally at the head of the work: Professor R. H. Tucker, the most eminent meridian worker, who has charge of the observational part: and the Trustees of the Carnegie Institution of Washington, who have provided the money.

The headquarters of the work will be at the Dudley Observatory, whose director is Professor Boss; the thousands of stars selected for observation were first observed there, then the same meridian instrument was taken to the southern observatory at San Luiz, and when the instrument has been returned to Albany, the stars at first observed there will be re-observed. There are various excellent reasons why this should be done.

The Dudley Observatory, near Albany, U.S.A., was founded in 1851, by subscription, principally aided by the generous donation of Mrs. B. Dudley—hence its name. It was organised in 1856, and placed under the direction of Dr. B. A. Gould. Until 1877 it was chiefly a meteorological observatory, but in 1878 a section of the Astronomische Gesellschaft scheme for the re-observation of all the Bonn Durchmusterung stars as bright as the ninth magnitude, and a considerable selection of others a few tenths of a magnitude fainter, was undertaken at the Observatory; the work of re-observing 8,241 stars between $+5^\circ$ 10′ was commenced on August 19th, 1878, and completed on August 5th, 1882; each star was observed twice or more times. Professor Boss was engaged on the Zone observations and reductions throughout; the assistants, O. H. Landreth, T. D. Palmer, and R. H. Tucker were helping for one, three and four years respectively. Of Mr. Tucker, who was in charge of the whole work during Professor Boss's absence in Chili to observe the Transit of Venus, in December, 1882, the Director has acknowledged that "the record of observation and computation bears, throughout, high testimony to the character of his efficiency and zeal." This catalogue of 8,241 stars was published in 1890 and was one of the first two published in connection with that great and important scheme. It was accomplished by means of the Olcott Meridian Circle—so named from a generous donor of funds—constructed by Pistor & Martins of Berlin, in 1856, and is of eight inches aperture and ten feet focal length.

The position of the Observatory there was $4^h\ 54^m\ 59^s{\cdot}2$ W. of Greenwich and $42^\circ\ 39'\ 49''{\cdot}5$ north latitude; it was one hundred and seventy feet above the sea and situated on the northern side of the city of Albany in the valley of the Hudson river. Owing to the smoke and disturbance from engines and trains from the railway and from the frequence of local mist and fog, good work was interfered with, so much so that it seemed advisable, if not imperative, that the observatory be refounded on a new site: the money was forthcoming — as is usual for astronomy in the U.S.A.—and about 1893 the observatory was rebuilt on its present site, not very far from its original locality. Besides the Olcott Circle its other chief instrument is an equatorial telescope of twelve-and-a-quarter inches aperture by Brashear, Warner & Swassey. The exigencies of the meridian work have prevented the equatorial being much used. It is this Olcott Circle that has been temporarily moved to San Luiz.

Since the Observatory has been under the direction of Professor Lewis Boss, the chief work has been meridian observations, researches upon proper motions, and motion of the solar system. The most recent work has been the observation and preparation of a catalogue of positions and proper motions of all stars to the seventh magnitude, in connection with the department of Meridian Astrometry of the Carnegie Institution of Washington, which Institution has appropriated to the Dudley Observatory, under grant No. 100, £1,000 for:—(1) The completion and publication of a catalogue of about 10,000 stars, 8,000 being between declination $-20°$ to $-37°$, to the 7·5 magnitude: these observations were made between 1896 and 1901; (2) For the homogeneous determination of star positions and motions, computed and discussed from all available observations and star catalogues, to the sixth and in some cases to the 7·5 magnitude, with an accuracy of the highest possible order. This Preliminary General Catalogue, formed from various sources, has now been published; it contains the positions of 6,188 stars reduced to the epoch 1900·0 and includes results which are primarily designed to furnish a large number of systematically and accurately observed motions of stars. The intention was to include all stars that seemed to show a proper motion of 10″ a century, derived from observations made at various observatories. In January, 1902, Professor Boss again made application to the Trustees of the Carnegie Institution for aid in a general investigation of both the nature and amount of the motions of the stars. Specific things proposed to be investigated were (*a*) the direction and velocity of the solar motion in space to be determined with far more accuracy than at present known; (*b*) to investigate the subject of "star-swarms,"—swarms of stars moving in a common direction like meteors—a new subject, to which Professor Boss has been specially attracted; (*c*) to determine with accuracy the relative distance of various orders of stars; (*d*) to determine the constant of precession more accurately than is now known; and to examine other questions as they arise. Professor Boss considered that, as the basis of these investigations, the motions of the stars must first be accurately known, and that this would be both the greater and the most laborious part of the work. It is with this general investigation and the specific investigation (*a*), that Professor Boss and his staff have been progressing to the extent to be indicated later.

The fact of so much having been already accomplished served to prove beyond doubt to Professor Boss that the real value of his results to that period, about 1904, and of the final discussion, will depend upon the systematic accuracy of these determinations of motion, and upon having a good determination of motion for each star. Both these requirements called for further special observations, the great need in this direction being a new determination of the positions of the standard stars, distributed from the north to the south pole of the sky. Professor Boss' plan proposed to the Carnegie Institution was further supported by those results. The Dudley Observatory Meridian Circle was then being altered to meet his views with regard to such standard work. Aided by a grant, the first series of re-observation of the selected standard stars or points of ultimate reference, would be completed at Albany within about two years; after that he proposed to dismount the instrument and re-erect it upon a suitable site in the Southern Hemisphere. The [illegible] he had selected as eminently suitable were S[illegible], in Argentina, specially recommended by M[illegible]s, the chief of the meteorological service, as p[illegible] an excellent and steady climate; another w[illegible]fontein, in South Africa, highly recommende[illegible] D. Gill, and places in Australia were also [illegible]. The idea in selecting a southern station [illegible]bserve stars at Albany from the north pole to [illegible] south as possible, and then to use the southern [illegible]tory for observing stars from the Albany zenit[illegible]e south pole, and so interweave the two series that the elimination of systematic errors of observation might be effected by making them work in opposite directions in the two positions of the instrument. As a necessary addition to this proposal it was further urged that special re-observations be made of those stars, mostly south stars, which had been neglected during the past twenty to thirty years; the accuracy of the places of these particular stars is much desired in order to obtain improved knowledge of their proper motions, and so help to bring up the quality of their places to approximate that of the standard stars. Professor Boss said that in one-fourth of the southern sky, that near the southern pole, only thirty *per centum* of the stars to the seventh magnitude had been accurately observed since 1880, and scarcely any since 1894; the need of their re-observation was, therefore, very great and urgent.

In connection with the Carnegie Institution's desire for the establishment of a southern observatory it was proposed by Professor Boss, and warmly supported by eminent astronomers, that his particular scheme of research work, essentially referred to in (*a*)—the re-observation and determination of standard positions of a large number of stars from the north to the south poles of the sky—was specially that kind of work for which a portion of the funds of that Institution could be most appropriately utilized, especially as the qualifications, time, and energies of several astronomers were now available for carrying out such a grand scheme. In making this application to the Institution, Professor Boss said he would use the same instrument as employed at Albany, which he considered to be one of the finest meridian instruments in the world for such work, and one in which the investigation of the division-errors of its circles has been accomplished with the highest degree of accuracy, by the combined labours of four observers lasting more than a year. He proposed to take personal charge of and responsibility for the whole of the investigations both for the northern and for the proposed southern observatory; and intended to go to the Southern Hemisphere to organize the work, to remain there for a time in order to ensure its smooth, speedy, and accurate running, and, towards the end of the southern series of observations, to re-visit that observatory to satisfy himself and colleagues that no point of importance had been neglected. In making his application for a grant to carry out his plans of 1902, in their most complete and satisfactory manner, he specially drew attention to, and emphasized, the fact that this observational portion and its reduction to standard points of reference, was both the most costly and the most laborious of the four items for investigation proposed for the Institution's kindly interest and pecuniary support.

The Board of Trustees of the Carnegie Institution agreed to aid Professor Boss, and, under grant No. 479, £5,000 was appropriated for the use of the Department of Meridian Astrometry, to be directed by Professor Boss at the Dudley Observatory, Albany, New York, for "*study of motion and structure of the stellar system of the Northern and Southern Hemispheres.*"

Work upon this larger General Catalogue of about 25,000 stars, was commenced at Albany at the earliest moment in 1907, October 7th, and by the end of 1908, August 15th, or after ten months' work, 10,421 meridian observations were obtained with the Olcott Circle. They were chiefly made by the two assistants, Mr. A. J. Roy and Mr. W. B. Varnum, whose zeal, loyalty, and efficiency, as Professor Boss specially testifies, is worthy of all praise. Eight others have also assisted in the work at Albany. These observations were made upon a fundamental system, and are mostly of standard stars between 83° north zenith distance and 40° of south declination. All the stars visible from the Albany zenith to this south declination can also be observed at the finally-adopted site of the southern observatory at San Luiz, latitude—33° 18′ and longitude 66°·3 or $4^h\ 25^m\ 25^s$ W. of Greenwich. So soon as the favourable conditions of the climate were ascertained, and it had been decided that San Luiz, in Argentina, should be the site for the southern observatory, progress was made with the preparations for the establishment of the observatory during 1907 and 1908. San Luiz is a town of about ten thousand inhabitants, and is situated on the Trans-Andean Railway, about five hundred miles inland or west of Buenos Aires, and at an altitude of two thousand five hundred feet above sea level. The site is not near enough to the Andes to get influenced by the intense and oppressive heat waves of the Andean plains.

The U.S. Department of State, through the courteous and cordial interest of the Secretary of State, Mr. E. Root, was specially helpful in arranging matters with the Argentine minister, Senor Don E. Portela, who interceded and induced the Argentine Government to facilitate the choice of a site, for various permissions, and for other privileges.

By the valuable influence, interest, and courtesy of Mr. W. G. Davis, Director of the Meteorological Department in Argentina, Dr. L. S. Rowe, Mr. De la Plata, Mr. Naón, and Mr. Ezcurres, Ministers of Foreign Affairs, of Justice, of Public Instruction, and of Agriculture respectively, they were saved much trouble and expense in the entry of the instruments, in their free conveyance to San Luiz, in free tickets for the observers, and in the free use of a site on national property of the Escuela Regional (San Luiz), which is under the direction of Dr. C. L. Newton.

So the Argentine authorities—especially those at San Luiz—having entered thus heartily into the matter, it was possible for Professor Boss, with Professor R. H. Tucker and Mr. W. B. Varnum, to sail in the SS. *Velasquez*, on August 20th, 1908; they arrived at Buenos Aires on September 13th, and at San Luiz on September 20th, where they were met by a party of official representatives of the Provincial Government of San Luiz, consisting of Senores Gazari, Quiroga and Romanella, and by many prominent citizens of San Luiz. Professor Boss and his colleagues at once proceeded to choose the actual site at San Luiz, to select the quarters for the observatory staff, offices, and so on, and to make general arrangements for the work. Certain instruments and portions of some of the constructive materials were taken out there by these astronomers. As soon as the ground could be prepared, and the construction of the observatory had been planned and started, Professor Boss returned to Buenos Aires on October 7th, leaving Professor Tucker and Mr. Varnum to take charge and superintend the erection.

On October 10th, Professor Boss sailed in the SS. *Velasquez* on his return to New York. On the sixth day out the ship ran at full speed upon the rocky coast of San Sebastian Island; the night was very dark, with rain and fog. The ship and its cargo became a total wreck, but after some dangers and hardships, all the passengers, crew, and most of their luggage were saved, and they proceeded to Santos, Brazil, from which port Professor Boss again started, in the SS. *Titian*, for New York, on November 11th.

(*To be continued*).

REISSNER'S FIBRE.

At a recent meeting of the Linnean Society of London, Professor Dendy and Mr. G. E. Nicholls exhibited a series of lantern slides illustrating the structure and relation of the sub-commissural organ which has a sensory function in brains of various vertebrate types as well as of Reissner's fibre which runs from the sense organ down the spinal cord. The slides were described by Professor Dendy, while Mr. Nicholls gave a brief account of some experiments which he had made, which so far seemed to support the view that the organs in question constitute an apparatus for automatically regulating the flexure of the long axis of the body. Reissner's fibre does not apparently exist in man, though some traces of the sub-commissural organ occur in the embryo.

THE SPARROW HAWK *(Accipite*

Illustrated from Photographs

By ARTHUR BROOK.

Nest and Eggs.

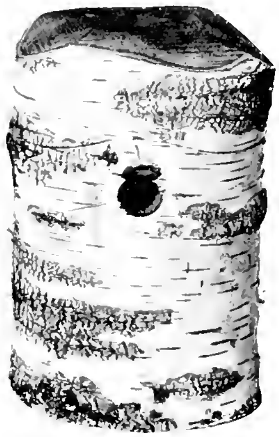
Young in the Nest.

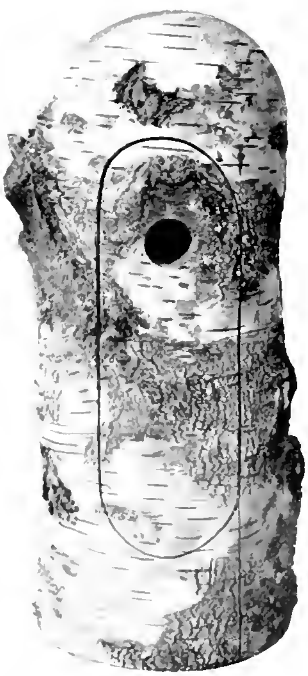
A nearly-fledged Bird.

The Hen on the Nest.

NESTING SITES FOR BIRDS.

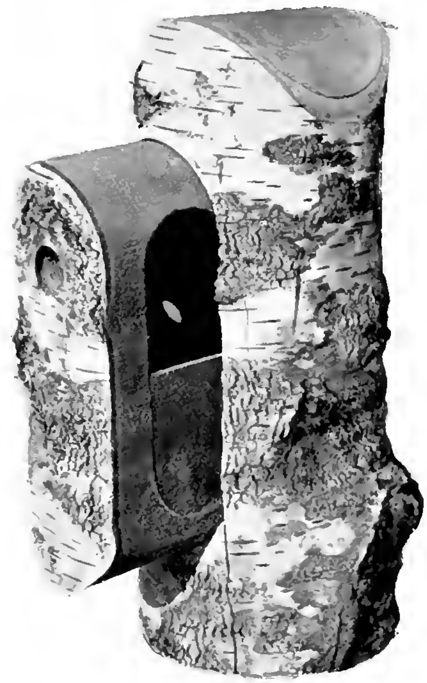
The boxes at the top of the page are on the same plan as those which have been used with great success in the Brent Valley Bird Sanctuary, but some improvements have been made in the way in which the lid opens and is fixed in place.





The boxes seen in the middle of the page are hollowed out from natural logs of the Birch, the tops can be removed so that they may be cleaned out or the contents examined from time to time.

The others shown at the bottom of the page are also made from natural logs, but in this case the centre is removed from the side instead of from the end, and after being hollowed out a second and a third time the piece is replaced once more in the log from which it can be pulled out like a drawer.



THE ENCOURAGEMENT OF INSECT EATING BIRDS.

ALTHOUGH here and there in this country those who are fond of birds have furnished them with nesting sites, which is an important point in these days when it is not easy for many species that build in holes to find accommodation, yet no general attempt has been made as in some other countries definitely to encourage insect-eating birds, which are specially useful to those who are engaged in growing crops.

FIGURE 1.
The parts of a box made from a log so arranged that the top lifts off.

The Brent Valley Bird Sanctuary Committee have shown what can be done in the way of protecting birds on the borders of London, and with a view to making the movement in favour of attracting birds more general, they have introduced and are showing at various exhibitions a number of new designs for nesting boxes.

The Chairman of the Committee has contributed an article on the subject to *The Country Home* for March, and here and on the opposite page we give illustrations of some of the more important kinds of nesting sites with detail[illegible] construction.

The nesting sites made fr[illegible] have been used with great effect in the S[illegible] [illegible]t it seems that in gardens and near houses it might be advisable to use materials which are more natural and less suggestive of a trap. The ordinary boxes made from logs

FIGURE 2.
The parts of a nesting site in which the centre of the log can be drawn out.

of which the tops come off, can easily be erected on posts, and are suitable for wrens and tits when they have a small opening, and for robins when the aperture is a little bigger. The latter birds sometimes prefer a box with an open front, and this is the case with flycatchers. Various boxes have been designed for their benefit (see Figures 3 and 4), and a modification of Figure 2 of which the upper half of the front of the movable piece has been cut right away. All particulars can be obtained from the Secretary of the Selborne Society, at 42, Bloomsbury Square, W.C.

FIGURE 3.

FIGURE 4.

Two simple forms of open nesting boxes for birds which do not care to build in complete darkness, but which like protection from the rain.

THE FACE OF THE SKY FOR MARCH.

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

THE SUN.—On the 1st the Sun rises at 6.49 and sets at 5.37; on the 31st he rises at 5.42 and sets at 6.27. The Sun enters the sign of Aries at 6 p.m. on the 21st, when Spring commences. Small groups of spots may usually be observed on the Sun's disc, but there has been a considerable falling off in solar activity, both as observed visually and spectroscopically; at the time of writing one small spot is visible. The positions of the Sun's axis, centre of disc, and heliographic longitude are given below:—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Mar. 2	21° 48′ W	7° 14′	224° 24′
,, 7	22° 58′ W	7° 15′	158° 32′
,, 12	23° 50′ W	7° 13′	92° 38′
,, 17	24° 40′ W	7° 7′	26° 44′
,, 22	25° 20′ W	6° 58′	320° 49′
,, 27	25° 50′ W	6° 46′	254° 53′
Apl 1	26° 18′ W	6° 31′	188° 56′
,, 6	26° 26′ W	6° 13′	122° 58′

The Zodiacal light may be seen in the West, shortly after sunset. After the middle of the month is the best time for observation, as the Moon will not have risen, and the tapering glow may be seen for 30 or 40 degrees along the ecliptic.

THE MOON:—

Date.	Phases.	H. M.
Mar. 7	First Quarter	11 2 p.m.
,, 14	Full Moon	11 59 p.m.
,, 23	Last Quarter	0 26 a.m.
,, 30	● New Moon	0 38 p.m.
Apl. 6	First Quarter	5 55 a.m.
Mar. 6	Perigee ...	4 30 p.m.
,, 21	Apogee ...	1 0 p.m.
Apl. 2	Perigee ...	8 12 a.m.

OCCULTATIONS.—The following are the principal occultations visible from Greenwich:—

Date.	Star's Name	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. point. E.	Reappearance. Mean Time.	Reappearance. Angle from N. point. E.
Mar. 6	A¹ Tauri ...	4·5	p.m. 11.57	71°	a.m. 0.47	270°
,, 7	k Tauri ...	5·6	8.52	88	p.m. 9.57	290°
,, 10	ω^1 Cancri ...	6·1	5.38	32	6.7	343°
,, 10	ω^2 Cancri ...	6·2	5.46	105°	6.58	272°

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
Mar. 1	21 50	S 15° 22′
,, 11	22 55	9 8′
,, 21	0 5	S 0 53′
,, 31	1 16	N 8 30′
Apl. 10	2 20	N 16 18′

Mercury is in superior conjunction with the Sun on the 20th, and is thus unobservable throughout the month.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
Mar. 1	0 10	S 0° 3′
,, 11	0 55	N 5° 8′
,, 21	1 40	10° 8′
,, 31	2 27	14° 44′
Apl. 10	3 15	N 18° 45′

Venus is an evening star, and may be seen immediately after sunset, looking W., not very high above the horizon. Throughout the month the planet sets about $2\frac{1}{2}$ hours after the Sun.

Conjunction of Venus and Moon, April 1st.

In the telescope the planet appears gibbous, about 0·9 of the disc being illuminated.

On March 2nd, the Moon appears near the planet, Venus being 2° 20′ to the North, but on April 1st, the two appear in still closer proximity as shown below, Venus at 5.45 p.m. being only 14′ to the North. The Moon will be only two days old, but if the weather is favourable it should be easy to see both the planet and Moon, quite early on in the twilight.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
Mar. 1	19 30	S 22° 34′
,, 11	20 2	21° 24′
,, 21	20 33	19° 53′
,, 31	21 3	18° 3′
Apl. 10	21 33	S 15° 55′

Mars is visible for a short time in the early mornings, rising about 4.30 a.m., near the middle of the month. The planet is an inconspicuous object in Sagittarius, and is ill-suited for observing telescopically, as the apparent diameter is about 5″. The Martian equinox occurs on March 7th, when Spring commences in the Southern Hemisphere.

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
Mar. 1	14 50	S 14° 58′
,, 11	14 49	14° 54′
,, 21	14 48	14° 44′
,, 31	14 45	14° 29′
Apl. 10	14 41	S 14° 11′

Jupiter rises in the E.S.E. at 11.30 p.m. on the 1st and at 9.25 p.m. on the 31st; is the most conspicuous object in the late evening sky looking East. The planet is describing a retrograde path in Libra about 1° N. of α Librae. The attendant bright moons can be seen in very small telescopes or even in a pair of binoculars magnifying 6 or 8 times, whilst the belts are also visible in small telescopes of about two inches aperture using a magnifying power of about 50. The equatorial diameter of the planet on the 19th is 41″·5.

whilst the polar diameter is 2″·7 smaller; this polar flattening is readily observed in telescopes powerful enough to see the belts.

In larger telescopes, markings on the belts may be observed; these rotate with the planet and recur in the same position every 9^h 55^m which is the planet's rotation period.

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

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Mar.				Mar.				Mar.			
8	I.	Sh. E.	11 37	23	I.	Ec. D.	10 24	31	I.	Sh. I.	9 4
16	I.	Oc. R.	11 40	24	I.	Tr. E.	10 4[illegible]	[illegible]	I.	Tr. I.	10 16
21	II.	Tr. I.	11 5[illegible]	30	II.	Oc. R.	10 56	31	I.	Sh. E.	11 46

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse.

SATURN:—

Date.	Right Ascension.	Declination.
	h. m.	
Mar. 1	2 5	N 10° 16′
,, 16 ..	2 11	10° 40′
Apl. 1	2 18	N 11° 28′

Saturn is only observable for a short time each evening during the month, as he sets at 10.28 p.m. on the first and at 8.45 on the 31st. The planet appears as a fairly bright star looking nearly due West as soon as it is dark. Observed in the telescope, the ring appears wide open, as we are looking on the Southern surface at an angle of 18°. The apparent diameter of the outer major and minor axes of the ring are 39″ and 12″ respectively, whilst the diameter of the ball is 15″.

The Moon appears near the planet on the evenings of the 4th and the 31st, whilst Venus appears in proximity on the 29th.

URANUS:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Mar. 1 ...	19 59 30	S 21° 7′ 15″
Apl. 1 ...	20 4 34	S 20° 53′ 48″

Uranus is visible in the early [illegible] ing about 4.15 a.m. near the middle of the month.

NEPTUNE:—

Date.	Right Ascension.	[illegible]tion.
	h. m. s.	
Mar. 1	7 21 50	[illegible]
Apl. 1	7 20 55	N [illegible]

Neptune is situated in Gemini about three [illegible] degrees S.E. of the star δ Geminorum.

Near the middle of the month the planet is on the m[illegible] about 7.45 p.m., and sets about 3.45 a.m. The planet [illegible] difficult to identify among the numerous small stars appearing in the same field of view, and as he is practically stationary this month he cannot readily be detected by his relative motion. Moreover, it requires a high power (about 300) and good definition to distinguish his disc.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Near to	Characteristics
	h. m.			
Mar. 1–4	11 4	+ 4	τ Leonis	Slow; bright.
.. 14	16 40	+54	μ Draconis	Swift.
.. 24	10 44	+58°	β Ursae Maj	Swift.

Minima of Algol occur on the 11th at 10.21 p.m., and on the 14th at 7.10 p.m. Its period is 2^d 20^h 49^m, by which other minima may be deduced.

Double Stars.—γ Leonis, X.^{h} 14^m, N. 20° 22′, mags. 2, 4; separation 3″·8. In steady air, the prime requisite for double star observations, this double may be well seen in a 3-in. telescope with an eyepiece magnifying about 30 to the inch of aperture, but on most nights one with a power of 40 is better. The brighter component is of a bright orange tint, whilst the fainter is more yellow.

ι Leonis XI.^{h} 19^m, N. 11° 5′, mags. 4, 7½; separation 2″·2. A pretty double of different-coloured stars, the brighter being yellow, the other blue. This object requires a favourable night and a fairly high power on small telescopes.

α Leonis (*Regulus*) has a small attendant about 180″ distant, magnitude 8·5, and easily seen in a 3-inch telescope.

α Canum Venat (*Cor Caroli*), XII.^{h} 52^m, N. 38° 49′, mags. 2·5, 6·5, separation 20″. Easy double; can be seen with moderately low powers, even in 2-in. telescopes.

CORRESPONDENCE.

COLOURS ON THE ECLIPSED MOON.

To the Editors of "KNOWLEDGE."

SIRS,—I think I remember a recent question in "KNOWLEDGE" to this effect: "What would be the distance of the red light from the sun refracted through the earth's atmosphere, regarding this as a lens stopped down by a large central circular disc," and I think this had reference to the colours on the surface of the moon in eclipse. Now the action is quite unlike that of any lens because the density of the air diminishes from the surface upwards. Regarding the sun as a point of light, the focus for red rays passing close to the surface of the earth would fall at a point somewhat nearer than the moon's distance, and the difference of position for any other coloured light would be very small, but the light which passed through the outermost layer of the atmosphere would fall only just inside the vertex of the earth's geometrical conical shadow nearly a million miles away, and at every point between these extreme distances there would be a focus of some infinitesimal fraction of the light; moreover, the sun is not a point and the question is still more vague. The light which passes through the earth's atmosphere would cover a surface which, at the distance of the moon, would be very much larger than the moon's disc; the distribution of the light over this surface would not be uniform, and would be very slightly different for different colours, but this could not possibly produce any recognisable colour difference; the colours observed are due to a cause quite distinct from refraction. The green colour often noticed at the edge of the shadow before and after totality is no doubt due to the familiar subjective complementary colour-effect of the reddish light in the shadow, and the coppery colour in the shadow is due to the same cause which gives us a blue sky and a red rising and setting sun, namely, that light of short wave-length is much more reflected and scattered by small particles in the air—or according to Lord Rayleigh, by the molecules of the air itself—than the red rays with greater wave-length; and the light which reaches the eclipsed moon has passed through a depth of air about twice as great as that through which the light from a setting sun has passed.

The very great differences in the brightness of the eclipsed moon on different occasions is very curious, and though clouds over large surfaces on the earth might well cause considerable differences in the light, it seems hardly sufficient to account for it entirely.

J. H. G.

ARTIFICIAL MOCK SUNS.

To the Editors of "KNOWLEDGE."

SIRS,—At the end of November I had a view of four mock suns, and glimpses of five others, all, however, produced by a chance arrangement of windows. I was seated in a train travelling west along the north shore of the Lake of Geneva: it was between 2.30 and 3 p.m., and the low sun shone straight into the carriage.

There were three panes of glass between me and the outer air—viz.: (*a*) the glass window of the carriage; (*b*) the glass window of the corridor, distant about two-and-a-half feet from (*a*); and, between these (*c*) the window of the carriage door, which, being open and folded back, was about an inch distant from (*a*). On either side of the sun, and distant about five degrees, there appeared fainter, but still very bright, sun-images. Beyond each of these again, at the same distance, were faint sun-images. When the carriage was slightly tilted on a curve, fainter images were seen above each of these five suns, ten suns in all. The phenomenon was not visible from the corridor, and was pretty clearly caused by a reflection between the near panes (*a*) and (*c*). How far is this analogous to the mock suns of Polar explorers?

AGNES FRY.

THE ETERNAL RETURN.

To the Editors of "KNOWLEDGE."

SIRS,—In reply to your correspondent, Mr. H. D. Barclay, *re* the theory of Nietzche, I would suggest that much depends upon the meaning attached to the words "identical individual." Our *identity* consists of the consciousness of the continuation of our psychic reality, notwithstanding repeated entire material changes and replacings of our bodily organism. The indestructibility of the material constituting the organism is a possible conception, as also its adaptability to new combinations; but to assume that a re-combination of the precisely same elements will constitute the same being, is to assume that the identical psychical entity is not only dependent upon, but is absolutely produced by, that particular combination.

This is to grant eternity to matter, but to make the actual existence of mental phenomena subject to creation and destruction. Again, many misleading words are used in reference to force. To speak of the "sum total of force" is to give it "reality," to constitute it a tangible entity, having dimensions and duration, a power real and potent to move inert matter. But we know of no such force. "Matter and its activities" is the limit of physical science, force is the name of those activities. To give it occupation in space is to create it matter; "to pervade infinite space" is to exclude the possibility of other existence.

Mr. Barclay, I venture to think, is right in affirming that *absolute* vacant space seems unthinkable, though this may be so "in the absolute." Vacant space is not only thinkable, but an essential concomitant to material existence.

May we have better elucidations of this most interesting subject from more capable pens?

FRED GILMAN.

SOLAR DISTURBANCES DURING JANUARY, 1911.

By FRANK C. DENNETT.

THE great falling off in the number of outbreaks upon the solar surface was very marked during January. With the exception of the five days, the 4th, 5th, 17th, 21st and the 22nd, the sun has been examined every day. Upon the 19th, 20th, 25th, 27th and the 28th no trace of disturbance, bright or dark, could be found. On ten other dates faculae alone were to be seen. The longitude of the Central Meridian at noon on January the 1st was 294° 30′.

No. 1.—A spot first seen near the east limb on January the 3rd. There appeared to be two umbrae on the 7th, the larger being again cut across by a bright bridge; two pores were situated just behind it. One pore still there on the 8th, and the umbra bridged. On the 10th the bridged umbra seemed of a violet hue, and the filamented penumbra appeared to brighten inwards. The bright fringe, especially on equatorial side, still seen, as well as the bridging, on the 13th and the 14th, when the spot was evidently dwindling. On the 15th, when last seen, still bridged, the umbra seemed to be edged with brightness, but a penumbral wing stretched south-east. The greatest diameter of the spot was 15,000 miles. As it neared the western limb it became surrounded by faculae.

A group of faculae, A, like a companion outbreak to No. 1, seen on the 14th.

B and C, facular ridges seen on the 14th–15th round the eastern limb, the latter seen again the 25th–26th, when approaching the western limb.

D, a small bright facula near the western limb on the 25th.

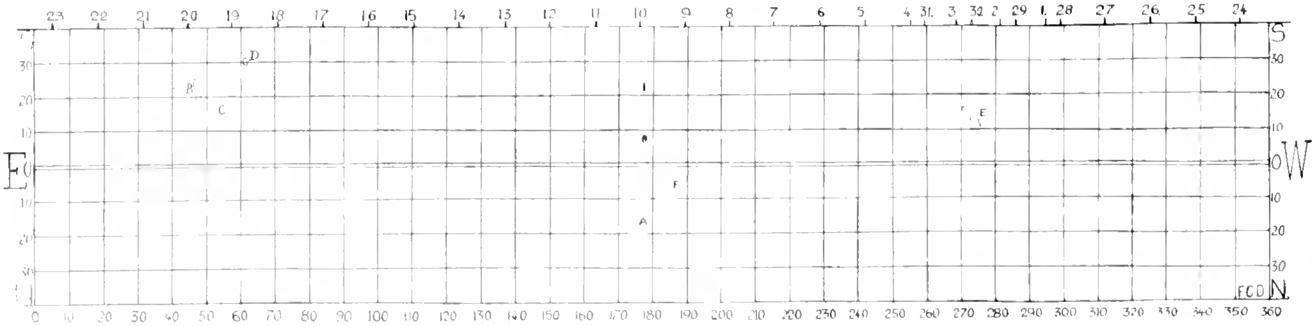
Near the eastern limb on the 25th a bright ridge, E, recorded.

A small facular knot in a disturbed area, F, seen on the 31st.

This great falling off in the number of outbreaks seems to indicate that we are approaching the time of solar minimum. As one cycle ends the spots are as a whole nearer to the equator. The new cycle is usually indicated by the outbreak of spots far away from the equator, so that it is necessary to watch the outer boundaries of the spot-zones. It seems probable that the signs of returning activity may be noted in the northern zone.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, W. Strachan, and F. C. Dennett.

DAY OF JANUARY.



QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are prin[illegible]ge.

QUESTIONS.

Numbers 16, 17 and 18 (December number, page 461), 21 (January number, page 39), 26 and 27 (February number, page 49), still remain unanswered.

28. PALLAS AND *d* AQUARII.—On September 22nd last, at transit time, (a moderately good night, and Pallas being then of 9·1 magnitude), the Planetoid was quite mysteriously missing to the writer in the immediate neighbourhood of *d* Aquarii. Owing to bad weather and moonlight it had last been observed only on the 13th, and was again recovered on the 24th. As it had obviously closely approached *d* Aquarii would some one of your astronomical readers care to very kindly give me its position-angle and distance from the named star at transit on 22nd September, or, failing that, either the apparent place for the date of the star, or a 1910 mean-place?

I should also feel very grateful for particulars of the magnitude, distance and position-angle of the small companion of *d*.

ASTEROID.

29. CONSTITUTION OF THE ATMOSPHERE IN WINTER.—As deciduous trees and plants do not elaborate O, nor consume CO_2 during the winter, have any experiments shown that there is a deficiency of O, or a preponderance of CO_2 during this season?

W. HARMAN.

30. FINDING THE TIME BY THE HEAVENLY BODIES.—I have been much interested in the recent correspondence on finding the time by night through observation of the stars.

Might I ask whether any of your readers can go further and inform me on the following problems connected with the time by day?

(1) How can the time of the day be ascertained by measuring the ratio of the length of a stick to that of its shadow? As an example, imagine this ratio to be one-half on May 1st, what is the time?

(2) At what times in the year will the length of a stick be the same as that of its shadow at noon?

In both instances I assume the latitude of London.

(3) Can the latitude of a place be determined by comparing the ratio between the length of a stick and that of its shadow at noon?

INTERESTED.

31. WIRELESS TELEGRAPHY AND THE WEATHER.—I have heard it stated that wireless telegraphy may be, to a certain extent, responsible for changes in weather. Can any scientific reason be given for this if it be true?

JOHN GLAS. SANDEMAN.

REPLIES.

10. WATER AND ITS OWN LEVEL.—Are not the difficulties of G. G. B. and Mr. A. Mercer referable simply to their neglect to define to themselves the meaning they attach to the expression "its own level"? The latter correspondent's suggestion is that the surface of a small area of water may possibly be *flat*, whereas the truth is that, eliminating all extraneous forces (such as centrifugal force, solar and lunar attraction, winds, and—in minute wet surfaces—globular and capillary attraction), no water-surface, however small, can possibly be flat. In other words it can never be tangential to any spherical surface, but must be itself an actual part of a spherical surface, and of a curvature appropriate to its radial distance from the Earth's centre. Consequently, that which the surface of any body of water—if disturbed—does again seek is "its appropriate spherical curvatu[illegible] word "level" be assumed necessarily to mean a [illegible] then the whole expression "Water finds its own [illegible] be considered not only unscientific but directly un[illegible]

If the above statement of theory be accepted th[illegible] occur to me as some of the more curious of the [illegible] results:—

If the rotation and revolution of the Earth were sudd[illegible] stopped (again we must eliminate external gravitational forces, as also the moment of inertia), the equatorial oceans would immediately flow away northwards and southwards, in an attempt to reduce the spheroidal wet surface of our globe to that of a true sphere.

Again, under existing circumstances, the surface of the Dead Sea is no less than one thousand two hundred and ninety-two feet below that of the neighbouring Mediterranean. Consequently, being part of a sphere of lesser radius, any circular acre (say) of the former sea will have a wholly different surface-curvature from that of a circular acre of the Mediterranean, and—sequentially—a lesser right horizontal diameter.

Much more markedly will a given area of ocean in equatorial regions differ from the same in polar regions.

More strikingly still follows this fact, that any particular portion of the ocean-surface must have different curvatures, even at high-water and low-water respectively; and consequently that the tables for calculating horizon-dip and distance given in such books as "Chambers' Tables" and "Molesworth's Formulae" can only be averages or approximations, since they can only strictly be true for one latitude or one state of the tide.

Lastly, one has, of course, to admit that the surface of a stationary cup of tea varies momentarily, owing to the lunar and solar tides caused in it. But what seems to me to require, perhaps, even a larger degree of imagination, is to realize that the surface of the liquid must undergo a continuous alteration of curvature even as one raises the cup from the table to one's lips.

W. E. YERWARD-JAMES.

13. THE FINDING OF THE TIME AT NIGHT.—To find the time at night without instruments or notes of any kind, it is necessary to acquire the faculty of estimating, by eye, the distance in time of any star from the meridian.

The imaginary arc representing the latter can be readily conceived by reference to the Pole Star. Having determined the first-named element the remainder is a simple question of Right Ascensions (R.A.).

Commit to memory R.A. of a very few conspicuous stars and learn to recognise them at sight.

The R.A. of the Sun is still easier, it being only necessary to recollect that it starts from $0^h\ 0^m$ at the vernal equinox, March 22nd, and increases two hours per month till the annual round is complete at twenty-four hours.

Proceed as follows:—

R.A. of star + or − time from meridian = R.A. of latter.

R.A. of meridian + or − R.A. of Sun = time.

Example, January 5th, 1911.

Sirius in S.E. quarter, apparently $3^h\ 30^m$ E. of meridian.

R.A. of Sirius ... $6^h\ 40^m$

Deduct ... ... $3^h\ 30^m$

R.A. of meridian $3^h\ 10^m + 24^h = 27^h\ 10^m$

R.A. of Sun deduct ... ... $19^h\ 0^m$

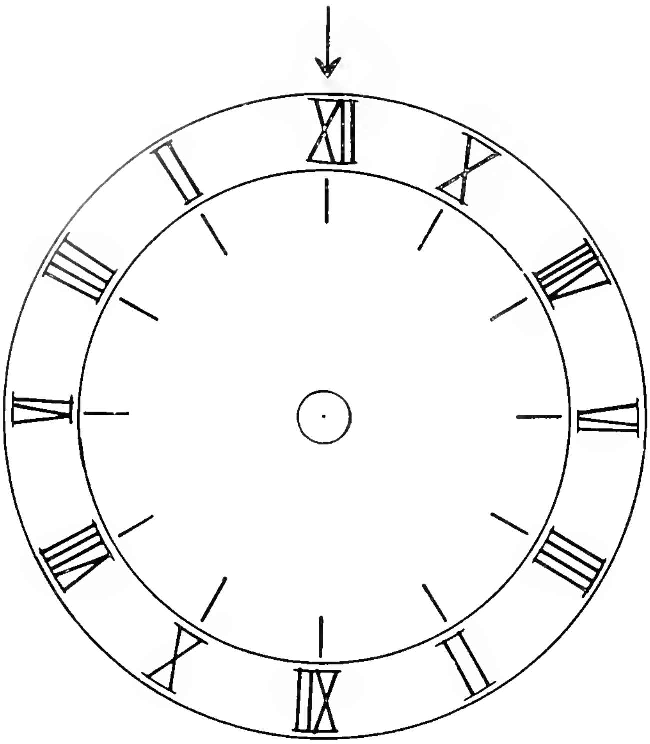
Time = $8^h\ 10^m$ p.m.

EDMUND ROURKE, R.N.

13. THE FINDING OF THE TIME AT NIGHT.—In the note by R. H. M. B. in the January number, in the diagram of the dial a IV was misprinted for VI, and for the benefit of our readers who may be wishful to use it we insert an amended illustration.

Polaris and β Ursae minoris.

1 Jan. 1 July	VIII	1 Apr. 1 Oct.	II	
1 Feb. 1 Aug.	VI	1 May 1 Nov.	XII	
1 Mar. 1 Sept.	IIII	1 Jun. 1 Dec.	X	



14. WHICH IS FASTEST—SIGHT OR HEARING?—This question is somewhat indefinite. In any practical case e.g., the sight and sound of an electric spark, the relative velocities of light and sound make it certain that the retina will be affected earlier than the ear drum, but it does not necessarily follow that the consciousness of the light will precede that of the sound, though it will certainly be so if the spark is distant by more than a very few inches. If the question is which can produce the quickest physical response, it is practical and interesting, and can be made the subject of experiment; in this case, the relative intensities of the light and the sound are an important factor, and results with different individuals vary considerably.

J. H. G.

22. RADIUM.—The ratio given on page 49 of Radium to Uranium should read $3{\cdot}8 \times 10^{-7}$.

25. THE TIDES.—Mr. Hardcastle in a reply to a query of mine has, unavoidably, as I quite see, from the wording of the question, misapprehended my object. The question was suggested by the pages in Darwin's "Tides," pages 240–242, to which he refers me, and I purposely did not mention Darwin or carry the question a stage further on, because I wanted to elicit an independent answer and, if possible, one independent of the mathematical fiction of considering free wave and forced wave motions in a single wave as separate entities. A word about this "fiction" later.

Adopting this fiction, it seems to me that a mental picture of the way in which friction comes in and its direction, is much more easily formed (the free wave tendency being continuously destroyed by the friction) than if the wave form is considered as simply due at each moment to the combined action of lunar force and gravity together. Now I imagine that Darwin deliberately elected to avoid the fiction as possibly liable to produce misconceptions in anyone new to the subject and probably without mathematical knowledge. With the attempt I feel every sympathy, but it creates, I think, more difficulties than it avoids. There seem to me points in his presentment of the subject which to a novice will appear shadowy or even false. Moreover, I am doubtful whether he has really avoided the fiction, and he has made his argument more difficult to follow by unconsciously omitting a step (or half-step; the principle has been explained earlier). At one point a student will almost invariably ask, "How can a change in the depth of the ocean suddenly reverse the action of the friction?" and I think the answer would implicitly involve the use of the tabooed fiction. To take only one point, which point, however, forms the basis of the whole argument, on page 241. "When, as in reality, the liquid is subject to friction, it gets belated in its rhythmical rise and fall, and the protuberance is carried onwards by the rotation of the planet beyond its proper place." Now the reader will very likely argue that friction would cause moving particles to come to rest sooner, and therefore the rise and fall would be accelerated, and the tidal prominence would fall behind instead of in front of the moon, and I certainly think that failure to see further into the matter would not indicate want of intelligence. Perhaps this may seem hypercritical, and it is impossible to define strictly what constitutes a *popular* explanation; in general terms I should define it as one which gave the reader a clear mental picture of what was going on, without suppressing difficulties in the principles applied. With regard to the latter point I need not say about a book so widely known, how singularly free in general it is from this weakness, and perhaps this is the only case (probably the most difficult of those set for explanation), where I should feel inclined to criticise the treatment as not quite satisfactory.

With regard to the "fiction," it is in reality no greater than that of identifying a force with two components into which it may be resolved, and is in fact, under more complex conditions, identical with it; but I certainly think that a student beginning the study of dynamics should be encouraged to regard the kinematical parallelogram law, when applied to dynamical problems, in the light of an hypothesis, to be verified by finding that in every sort of combination it leads to consistent results and is always confirmed by experiment.

J. H. G.

THE ANCESTRY OF DOMESTIC CATTLE.

AT a meeting of the Zoölogical Society of London, held on February 7th, Professor J. Cossar Ewart, F.R.S., gave an account of some skulls of oxen from the Roman station at Newstead, Melrose. The evidence which he had obtained was against the descent of all European cattle from the Urus (*Bos primigenius*) as well as of that of all European, Indian, and African breeds from the Asiatic Urus (*B. nomadicus*). His conclusions are as follows:—

1. That the Celtic Shorthorn (*Bos longifrons*) is probably more intimately related to the Zebu of India (*Bos indicus*) than to the European Urus (*Bos primigenius*).
2. That long premaxillae are usually correlated with an occiput of the *Bos primigenius* type, while short premaxillae are usually correlated with an occiput of the *Bos acutifrons* type.
3. That polled black Galloway cattle and polled white "wild" Cadzow cattle are intimately related to the Urus, that flat-polled Aberdeen-Angus cattle probably include amongst their ancestors an ancient Oriental race now represented by, amongst others, a Syrian breed with rudimentary horns, and that round-polled cattle may belong to a still more ancient Oriental race descended from *Bos acutifrons* of the Punjab Siwaliks.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, D.Sc.

NOVA LACERTAE.—The visible existence of Nova Lacertae, before its outburst, noted as possible by Mr. Bellamy last month, has now been fully verified. Professor Wolf has measured plates taken in 1904 which give the position (referred to the equinox of 1900) Right Ascension $22^h\ 31^m\ 44^s{\cdot}99$ North Declination, 52° 11′ 55″·9. His plates of the present year give Right Ascension $0^s{\cdot}10$ greater, and Declination 0″·1 greater. Professor Barnard has also identified the object on plates of his, taken in 1893, 1907 and 1909. He has also measured these plates, finding the position practically identical with that of the present year, thus leaving no doubt of the identity of the object, and showing that its proper motion is small, which we expect to be the case with Novae, from the fact that they always appear in or near the Milky Way, and are, therefore, very remote. The magnitude before the outburst was twelve-and-a-half according to Wolf, fourteen according to Barnard. It would not, therefore, be visible on plates taken with a short exposure, which probably explains its absence on the plates taken at Harvard on November 19th last, and on earlier dates. This is, I believe, the first occasion on which a Nova has been certainly identified with a visible pre-existent object; of course, the probability of doing so increases as the storehouse of plates grows larger. But this is not the only reason, for plates of the Nova Persei region were in existence, and failed to reveal any trace of it. It is evident that that outbreak was on a grander scale than the present one, for it sprang up from the fifteenth magnitude (or fainter) to the first, while this has only risen from the fourteenth to the fifth. It will be interesting to see whether it declines to its former magnitude, or remains permanently brighter. Professor Barnard notes a peculiarity which it shares with Nova Geminorum, viz., that it has two distinct and sharp foci, one at the ordinary focus, the other eight millimetres further out, and due to the great brilliance of the crimson H (alpha) line of hydrogen. The Nova has been steadily declining since the outburst; its light fell off during December from the fifth to the seventh magnitude, and by the end of January it was about eight-and-a-half. Its circumpolar position will enable it to be continuously kept in view during the decline of its light.

THE SPECTRUM OF MARS.—Astronomers will remember Professor Campbell's expedition to the top of Mount Whitney, in the endeavour to obtain evidence of the presence or otherwise of water-vapour in the atmosphere of Mars. He has now approached the problem in another manner. It is many years since the shift of lines in the solar spectrum due to rotation was used to distinguish solar lines from those that had their origin in our atmosphere. Great dispersion was necessary, owing to the slowness of the sun's rotation. In the case of Mars, an equal dispersion is unattainable, owing to the faintness of the spectrum, but the relative velocity is much higher. Professor Campbell and Dr. Albrecht, took a series of plates with a specially designed grating-spectroscope in January and February, 1910, using plates rendered sensitive to the red-end, where the water-vapour band is situated. After careful examination of the plates they state that the amount of water-vapour in the planet's atmosphere on February 2nd, 1910, was certainly less than one-fifth of that in the air above Mount Hamilton at the time. The amount of oxygen in Mars' atmosphere was also relatively small. These results are only what we should expect, for it is obvious, both from the planet's small mass, and from the great distinctness with which the markings are seen, that its atmosphere is very much rarer than our own. Those who deny the existence of water-vapour in its atmosphere are driven to adopt the conclusion that the polar caps, and the occasional presence of cloud and mist, are due to some other substance, such as carbon dioxide.

HALLEY'S COMET is still [illegible]tion, and is being assiduously followed by Profess[illegible]ith the forty-inch Yerkes' Refractor. It is now of the [illegible]gnitude, round, 32″ in diameter, slightly cond[illegible]ithout a visible nucleus. It is considerably further [illegible]n than when first photographed in August, 1909, [illegible] two magnitudes brighter, showing that the physi[illegible] at perihelion persists for some time. Profess[illegible] hopes of keeping it in view till the end of the yea[illegible] be far outside the orbit of Jupiter, which it will c[illegible] next. It will remain invisible for seventy-four years, [illegible] probably be detected in August, 1985, passing perihelion [illegible] February, 1986.

D'ARREST'S COMET was still in view at the end of January, being seen by M. Gonnessiat at Algiers on January 22nd, when it was of magnitude fourteen-and-a-half. The Paris Observatory has recently lost by death M. G. Leveau, whose name is especially associated with this comet, from the laborious care with which he has followed its movements ever since 1864; the large perturbations by Jupiter render the work difficult, but nevertheless his predictions have been extremely exact, extending even down to the present return. He also constructed tables of the minor planet Vesta, by which its motion can be calculated with greater convenience and accuracy than by the method formerly employed.

BOTANY.

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

IRON BACTERIA.—Molisch has recently published one of his excellent monographs (*Fischer, Jena*: M. 5), the latest production of his prolific pen being an important summary of his own work, continued for eighteen years, as well as that of other investigators, on this interesting group of bacteria. Since the iron bacteria are of practical as well as scientific interest, this monograph ought to be translated into English, in order to attract wider attention among workers in hydraulic and sanitary engineering, as well as in biological science. To the six already-known species of iron bacteria, Molisch adds three more, of which one grows in the stems and leaves of aquatic plants. He finds that these bacteria can grow quite well in absence of iron, and that they can make use of manganese instead of iron. The iron dissolved in the water is, according to Molisch, merely deposited in the slimy sheaths of the bacterial filaments in the form of carbonate of iron, which becomes oxidised to ferric oxide, and this is apparently not used by the bacteria in their vital processes but simply acts as a protection to the protoplasm—in much the same way as the silica deposits in diatoms and the epidermal cells of grasses, and so on.

The iron bacteria occur in most bogs, chalybeate springs, stagnant waters, and sometimes in iron water-pipes—in the latter case often plugging up the pipes, besides fouling the water itself; so far, no species have been found in sea-water. These bacteria may be removed by filtration through sand or coke, or by chemical treatment, and in either case Molisch finds that the real cause of the disappearance of the bacteria is the loss of soluble organic substances which are removed by these processes, the absence of the iron itself being a matter of indifference. Various other organisms—certain Algae, Flagellates, and Infusoria—are capable of fixing iron; some of these can also fix manganese, and their mode of action appears to be the same as that of the iron bacteria. Molisch also discusses the formation of bog iron, in which the iron bacteria often play an important part; the formation of rust in iron water-pipes, which is probably due primarily to the action of the water itself acting on bare iron surfaces, though here again the iron bacteria may flourish if organic substances are present in addition to soluble iron oxide; and the therapeutic use of chalybeate waters, which are often quite useless for medicinal purposes on account of the precipitation of the iron as insoluble ferric hydroxide.

NITROGENOUS SALTS IN SEA-WATER.—Gebbing (*Internat. Revue d. ges. Hydrobiol. und Hydrogr.*, 1910) has collected the results of the German South Polar Expedition with reference to the nitrogen-content of sea-water, comparing these results with others previously obtained. Although chemical in character, Gebbing's paper is of great interest in connection with the distribution and periodicity of the plankton or surface-living vegetation of the sea. The chief results are the following. The content of the ocean in ammonium salts is fairly constant, the average value being 0·05 milligrams per litre. The distribution of the nitrates and nitrites is, however, very variable, the highest proportion of these salts in the surface water being found in the Antarctic Ocean, while it dwindles towards the Equator from 0·5 milligrams to 0·1 milligrams per litre. In the North Atlantic and in the North Sea there is marked poverty in these salts, as compared with the Southern Hemisphere, there being practically no increase on passing northwards from the Equator. The scanty plankton of tropical seas is probably due to the fact that the higher temperature favours the growth of denitrifying bacteria, which attack nitrates and nitrites, setting free nitrogen. At the Equator, also, there is a much more rapid falling-off in nitrogen-content in passing below the surface, and this may obviously be attributed to the greater vertical circulation of the water in the Tropics. Gebbing's interesting memoir is an important contribution to biology as well as to chemistry and oceanography, and helps in clearing up various problems in the distribution of the floating vegetable population of the sea, which is largely used as food by the animal plankton as well as by the larger denizens of the ocean.

CYCAD ROOT-TUBERCLES.—The remarkable coralloid roots of Cycas have long been known to harbour colonies of the Blue-green Alga *Nostoc* or *Anabaena*, which usually form a definite layer in the cortex of these roots. In addition to the *Nostoc*, bacteria occur in these roots, evidently causing the formation of the tubercles and living in symbiosis with the Alga. An interesting paper on this symbiosis was read by Professor Bottomley at the Sheffield Meeting of the British Association (see Botany Notes in "KNOWLEDGE," October, 1910); the presence of the bacteria was noted by Schneider in 1894 (*Bot. Gaz.*). Now, Zach (*Oesterr. Bot. Zeitschr.*, 1910) has found that in addition to the *Nostoc* and the bacteria, these Cycad roots contain a fungus which attacks the cortex cells and causes degeneration of the nuclei, loss of starch and production of calcium oxalate in the infected cells. No fungus filaments occur, however, in the *Nostoc* zone, and Zach found that the fungus has nothing to do with the causation of the tubers, but lives in the roots simply as parasite.

RECENT WORK ON THE LOWER FUNGI.—Among many interesting papers on the lower Fungi, there are some which serve to link up the Yeasts to the more typical lower Ascomycetes. The Yeasts have long been regarded as degenerate Ascomycetes, their peculiar features—such as the budding process of multiplication and the general absence of sexual fusion—being correlated with their mode of life in sugar solutions, which they decompose with the formation of alcohol and carbon dioxide. The work of Hansen and others has shown that not all Yeast species cause alcoholic fermentation, and that some species produce a definite, though simple, mycelium or filamentous plant-body, while the spores of some species have a peculiar hemispherical or hat-like form, which agrees exactly with the shape of the spores in *Endomyces*. Barker's interesting discovery of the conjugating Yeasts, in which the cells fuse in pairs before producing spores, may be regarded as an indication of a simple sexual process similar to that observed in such simple Ascomycetes as *Eremascus* and *Gymnoascus*.

Guilliermond (*Rev. gén. Bot.*, 1909) has investigated the following forms of lower Ascomycetes:—*Eremascus*, *Endomyces*, *Saccharomycopsis*. In *Eremascus* the cells of the mycelium are at first multinucleate, but later become uninucleate, and the asci arise in most cases from two fused cells, but sometimes without fusion (parthenogenesis). In fusion, a nucleus from each of the two cells migrates into the young ascus, the two nuclei fuse, and the fusion-nucleus divides until the eight spore-nuclei are formed. In *Endomyces fibuliger* the mycelium, when in sugary liquids, forms buds exactly like those of Yeast, and multiplies rapidly in this way. In a paper which appeared simultaneously with that of Guilliermond, Dombrowski (*Comptes rendus du lab. de Carlsberg*, 1909) showed that these Yeast-like cells of *E. fibuliger* can produce conidia, differing from the sprouting Yeast-like cells themselves in being able to resist heating to 55° C., a temperature which destroys the budding cells. Guilliermond found that, as a rule, the asci arise singly as branches from the ordinary mycelium, showing no trace of a fertilisation process, and producing only four spores. In some cases, however, anastomoses occur between the ascus mother-cell and the neighbouring mycelium cell, or between an ascus mother-cell and a Yeast-like cell, and this he thinks points to degeneration of a former fertilisation. In *Endomyces magnusii* the asci may either arise parthenogenetically, or after conjugation of two mycelial branches differing in size, four spores being formed; in this species no Yeast-like budding occurs, though resting cells are formed. In *Saccharomycopsis*, there is no trace of fertilisation; the ascus contains four spores; according to the culture conditions the plant produces either a mycelium or Yeast-like cells, and the genus is closely related to *Endomyces*, being distinguished from the Yeasts (*Saccharomycetes*) by the double wall of the spore. Guilliermond concludes with a discussion of the systematic arrangement and inter-relationships of the lower Ascomycetes, pointing out that in *Eremascus* the only method of reproduction is the formation of an ascus from two fused cells, while in *Endomyces* the asci may be formed either by fertilisation or by parthenogenesis, and in addition to ascospores the plant reproduces itself by Yeast-like budding and by conidia. The genus *Endomyces* forms a transition from *Eremascus* to the Yeasts, a form like *E. fibuliger* connecting *Eremascus* to the ordinary Yeasts (*Saccharomyces*) and the Conjugating Yeast (*Zygosaccharomyces*), while *E. magnusii* leads to the Splitting Yeast (*Schizosaccharomyces*).

Guilliermond's important results are confirmed by a paper by Lewis (*Maine Agric. Exp. Sta.*, Bulletin 178) on a new species of *Endomyces* discovered by him on decaying apples. In this fungus—*Endomyces mali*—the asci arise by parthenogenesis on short lateral branches of the mycelium and produce four spores, while conidia are also produced, but no Yeast-like budding occurs and the Fungus cannot ferment sugar, though *Endomyces magnusii* can do this.

Westling (*Svensk bot. Tidskr.*, 1909) has described a new genus, *Byssochlamys*, which he regards as forming a connecting link between *Endomyces* and *Gymnoascus*. This Fungus was found on plants that had been preserved in alcohol, and it could not only exist but actually flourish in strong alcohol (90%), which kills even the spores of most other Fungi! This new Fungus proved even more long-suffering under adverse conditions than the ubiquitous and highly-resistant Blue Mould (*Penicillium*), and grew well at 37° C., ousting *Penicillium* from a culture heated to this temperature. *Byssochlamys* reproduces itself by means of ascospores, conidia, and thick-walled resting cells (chlamydospores); the asci have eight spores and arise laterally from a spirally coiled ascogonium, which is usually fertilised by a male filament (antheridium) but is sometimes parthenogenetic.

HELIOTROPISM.—Some of the more recent work on heliotropism was summarised in these columns a short time ago. An interesting paper by Figdor (*Ann. jard. bot. Buitenzorg*) shows that not only do foliage leaves perceive the stimulus of one-sided light but that this stimulus is transmitted backwards to the stem. Figdor experimented with the leaves of *Begonia*, arranging his apparatus so that only the leaf-blade was exposed to the light, and found that not only the leaf-stalk but the stem below the leaf showed strong curvature towards the light. Figdor had previously shown, also in experiments with *Begonia*, that the stem itself can perceive and respond by curvature to the stimulus of light falling upon it from one side, but his recent result is of great importance in showing that in Dicotyledons, as well as in

Monocotyledons (*e.g.* grass seedlings), the stimulus can be transmitted from the receptive surface of the leaf to the lower parts of the plant.

MALE NUCLEI IN FLOWERING PLANTS.—Some years ago, Nawaschin observed that when the pollen-tube of an Angiosperm—he worked with *Lilium martagon* and *Fritillaria tenella*—reaches the embryo-sac, both of the male or generative nuclei enter the sac, one fusing with the egg and the other with the central nucleus (variously called the "secondary" or "definitive" or "fused polar" nucleus), the embryo arising as the result of the former fusion, and the endosperm as the result of the latter. This remarkable discovery, which was made almost simultaneously by Guignard, and has since then been confirmed in a large number of Monocotyledons and Dicotyledons from the lowest to the highest families, also led to the observation that the male nuclei are elongated and worm-like, or even spirally coiled, like the body of the motile male cells of lower plants, and Nawaschin suggested that these nuclei might have the power of independent locomotion. Most later writers have rejected this view and considered that these nuclei are carried along passively by streaming of the protoplasm in the embryo-sac, but Nawaschin has recently (*Oesterr. bot. Zeitschr.*, 1909; *Ann. jard. bot. Buitenzorg*, 1910) obtained evidence, almost amounting to positive proof, that the two sperms actually move towards the two nuclei with which they fuse, and that when spirally coiled like a cork-screw they rotate during their passage through the embryo-sac, and thus burrow through the protoplasm on their way to the egg and the polar nuclei.

CHEMISTRY.

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

TETRODON POISON.—Various species of *Tetrodonae* are common in the seas of Japan, and are extensively used as food, after removal of the ovaries, in which is secreted the characteristic poison of the fish. This toxic substance, which is not present in the flesh, has been investigated by Mr. Y. Tahara (*Biochem. Zeits.*, 1910, xxx, 255), who isolated it by grinding up the ovaries of the fish with water, concentrating the liquid, and precipitating albuminous substances and phosphates. On now adding ammonia to the filtrate the poison was precipitated in an impure condition, and was subsequently purified by repeated treatment with lead acetate and ammonia, and extraction with alcohol, in which it was partially soluble. As thus purified tetrodon poison was a white powder, which absorbed moisture on exposure to the air. It was nearly insoluble in most organic solvents, and was only sparingly soluble in water. Its reaction was neutral, and it is therefore suggested that it should be termed *tetrodotoxine*, instead of *tetrodonic acid*, as heretofore. Apparently it was neither an alkaloid nor a protein, but formed precipitates with the hydroxides of heavy metals, and on treatment with dilute hydrochloric acid was decomposed, with the formation of a basic substance and a crystalline body containing no nitrogen. The preliminary analyses indicated that tetrodotoxine had a composition agreeing with the formula $C_{16}H_{31}NO_{16}$, and this is provisionally assigned to it. Physiological experiments proved that the toxine was very active.

FILAMENTS FOR ELECTRIC LAMPS.—The modern methods of preparing the filaments for incandescent electric lamps are particularly ingenious, and illustrate the ways in which chemical processes may be used to overcome apparently insuperable difficulties. The carbon filaments are now almost universally made by a method similar to that used in the manufacture of artificial silk. A solution of nitrocellulose (collodion cotton) in acetic acid is rapidly pressed through a small opening, and the resulting filaments are twisted into the required shape round carbon blocks, which are placed in boxes of fire-proof clay and heated in a furnace until the filaments are carbonized. They are then heated, by means of an electric current, in an atmosphere of benzine, so as to remove the last traces of volatile substances. It is essential that the carbonised filament should be homogeneous throughout, and that, as far as possib[illegible] have been converted into the graphic form of carbon. [illegible] not decomposed so rapidly by the current, and thu[illegible] blackening of the glass.

The amount of electricity consu[illegible]on lamps has led to the extensive use of lamps cont[illegible]ic filaments, and an interesting survey of the diffe[illegible]s that are being used for the production of these [illegible] Mr. H. Baumhauer in the *Zeit. angew. Chem.* [illegible], 2065). The only metal of sufficiently high melting-p[illegible] been found suitable for the direct production of fila[illegible]n the pure metal is tantalum, and tantalum lamps [illegible] been sold for some years.

It was shown by Weiss (*Zeit. anorg. Chem.*, [illegible], 288) that titanium and zirconium melted at too low temperatures to be available for the purpose, while he was unable to melt tungsten, the estimated melting-point of which is 2800° C. Owing to this, it has not been found possible to prepare filaments of tungsten directly from the metal, but the problem has been solved in other ways. Thus, in one type of lamp no longer on the market, tungsten filaments were prepared by coating carbon filaments with a deposit of sublimed tungsten chloride, and then heating them in a current of hydrogen to reduce the tungsten compound to the metallic form, and expel the carbon. Owing to the low resistance offered by the filaments this process was abandoned, and at the present time tungsten filaments are made by mixing tungsten oxide with an excess of zinc dust and heating the mixture in a loosely-covered iron vessel until the reaction takes place. The zinc is then dissolved from the mass by means of hydrochloric acid, and the reduced metallic tungsten is left in the form of a black powder. This is made into a paste with caramel or gum tragacanth, and is forced through minute openings, so as to form filaments, which may be dried and heated in a current of hydrogen to expel the carbonaceous agglutinating material.

A still more recent method of manufacturing tungsten filaments is by means of a colloidal solution of tungsten obtained by alternately treating the metal with acid and alkaline reagents, so as to obtain a flocculent gelatinous mass. This is separated from water by squeezing it in silk, and is then ready to be made into filaments without the necessity of adding any binding substance. This process is used in the manufacture of the "Sirius" and "Colloid" lamps, while in the case of other tungsten lamps a binding material is also employed.

Attempts to use other metals of high melting-point, such as osmium and zirconium, have not proved nearly so successful as the methods in which tungsten is used alone, and processes of adding metals to the carbon filaments in the ordinary lamps have also proved unsatisfactory. Thus, according to Mr. Baumhauer, a lamp recently put upon the market contained carbon filaments coated with zirconium, but although at first there was greater emission of light and smaller consumption of electricity, the life of the filament was considerably shortened, and the consumption of electricity soon rose to that of an ordinary carbon lamp.

GEOLOGY.

By RUSSELL F. GWINNELL, B.Sc., A.R.C.S., F.G.S.

THE ORIGIN AND PEOPLING OF THE DEEP SEA.—Under this title a translation of a paper by Professor Johannes Walther appears in the *American Journal of Science* for January. Comparing land and water, Dr. Walther points out that while temperature decreases with height and depth respectively, in the ocean great depths, and hence low temperatures, preponderate. Half the Earth's surface is deep sea, with an average depth of four thousand metres and a maximum of from eight to ten kilometres. The inhabitants of this great area are considered with especial reference to the light which they throw on the origin of the deep sea. The characteristics of abyssal depths are:—(1) a uniformly low temperature; (2) quiet water, with no noticeable movement; (3) no light, and as a consequence no green-plant life. Hence all light-hungry and plant-eating animals, and all which need moving and warm water, are absent; nevertheless, life is abundant in the abysses. Where sunlight and green plants are wanting no organic life can be maintained; the fauna of the deep sea is dependent upon the stream of cold south polar water pouring oxygen and food into its abyssal depths. *The origin of this fauna must, then, be sought in sunlit areas rich in plants.* When did the peopling of the abysses take place? The significant fact appears that no single Palaeozoic animal is found in the present deep sea, although a number of shallow-sea and other genera survive from the Palaeozoic Era (e.g. Lingula, Mytilus, Pleurotomaria, Nautilus, Serpula, Astropecten, the littoral Limulus and the fluviatile Ceratodus, besides soft-bodied animals which could not be preserved fossil). Animals now living below two thousand metres date only from the Trias, the resemblance to Jurassic and Cretaceous faunas being particularly close; among the Echinoderms, for example, are found Pentacrinus, Asterias, Echinus, etc. Evidently, then, *the peopling of the deep sea is traceable, at the earliest, to the Triassic Period.*

Now we know that the elevation of mountain-chains is counterbalanced by the formation of extensive depressions; also that at no other period did such enormous mountain folding occur as took place between Carboniferous and Triassic times, when the Hercynian movements in Europe occurred, the Appalachians were formed in America, the Sudanese mountains were originated in Africa, and other folding took place in Asia and elsewhere. *In the deep ocean abysses Dr. Walther sees the complementary depressions to these mountain chains.*

Thus general biological grounds, the stratigraphical position of the present deep sea fauna, as well as tectonic investigation, force us to the conclusion that the deep sea as a life-region is not a characteristic of the Earth in its oldest periods, and that its origin is found in the time when in all parts of the present continents began tectonic folding movements which so decidedly changed the relief of the Earth's surface.

THE GREAT NEW ZEALAND ERUPTION.—In the January number of the *Geographical Journal* Professor James Park describes the volcanic outburst of Mount Tarawera, which took place in 1886, and which utterly destroyed the celebrated pink and white terraces of Rotomahana. The subsequent changes due to waning vulcanicity and to denudation are also dealt with. Mount Tarawera—three thousand six hundred feet high—rises abruptly from the lofty rhyolitic plateau of Rotomahana, in the North Island of New Zealand. During a space of about three hours the mountain was gradually rent across from north to south by a great fissure, nearly nine miles long, averaging two hundred yards wide and from one hundred to three hundred yards deep. The vulcanism was of a rare or new type; for whereas fissure eruptions are distinguished by quiet emission of lava-floods, in this case the ejecta were almost entirely fragmental, consisting of dust, lapilli, bombs, and so on, derived from an augite-andesite magma, intermixed with some rhyolitic ash. These materials were spread over an area of nearly six thousand square miles, in a sheet varying up to fifty feet in thickness, and dust fell on vessels one hundred and fifty miles away. This great ash sheet has since become covered with dense jungle, and has been deeply scored by rain into narrow gutters and ridges. The sections thus exposed are seen to consist of grey dust and black ash, so well stratified as to be easily mistaken for a subaqueous tuff.

During the course of the fissuring Lake Rotomahana was encountered, and as a result a shattering explosion converted the lake-bed into an active volcano over a mile in width. A native village on its shores was simply blown out of existence, all the inhabitants being instantly killed. Several other villages were overwhelmed with dust, not a soul surviving. For a few months violent hydrothermal activity was displayed, a pillar of steam rising to over fifteen thousand feet; it then waned and ceased, and the lake-bed filled up again with water. About 1897, geysirs again began to play and the world-famed Waimangu geysir was in action until two or three years ago. Though this has now ceased, solfataric action is still very conspicuous on the lake-shores. At Echo crater the formation of iron pyrites can now be seen in progress; the crater-floor is covered with a thin siliceous crust, through which boiling water and steam escape. Interaction takes place between the hot ascending mineralised waters, and the H_2S with which the steam is charged, and as a result FeS_2 is deposited, first as a black and then a bright yellow film on all the loose stones lying around.

Though of an abnormal type, the 1886 eruption was merely one of a long succession of volcanic phenomena which have been in progress since Pliocene times along the great tectonic fracture known as the Whakatane fault—along which are situated many other volcanoes, active, dormant and extinct.

GEOTECTONIC SYMMETRY.—Last November there appeared in these columns a note dealing with the "Canadian Shield," a great mass of gneiss and schist forming one of the "corner stones" of the earth. In the *American Journal of Science* for December R. Ruedeman points out the strikingly symmetrical arrangement of the large area of Palaeozoic rocks, which extends southwards from this Canadian "protaxis," or shield of pre-Palaeozoic rocks. This area, the "Palaeozoic Platform" of North America, is roughly bounded on the west by a line connecting the head of Lake Superior with the Ozarks, and on the east by a line enclosing the Adirondacks and Appalachians. It corresponds in its relation to the Canadian shield with that of the Russian platform to the Baltic shield. It is bounded on the west by the trans-continental depression occupied by Cretaceous and Tertiary rocks.

On either side of the Canadian shield there stand out, like a corner-stone, a pre-Cambrian area ("Isle Wisconsin" and "Isle Adirondack"), in quite symmetrical positions. From each of these extensions there runs outward, along the margin of the shield, a deep depression, the Lake Superior basin and the St. Lawrence basin, respectively. From these same corner-stones there extend southwards a pair of arms, as it were, each consisting of a broad belt of pre-Cambrian and early Palaeozoic rocks, nearly the full length of the Continent. In both cases this elevated tract of old rocks terminates to the south in a pre-Cambrian mass, and these two masses—"Isle Ozark," on the west, and "Isle Appalachia," on the east—are symmetrically situated.

Thus is enclosed a great median basin (that of the Great Lakes and Ohio) which is itself symmetrically sub-divided by the Cincinnati geanticline. This broad anticline, striking north and south, separates two sub-basins of younger Palaeozoic strata, situated in symmetrical east and west positions; it dies away to the north, being replaced by the Michigan basin. In this basin we may, perhaps, see a result of a longitudinal oscillation of the axis of the Cincinnati geanticline, for it also lies symmetrically to the whole arrangement, constituting, with the Cincinnati uplift, the axis of symmetry of the whole "Palaeozoic Platform."

One serious disturbance of symmetry has occurred, due to Atlantic pressure exerted from the south-east; this has pushed the eastern arm inwards, thus giving rise to the Appalachian basin-folds. Even here, however, the belt of old rocks is recognizable, running south and south-west from New York as far as Alabama.

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

The weather of the week ended January 21st was, generally speaking, dry but dull, with a good deal of fog. Temperature was above the average in Scotland and in Ireland N., but below it elsewhere. The highest readings were 53° at Killarney and Scilly on the 16th, while the lowest readings were 21° at Swarraton on the 15th, and at Durham on the 21st. In Scotland N. and the English Channel, the lowest readings were 33°, but in all the other districts frost was recorded, from 28° downwards. The lowest readings on the grass were 15° at Crathes and Llangammarch Wells, and 16° at Durham and Kew. Rainfall was deficient in all parts and in most districts markedly so; at many stations no rain was reported during the week. In Scotland N., however, there were stations where rain fell each day, though not to excess, The amount of bright sunshine did not vary much from the average except in Scotland E. and England N.E., where it was nearly twice as much as usual. Crathes reported 27·1 hours or 54 per cent. At Westminster the duration was only 0·2 hours for the week. The temperature of the sea-water varied from 38° at Cromarty to 48° at Plymouth and Scilly.

The week ended January 28th was warm, and at each of the stations included in the Weekly Weather Report the mean was in excess of the average. Maxima of 50° or upwards were reported from all districts, the highest being 59° at Killarney on the 25th. The lowest of the minima were 25° at Shields and 26° at Kilkenny and Hereford. On the grass readings down to 20° at Tunbridge Wells and 21° at Dublin (Trinity College) were reported. Rainfall was scanty in most districts, very much so in some. In the Midlands the total (district) fall was only 0·04 inch, as compared with an average of 0·50 inch. At several stations the week was rainless. In Scotland the fall was heavier, though still below the average. Bright sunshine was also below the average, except in Ireland S. and England S.E. In Scotland E. the deficiency was large, and in this district the highest amount at any station was only 3·8 hours (7%) at Nairn. The sunniest station was Dublin, with 18·7 hours (32%). At Westminster the amount was 5·3 hours (9%). The sea temperature round our coasts ranged from 36° at Cromarty, to 49° at Scilly.

FIGURE 1.
A single Rotifer, feeding.

The week ended February 4th contrasted strongly with that which had preceded it, being much colder and with much more sunshine. Except in Scotland N., the temperature was below the average in all districts, and in England S.E. the mean value was only 34°·7, as compared with 41°·4 in the previous week. The highest reading reported during the week was 51° at Colmonell, Killarney and Valencia. In the Midlands and England N.W., the maximum did not exceed 46°. The minima fell to 11° at Balmoral and to 13° at Llangammarch Wells, while the thermometer, exposed on the grass registered as low as 1° at Llangammarch and 6° at Birmingham. Rainfall was scanty; indeed over a large part of the Kingdom the week was rainless, but sunshine was abundant for the time of year, and was in excess of the average in all districts. The highest amounts for the week were 35·6 hours (57%) recorded at Hastings, and 35·4 hours (55%) at St. Heliers, Jersey. At Westminster the total duration was 12·2 hours (20%). The temperature of the sea-water it may be added ranged from 36° at Eastbourne to 48° at Scilly.

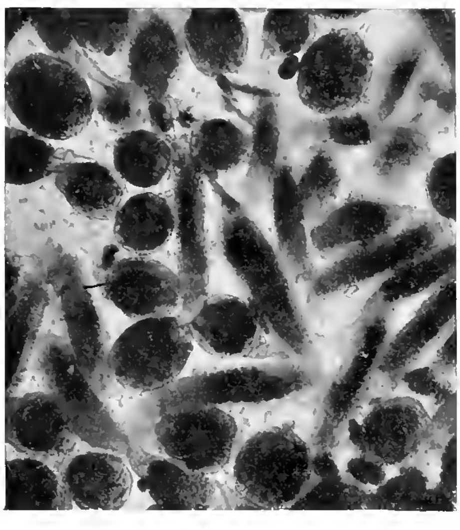


FIGURE 2.
A cluster of Antarctic Red Rotifers.
(Philodina gregaria.)

The week ended February 11th was cool, cloudy and very dry. Temperature was slightly above the average in Scotland N., but below it in all other districts. The highest reading was 53° at Killarney on the 11th, but as a rule the maxima were below 50°; in England N.E. and E. the highest was only 45°. The lowest reading was 11° at Balmoral, also on the 11th. At quite a number of stations the maximum and the minimum were both recorded on the same day. The lowest reading recorded on the grass was 8° at Balmoral. Rainfall was below the average everywhere, and in the English Channel less than one-twentieth of the normal amount was reported. Even in Scotland N. the total collected was only one-sixth of the average. Sunshine was deficient generally, though in Scotland N. and in Ireland it was slightly in excess. Valencia, in Co. Kerry, reported the large-t[illegible], 21·0 hours (33%) and Deerness, in Orkney, had th[illegible] [illegible]ghest amount with 18·6 hours (32%). Westminster re[illegible] [illegible]hours (9%). The sea temperature varied from 36° at [illegible] 47° at Scilly.

INVESTIGATION OF THE UPP[illegible].—On January 17th, a balloon from [illegible] [illegible]ll reached an altitude of fifteen [illegible] [illegible]etres, at which height the tempera[illegible] [illegible]ed was 210° absolute scale. At thi[illegible] [illegible]sand metres, however, the temper[illegible] [illegible] only 202° absolute, or −96° F., wh[illegible] the lowest temperature recorded in the British Isles up to the present time.

The record of a kite ascent at P[illegible] Hill, on January 26th, showed a sharp inversion of temperature at a height of nine hundred metres, and while at five hundred metres the humidity was 100 per cent. (saturation), at a thousand metres it was only 30 per cent. The cloud level was not reached on this day at a thousand metres.

MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD; JAMES BURTON; THE REV. E. W. BOWELL, M.A.; CHARLES H. CAFFYN; ARTHUR EARLAND, F.R.M.S.; RICHARD T. LEWIS, F.R.M.S.; CHAS. F. ROUSSELET, F.R.M.S.; D. J. SCOURFIELD, F.Z.S., F.R.M.S.; C. D. SOAR, F.R.M.S.

RED-SNOW.—Red-Snow, Gory-Dew, Bloody-Rain, and such-like names show that phenomena of this class appeal to the popular imagination. When some rapidly-increasing organism suddenly produces a blood-red pool on the ground, the simple-minded observer may readily suppose that it has come down as rain, and in superstitious countries and times there is fine scope for connecting the appearance with tragic or momentous events, the vengeance of heaven, and what not.

Even the scientific naturalist feels his imagination excited as he reads of Sir John Ross's "Crimson Cliffs" extending for miles.

De Saussure is commonly credited with the discovery of red-snow, in the course of his pioneer journeyings among the Alps, in the eighteenth century, but according to Schmarda (1846) the phenomenon was known to the ancients, and is mentioned by Aristotle (Hist. Animal. v., 12). In the nineteenth century there were numerous records of red-snow, and there is now quite an extensive literature of the subject. Ross appears to have been the first to find red-snow in the Polar regions, and he brought samples of it from the Crimson Cliffs of Greenland.

De Candolle (1824) compared the Arctic and Alpine red-snows, and declared them to be identical.

Red-snow has been found all over the world in suitable localities, but it does not appear to be of general occurrence in snowy regions. Darwin saw it in the Cordillera, but Hooker never saw it, either on his Antarctic voyage or in the Himalayas. Friends whom I have asked about it saw none on the snowy mountains of Norway and Switzerland. According to some accounts it appears to be most plentiful in the North Polar region, where it is reported from Spitsbergen, Scandinavia, Siberia, and so on. It is recorded also for the Alps, Pyrenees, Carpathians and Ural Mountains, the Sierra Nevada in California, Chili and Ecuador, in South America, and so on.

In the Antarctic, red-snow appears to be less common than in the North Polar region. The Shackleton Expedition did not find any for certain, but some members saw snow discoloured with what they supposed to be a red Rotifer common there. Bruce's Expedition found a little of it, but the only record I know is in Charcot's preliminary report of his last Expedition (1910). The naturalist of that expedition, M. Gain, informs me in a letter that they found both red and green snow, the former in considerable quantity, the latter forming extensive meadows ("prairies").

What is red-snow? As to the colour of it, is it so very bright? Perhaps we who have not seen it expect too much! Some describe it as blood-red or crimson; others say it is a dull purple; Darwin noticed the footprints of his mules stained a pale red, and the snow was only coloured where it had thawed rapidly or had been crushed. Sir Philip Brocklehurst, who saw our only supposed red-snow, tells me *it* was a very dingy yellow.

Red-snow has been almost universally attributed to a supposed Alga, best known as *Protococcus nivalis*, though it has borne many names, and is now officially recognized as *Sphaerella nivalis*. It is described as consisting of spherical cells, about a one-thousandth part of an inch in diameter, with a thickish cell-wall, and the protoplasmic contents permeated with chlorophyll, which is, however, completely masked by the red pigment haematochrome. In the growing season the cells enlarge and divide, usually into four daughter-cells, which then separate, take an oval form, and swim about by means of two flagella, which are extensions of the protoplasm projected through the envelope.

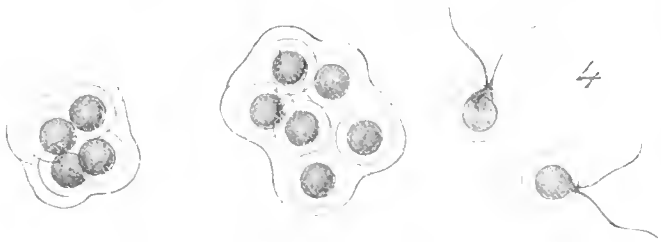


FIGURE 3.
Sphaerella nivalis, two clusters and two free swimming cells, the latter are marked 4.

It has been so little suspected that any organism but *Protococcus nivalis* could produce red-snow, that one may suppose it has sometimes been recorded as that species, without careful examination. Such was the view of Vogt, who accompanied Agassiz on his Alpine journeys.

Shuttleworth, in 1839, first suggested that other species might participate in making the red-snow.

Vogt (1840) made the remarkable discovery that his samples of red-snow contained a Bdelloid rotifer in abundance. He found associated with the rotifer some smooth and some warted globules, which he satisfied himself were its eggs, and he rather hurriedly concludes that there is probably no *Protococcus nivalis* in existence, the name having been given to rotifer eggs! Those globules of Vogt's are unlike any known eggs of Bdelloids, and I am sure he was wrong about them.

Vogt is not the only authority for the presence of rotifers in red-snow. Lagerheim, in 1892, found a Bdelloid in red-snow in Ecuador. He identified it as related to *Philodina roseola*, which is the same species as Vogt supposed his animal to be.

Now, although the Shackleton Expedition found no indubitable red-snow, we found abundance of red rotifers, which increased with prodigious rapidity and formed conspicuous blood-red stains on stones at the margins of lakes. I named it *Philodina gregaria*.

Vogt gives a very good figure of his supposed *Philodina roseola*, and the spurs are of such a form that Ehrenberg doubted the identification. These spurs are very similar to those of *P. gregaria*. The similar habitat gives colour to the suggestion that they are identical. The Alpine rotifer, living on the surface of snow, must become active at just about the melting-point temperature.—*P. gregaria* lives frozen in ice for years, and resumes activity whenever the ice melts.

It is now admitted that, while *Sphaerella nivalis* may be the commonest cause of red-snow, animals of various kinds may take part in producing the phenomenon. M. Gain, of the Charcot Expedition, makes the latest addition to the list, as he tells me he found reddish mites fairly plentiful in the Antarctic red-snow. There is probably a considerable fauna of red-snow.

What is the significance of the red colour of so many animals which live on the surface of snow? Has it a physiological function in relation to light, enabling the animal to absorb the rays, which will just make life possible in that inhospitable situation? It is noticeable that the red colour of the rotifers, both Alpine and Polar, is confined to the stomach.

There is a tendency, even in science, to reason from insufficient data to erroneous conclusions—"jumping to a conclusion," as it is termed in unscientific language. Let us take warning from some of the facts connected with red-snow. Vogt affords us an example of the danger, in his observations on the supposed eggs of the rotifer of red-snow. He watched till he observed a rotifer "deposit" one of the globules. If this were sufficient evidence, we could soon find such marvellous instances of alternation of generations as would rival the fabled origin of the Barnacle Goose. Had Vogt begun at the other end and waited for an egg to hatch, he would, perhaps, have reached another conclusion.

Red organisms are common enough apart from red-snow, and there is no need to assume that all the red organisms found in that situation have their red colour in virtue of the association. Vogt includes among his animals of the red-snow a Water-Bear with two claws, which he refers to as *Arctiscon* and *Macrobiotus*, but the number of claws and the red colour make it pretty certain that it was a larval *Echiniscus*. Ehrenberg got several kinds of *Echiniscus* high up (11,138 feet) on Monte Rosa. It seems a reasonable supposition that the colour of these animals has a special relation to a life among snow, but so far from this being the case, it is the normal colour in this extensive genus, in species living in all sorts of situations. One of the brightest red species inhabits Australia, where red-snow is little likely to occur.

Ehrenberg found on Monte Rosa, along with the *Echinisci*, a bright red rotifer, which he named *Callidina scarlatina*. It was found dried up, like pink dust, and, I believe, scattered over the snow. But *Callidina scarlatina* is not specially addicted to a life on the snow or even on mountain-tops. If Mr. Bryce's identification is right, it is a familiar species among hepatics growing on trees, in shady glens and similar places.

As to *Sphaerella nivalis* itself, the Alga of red-snow, I find upon enquiry that it is a flagellate Infusorian, related to that very energetic plant-animal, the Globe-animalcule, *Volvox*, claimed alike by zoölogists and botanists. If the flagellates are conceded to zoölogy, then all the organisms of the red-snow are animals.

JAMES MURRAY, F.R.S.E., F.Z.S.

MICRO-SLIDES ILLUSTRATING MITOSIS.—Every student of Cytology appreciates the difficulties attending the preparation of slides illustrating the phenomena of nuclear division. We have received from Mr. C. Baker, 244, High Holborn, a sample slide showing mitosis in all phases, as exhibited in the growing point of the root of *Lilium*. His list of slides also includes the root-tip of hyacinth and onion, and the testes of the newt showing the developing spermatozoa.

We have received a selection of slides from Mr. H. Gunnery, Acomb, York. He has specially devoted himself to the preparation of slides illustrating the phases of development in the embryo-sac and pollen mother-cells of *Lilium* spp. The slides we have examined are very good indeed. Special mention may be made of one, showing the embryo-sac containing two daughter-nuclei resulting from the first division of the nucleus of the megaspore. Mr. Gunnery has also sent for examination sets of botanical slides, designed to meet the requirements of the Intermediate Science and Board of Education Examinations. All the types are well illustrated in these sets, which are very reasonable in price.

E. LEITZ (LONDON) AND R. WINKEL (GÖTTINGEN).—We have received from E. Leitz (London), Catalogues Nos. 7 and 8, devoted to photomicrographic apparatus, and projection apparatus and drawing appliances involving the principle of projection. These catalogues give details of new apparatus specially designed to meet the most recent requirements. In this connection attention may be drawn to the photomicrographic apparatus as suggested by Professor Hermann for taking photographs of insects. As an appendix to the list No. 7 there are two plates of reproductions of actual photographs taken with the objectives and apparatus of E. Leitz.

Messrs. H. F. Angus & Co., 83, Wigmore Street, W., have sent us their new list of microscopes and accessory apparatus, by R. Winkel, Göttingen, for whom they are acting as agents in the United Kingdom. The optical instruments of this firm deserve to become better known amongst English workers, and we can cordially recommend the intending purchaser of a microscope to consider this list before coming to a decision. The apparatus listed ranges from the simplest demonstration instrument to that suited for the most exacting research.

ROYAL MICROSCOPICAL SOCIETY, January 18th, 1911.—Professor J. Arthur Thomson, F.R.S.E., President, in the chair.—Mr. T. Chalkley Palmer made some remarks upon a slide of *Surirella elegans*, stained to show the protoplasm which extended in unbroken continuity throughout the tubes of the keels, where, by its streaming, it acted through minute clefts upon the surroundings and moved the diatom to and fro. The special point was that the mount showed R. Lauterborn to be mistaken in assuming that the streaming substance in the keels was gallerte or jelly. – Professor J. Arthur Thomson, the retiring President, took as the subject of his address "The Determination of Sex." He discussed, historically and critically, five theories or sets of suggestions.

(1) It has been suggested that environmental conditions operating on the sexually-undetermined, developing offspring-organism, may, at least, share in determining the sex. The evidence in support of this has in great part crumbled before criticism, and before the counter-evidence of cytologists and Mendelians. But when we think of the gamut of life, we feel it to be rash to exclude even this possibility.

(2) It has been suggested that the sex is quite unpredestined in the germ-cells before fertilisation, and that it is then settled by the relative condition of the gametes (as affected by age, vigour, and so on), or by a balancing of the inherited tendencies which these gametes bear, neither ovum nor spermatozoon being necessarily decisive. The evidence in support of this is very far from satisfactory. Yet in view of some sets of experiments, of R. Hertwig, in particular it seems rash to foreclose the question.

(3) It has been suggested that the sex is predestined at a very early stage by the constitution of the germ-cells as such, there being female-producing and male-producing germ-cells, predetermined from the beginning and arising independently of environmental influence. The evidence in support of this is very strong, both on experimental and on cytological grounds.

(4) It has been suggested that maleness and femaleness are Mendelian characters, and one form of this very attractive theory is that femaleness is dominant over maleness, and that females are heterozygous as regards sex, and males homozygous as regards sex. But there are grave difficulties as well as very striking corroborations.

(5) It has been suggested that environmental and functional influences, operating through the parent, (or, in short, the parent's acquired peculiarities), may alter the proportion of effective female-producing and male-producing germ-cells. See, for instance, Russo's experiments on rabbits. This possibility remains tenable.

(6) It is suggested that there is no sex-determinant at all in the usual sense, but that what determines the sex of the offspring is a metabolism-rhythm, a relation between anabolism and katabolism, or a relation between the nucleoplasm and the cytoplasm. Many sets of facts converge in the inference that each sex-cell or gamete has a complete equipment of both masculine and feminine chara[illegible]ich there are doubtless chromosomic determinants. I[illegible] that the liberating stimulus which calls the masculi[illegible] feminine set into expression or development is aff[illegible] the metabolism-rhythm set up in the cytoplasmic fiel[illegible]ons. It may be that this metabolism-relation—be[illegible]plasm and cytoplasm, doubtless, and likewise b[illegible]olism and katabolism—leads first and necessarily t[illegible]lishment of ovaries or of spermaries, and secondly,[illegible]tly, or through the gonads with their internal se[illegible] to the expression of the contrasted masculine or femini[illegible]acters.

(7) This interesting problem still implies a [illegible] un-certainties. But some progress has been made in [illegible] last quarter of a century, and especially of late. Three [illegible] impressions stand out clearly: (1) That the main steps of progress have rewarded the coöperation of several distinct methods; (2) That the variety of organisms is so great that we should be very slow to argue dogmatically that what holds good in one set must hold good all round; and (3) That what is especially necessary on the part of biologists (according to their opportunities) is a *thätige Skepsis*,—until we arrive at secure conclusions.

This being the Annual Meeting of the Society, the following Fellows were elected as Officers and Council for the ensuing year:—

President, H. G. Plimmer, F.R.S.—Vice-presidents, A. N. Disney, R. G. Hebb, E. Heron-Allen, J. Arthur Thomson.—Treasurer, Wynne E. Baxter.—Secretaries, J. W. H. Eyre, F. Shillington Scales.—Members of the Council, F. W. W. Baker, J. E. Barnard, F. J. Cheshire, C. L. Curties, C. F. Hill, J. Hopkinson, P. E. Radley, J. Rheinberg, C. F. Rousselet, D. J. Scourfield, E. J. Spitta, Sir Almroth E. Wright.—Librarian, P. E. Radley.—Curator of Instruments, C. F. Rousselet.—Curator of Slides, F. Shillington Scales.

ALGA FROM THE SEYCHELLES ISLANDS.—A friend at the Quekett Microscopical Club recently gave me some specimens of an Alga from the Seychelles. Definite information was not procurable as to its exact habitat, but it was believed to be marine and to occur on rocks on the sea shore. Examination under the microscope leaves little doubt that it should be classed with the Lyngbyeae. It does not appear to correspond exactly with a recorded British species and certainly not with any from fresh water. It consists of unbranched filaments of considerable length; these are

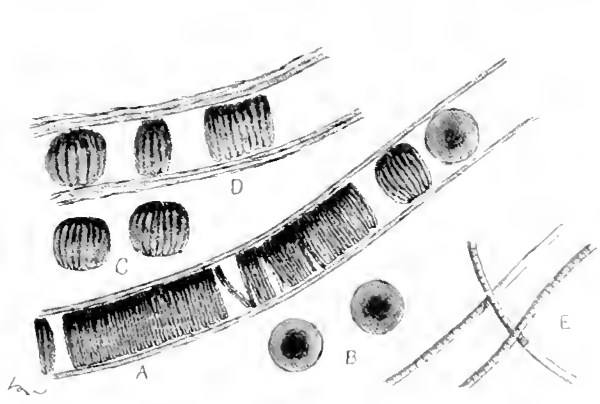


FIGURE 4.

composed of a somewhat thick-walled and strong sheath-like tube, inside which are discs of protoplasm, normally packed closely together; they are without individual cell walls and are, in the specimens given to me (preserved in formalin), of a pale olive green, and are somewhat granular in appearance. Figure 4, A. In what seems to be the young but mature condition these fill the tube, but later they show a tendency to cling together in rouleaux of six or more. Probably these are "hormogones," the non-sexual reproductive bodies of the order. They would emerge from the tube, and being disseminated in the water, develop into new filaments. The discs are lenticular, somewhat thicker in the centre than towards the periphery (Figure B, face view). When packed closely together in the sheath this is not evident owing to their compression, but when relieved from the pressure, and a few only adhering together, they form short cylinders, with rounded ends or almost circular collections (Figures C, D). In the older specimens the wall of the filament is greatly thickened and shows a distinct lamellose structure, the outer layers frequently split off, and where injured by sharp bending become broken, ragged and almost fibrous in character. In these cases the protoplasm is reduced in amount, loses its bright colour, becoming brownish, and mostly collects into the masses already described, as at D. The plant differs from the more common species of British Lyngbyeae in two respects. It is much larger than the majority; at E is represented on the same scale *Lyngbya inundata* Kutz, a rather small but plentiful species; the filaments in this case are 4μ in diameter; while those from the Seychelles are from 30 to 35μ, without the sheath. Dr. Cooke gives 25–30μ without sheath for *L. aestuarii*, a large British species found in brackish and salt water, but 7–10μ is the average diameter of the greater number. Also the protoplasmic discs are very much thinner than is usual in our own familiar species; here they average only about 2μ at the edge, and sometimes in young specimens less, looking under moderate magnification like discs of paper filling the thick walled tube.

The literature available on these lowly members of the vegetable kingdom is very scanty, and scattered through pamphlets and proceedings of various societies. If any reader of "Knowledge" can add information to what I have supplied, it would, no doubt, be welcome to many interested in the study of the lower Algae.

J. B.

QUEKETT MICROSCOPICAL CLUB.—January 24th, 1911, Professor E. A. Minchin, M.A., President, in the chair. Through the courtesy of Mr. E. M. Nelson, a note on the "Amician test" (see "Knowledge," 1910, page 326), by Mr. F. J. Keeley, of Philadelphia, was read. Mr. Keeley possesses a balsam-mounted slide, labelled "*Navicula Amicii*, Florence, Italy. From Professor Amici to C. A. Spencer." It is a fresh-water gathering and contains, besides a large proportion of typical *N. rhomboides*, a few valves under 50μ in length which form a class by themselves on account of their extreme delicacy and transparency. The author gives measurements of twenty valves and the number of transverse striae per ·01 millimetre in five typical specimens. From these particulars, Mr. Nelson considers the identity of the Amician test with the "English *N. rhomboides*" finally determined.—Mr. C. F. Rousselet, F.R.M.S., described and exhibited preparations and drawings of three new species of Rotifera. These are *Anuraeopsis navicula*, *Brachionus satanicus* and *Brachionus havanaensis*. These will be fully described and figured in the next issue of the Club's *Journal*.—Mr. R. T. Lewis, F.R.M.S., read a paper "On the larvae of Mantispa." He referred to the great apparent similarity between mature specimens of the Mantidae family and those of the sub-family Mantispidae. The wing structure, however, places the Mantis family amongst the Orthoptera and the Mantispidae with Neuroptera. The Mantidae construct a curious capsule or oötheca in which the eggs are laid in symmetrical rows and are entirely covered in from view, while the eggs of Mantispa are laid singly, each mounted on a slender stalk. On first emerging from the egg the young Mantis closely resembles the adult except as to size, colour, and the absence of wings. In Mantispa, the larva on emerging bears not the slightest resemblance to the perfect insect (a full description with drawings and exhibition of specimens was given). On leaving the egg the larva bores its way into the ovisac of a spider and feeds upon the eggs, or young, until it has changed its skin a second time. The legs then disappear, the head is reduced in size and loses its antennae, and the larva becomes a helpless fleshy grub, which presently spins a cocoon. Emerging from this it passes through two more moults and becomes a full-grown neuropterous *Mantispa*.

Mr. H. Gunnery, of Acomb, York, sent for exhibition a number of preparations, chiefly botanical, some especially fine of nuclear division in *Lilium*. These were shown under a number of microscopes kindly lent by Mr. C. Baker. Mr. Gunnery also sent a number of lantern slides, mostly photomicrographs. These were projected on to the screen. The thanks of the meeting were accorded to Mr. Gunnery and to Mr. Baker.

ORNITHOLOGY.

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

SPEED OF FLIGHT OF BIRDS ON MIGRATION.—Gatke in his well-known work on "Heligoland as an Ornithological Observatory" (1895), has a chapter on the velocity of flight of passing birds, in which some estimates of so high a value were given as to cause not a little surprise. The speed of Hooded Crows was stated to be one hundred and eight geographical miles per hour, and that of the Northern Bluethroat as one hundred and eighty; and Plovers, Curlews, and Godwits, were noted in numbers as crossing the island, over a measured distance, at a rate of nearly four miles in one minute.

A series of observations made in the autumn of 1909, under the direction of Dr. J. Thienemann, at the Migration Observatory at Rossitten (East Prussia), give very different results from Gatke. At Rossitten allowances were made for the factors influencing the birds (such as wind), and the following figures are the average results for the species named, calculated to English miles. (See *British Birds*, January, 1911, page 260.) They are here placed in order, from the lowest speed upwards:

Sparrow-Hawk ...	$25\frac{2}{3}$ miles	Brambling ...	$32\frac{3}{4}$ miles
Lesser Black-backed Gull ...	31 „	Siskin	$34\frac{3}{4}$ „
Great Black-backed Gull	$31\frac{1}{4}$ „	Linnet	$34\frac{3}{4}$ „
Hooded Crow ...	$31\frac{1}{4}$ „	Peregrine Falcon...	37 „
Rook	$32\frac{1}{2}$ „	Crossbill	$37\frac{1}{3}$ „
Chaffinch	$32\frac{3}{4}$ „	Jackdaw	$38\frac{1}{2}$ „
		Starling	$46\frac{1}{3}$ „

There are curious contrasts in these figures, and it seems clear that no fixed conclusions can be drawn until many further observations have been made and coördinated.

UNTOWARD FATE OF AN EGG OF THE GREAT AUK (*Alca impennis*).—Mr. E. Bidwell, in the current number of the *Ibis* (January 1911, page 184), tells a curious story of disregard of an ornithological treasure in the form of an egg of this extinct species. For about twenty years Mr. Bidwell has known of the existence of an egg in a small museum at Dinan, France. In September last, along with Mr. Henry Stevens, he visited the place with the intention of photographing the egg. The Castle (lately a prison) was found to have been made into a museum, but not many natural history specimens were exhibited, and the curator knew nothing of any Great Auk's egg being in the collection. The birds and other animals had been considered not worth moving, and on the previous afternoon had all been stored in an attic, at the Hotel de Ville. There, on the floor, amidst a jumble of stuffed birds, the remains of the Great Auk's egg were found. Mr. Stevens photographed the two largest fragments, and his photographs were shown by Mr. Bidwell, at a recent meeting of the British Ornithologists' Club. The price of a good specimen of this egg at present is about £250.

THE CENTRAL NEW GUINEA ORNITHOLOGICAL EXPEDITION.—The British Ornithologists' Union expedition has suffered a further loss by the compulsory retiral, through ill-health, of Mr. Walter Goodfellow, from the leadership. Capt. C. G. Rawling, surveyor to the party, has been appointed to take command. The arduous character of the undertaking receives further emphasis from the last report published (*Ibis*, January 1911, page 186). The camp and surrounding country had been completely flooded by the River Mimeka, and when the floods subsided the whole camp became a bog. Headquarters were then removed to the Waitakwa River for a further advance.

IRISH BIRDS—NEW RACES OR FORMS.—Visitors to the Natural History Museum, South Kensington, at present, will see amongst the British Birds, specimens of Coal-Tits with freshly-written labels bearing the name Irish Coal-Tit (*Parus hibernicus*). Mr. W. R. Ogilvie-Grant has recently described this bird as a new species and thus named it (*Bulletin British Ornithologists' Club*, Vol. XXVII, pages 36 and 37), on the strength of certain differences from the British Coal-Tit. It would seem, however, that the new form has yet to make good its claim to specific rank, sound critics being inclined to regard it rather as a geographical form.

This makes the third Irish bird which has recently been described and named as distinct from recognised species. The other two are the Irish Dipper named *Cinclus cinclus hibernicus*, by Dr. Ernest Hartert, and the Irish Jay named *Garrulus glandarius hibernicus*, by the same writer and Mr. H. F. Witherby.

HOW MANY KINDS OF BRITISH BIRDS ARE THERE?—The latest authoritative "List of British Birds" is by Mr. W. R. Ogilvie-Grant (1910) and enumerates four hundred and forty-two species. An analysis of the grouping adopted by the writer (which is the same as that used in the Natural History Museum, South Kensington), gives the following instructive figures:—

133	species are resident and breed.	= 185 breeding species.
52	species are regular summer visitors, and breed	
55	species are regular autumn, winter or spring visitors; not breeding.	
9	species are occasional visitors; used to breed.	
192	species are occasional visitors; never known to breed. To this number the American Pipit, mentioned in the last number of "KNOWLEDGE" (page 76) falls to be added.	
1	species is extinct (Great Auk).	
Total 442	species admitted unquestionably.	
3	varieties are named in the List, but not numbered.	
35	species, of which the history is doubtful, are named in the List within brackets, and are not numbered.	
480	birds in all are thus found named in this List.	

In the scientific names throughout this List, binomials only are used, the author having, with sound judgment, not adopted the new trinomials which are being used now by various writers.

NOTES FOR CORRESPONDENTS.—D. N. H., Chesham.—OWLS are not uncommon at Hampstead, and recently I have heard two kinds calling. On 1st May, 1910, I saw a "Brown" Owl (probably *Syrnium aluco*), seated high up in an ash tree in Platt's Lane, mobbed by two noisy Mistle-thrushes and a Blackbird, which it treated with unmoved contempt. The Barn-Owl (*Strix flammea*) is known to nest each season, and the Long-eared Owl (*Asis otus*) has nested in Ken Wood.

The MARSH-TIT (*Parus palustris*, or, if a trinomial is used, *P. p. dresseri*) is not rare in Bucks, and nests, but it may be local in its distribution, as it is in other districts. If the bird you saw was feeding it may have been taking small molluscs, as it is almost omnivorous.

Two forms of "Marsh" Tit are now recognised in this country. The new one is named the British Willow-Tit (*Parus kleinschmidti* or *P. atricapillus kleinschmidti*), and has been recorded from so many places that a careful examination of all "Marsh" Tits met with should be made by observers. For description, see Witherby's "British Birds," Vol. I., pages 23, 44, and 214 (1907), and Vol. IV., pages 146 and 284 (1910–11).

PHOTOGRAPHY.

By C. E. KENNETH MEES, D.Sc.

STANDARD LIGHT SOURCES.—Inasmuch as photographic investigations are mainly concerned with the measurement of the effects of light, it is naturally of great importance that a standard source of light of known strength and constancy should be readily available. Unfortunately, neither the production nor th[illegible]ment of light are susceptible of the very accur[illegible] possible to other sources of energy, the accuracy o[illegible]t being limited by the difference in intensity whic[illegible] perceived by the eye when two adjacent patches [illegible]d; while the production of a standard light depe[illegible] on a set of definitions of a standard lamp, wh[illegible]d in the introduction of a large number of diffe[illegible]ls more or less harmonized by photometric compari[illegible]

There is, indeed, no international standard [illegible] the sense in which the "volt" and "ampere" [illegible]rical standards: although the British standard which [illegible] as the "candle," and in practice is the light of a Pent[illegible] lamp, which has been adopted by most countries, the chief exc[illegible] being Germany and Austria, of which the standard is t[illegible] "hefner," the light of an Amyl-acetate lamp, of which the intensity is nine-tenths that of the standard candle.

Attempts have been made to introduce as international standards the light given by platinum at its melting-point, or by platinum foil heated by a standard current. But the practical difficulties attending the use of these methods seem to have prevented their general employment.

For photographic purposes, what is required is an accurate secondary standard, but the difficulties here are even greater than in visual work because lamps of different kinds and of the same visual intensity, do not produce at all the same effect upon a photographic plate, owing to differences in the spectral quality of the light produced.

The light by which photographic plates are generally used is daylight, and this differs so greatly in composition from artificial light sources that comparisons of plates made by artificial light sources may be most misleading when the plates are used by daylight, especially in the case of orthochromatic or panchromatic plates. This difficulty may be overcome by special methods of screening the light, and what is required for photographic investigation is, therefore, a method of producing light sources of constant intensity, which can be referred to some primary standard. The intensity of these light sources should be between one and four candles and they should be capable of burning for at least fifteen minutes without attention and without a variation greater than one per cent.

When the subject was discussed at the last International Congress of Photography the general opinion of the speakers seemed to be that the choice for such a secondary standard lay between acetylene burners and small metal filament electric lamps: the former being largely used in France and England, while in Germany the electrical standard is more favoured. An acetylene burner giving a single cylindrical jet of flame, from which a small portion is selected by means of a hood having a horizontal slit, will easily give an accuracy of one per cent, and has many advantages; notably, that it will burn for a long time without any attention, provided that the pressure in the generator is constant. The chief disadvantage of acetylene standards is that for accuracy they require very large generators and they are consequently rather expensive to instal, while it is impossible to render them portable.

An examination of small four-volt metallic filament lamps has shown that they will be constant to one per cent, if the voltage is maintained constant to a one-hundredth of a volt which can be done with comparative ease by means of a potentiometer, and as different lamps can be arranged with series resistances to give the same candle power for the same impressed electro-motive force, it should be possible to prepare an electric secondary standard without great difficulty.

The chief objections to these small lamps as standards—the rapidity with which they age—is of little importance in photographic work, where the total duration of exposures in a day's work would be exceedingly small.

It may be remarked that there seems to be an increasing tendency to use small metallic filament lamps, run off accumulators, as standards, especially in simple photometers of the portable type, and that in many cases these lamps are simply assumed to be constant without any control whatever. They are, in fact, very far from constant, not only giving a different intensity after the accumulator is charged, or when it is nearly exhausted, but decreasing rapidly from the time when the accumulator is switched on for five or ten minutes. Lamps used in this way may easily give rise to errors of ten per cent. or more, an amount which cannot often be considered negligible. The question as to the "primary" standard to be adopted for photographic purposes is still quite undecided, and is, probably, the most important problem to be considered by the next International Congress of Photography.

THE THEORY OF THE IRIS DIAPHRAGM.—Mr. C. F. Lan-Davis recently read before the Optical Society a paper in which he worked out the geometrical theory of the iris diaphragm, showing the conditions which will produce the maximum aperture, both for complete closing and for closing to a known aperture. The aims in designing an iris diaphragm are to obtain:—

The greatest aperture consistent with the smallest opening,
A long scale with equal division,
Light weight,
Ease in working,
Freedom from failure, and
Reasonable cost.

The factors which can be varied are the position of the pin in the fixed plate, the position of the pin in the slotted plate, width of the leaf, the length of the leaf, the number of the leaves, and the angle of the slots. For the greatest possible aperture the pins should be placed at the opposite extremities of the leaves, and twenty-five leaves are required. The maximum aperture obtainable is eighty-two per cent. of the total diameter of the iris, and no increase in the number of leaves will give a greater opening. If, however, the smallest apertures are not required, the number of leaves may be reduced or a greater aperture obtained.

The length of the scale is governed by the position of the pin, while by altering the angle of the slot, the division of the scale can be made more or less even without altering the total length of the scale; but the angle of the slot can only depart slightly from the radial direction without introducing uncertainty in setting.

THE EXHIBITION OF THE ROYAL PHOTOGRAPHIC SOCIETY.—The Royal Photographic Society will hold its Annual Exhibition during the month of May, at Prince's Skating Club, Knightsbridge.

In addition to the usual Pictorial Section, Section 2 will be devoted to photographs selected for their technical excellence; Section 3 to colour photographs, including transparencies by the screen-plate processes; Section 4 to Natural History photographs; and Section 5 to Scientific photographs.

As Sections 4 and 5 are of special interest to the readers of this column it may be desirable to give the names of the members of the selecting committees of these Sections, who will both select the pictures to be hung and award medals. The judges for Section 4 dealing with Natural History will be Messrs. W. Farren, F. Martin-Duncan, O. G. Pike and Dr. Francis Ward; while those for Section 5, which consists of photographs showing the application of photography to scientific objects, such as photo-micrographs, spectra, astronomical photographs, and radiograms, will be Dr. W. Deane Butcher (X-ray work), Messrs. Chapman Jones, J. W. Ogilvy (photo-micrography), W. Shackleton (astronomy), Major General Waterhouse, and the writer.

Pictures must be sent in by Monday, April 24th. Entry Forms and Regulations can be obtained from the Secretary, 35, Russell Square, W.C.

PHYSICS.

By A. C. G. EGERTON, B.Sc.

GENERAL.—There is so much that is of very great interest in the physical papers that have recently been published that it is quite difficult to choose those which are of the greatest general interest and demonstrate the advance that is being made in the various branches of physics. Lord Rayleigh has been investigating the perception of colour. Sir J. J. Thomson is perfecting a means of analysing the nature of a highly rarefied gas which he came upon in his studies of positive rays. Sir William Ramsay and Dr. R. W. Gray have accomplished a wonderful feat in weighing the emanation of radium. These are a few instances of the great activity that prevails in every branch of physics.

NATURE OF THE X-RAYS.—There is considerable controversy at the present time about the nature of X-rays. Professor Bragg advocates the view that the X-ray and the γ-ray emitted by radioactive substances, consist of an electron bearing with it a circumscribed positive electrification sufficient to neutralise the negative charge—this has been termed a "neutral pair." The older view, which originated with Sir George Stokes, was that the X-ray was an ether pulse travelling outwards and with ever-extending front. On this idea, as the distance from the source increased, so the energy at any point on the front of this spasmodic wave decreased. The X-rays and γ-rays give rise to secondary rays when they fall upon substances; and these rays consist of β particles. β particles are electrons such as radium ejects; they are precisely similar, though more rapidly moving, to the kathode rays obtained when the electric discharge is passed through vacuum tubes. Now it is found that the X-rays and especially γ-rays are able to liberate these secondary rays and to ionise the gas through which they pass at considerable distances from the source. This fact is difficult to explain on the pulse theory, but it is what would be expected if the X or γ-ray is a discrete particle moving at a great speed, comparable with that of light.

Professor Bragg discussed this most interesting question in his lecture on the kinetic theory of a fourth state of matter at the Royal Institution, on January 27th. He pointed out a similarity between the molecular kinetic theory, which deals with the collisions and motion of molecules, and the motion of the radiations from the radioactive elements—α, β, γ rays—and of X-rays. There are striking differences and striking similarities. Molecules, when they collide with each other, do not interpenetrate, but rebound when their spheres of influence touch. The α particle or other ray is able, in virtue of its small size and extreme velocity, to penetrate the atom it meets. The effect of the penetrated atom on the α or β particle is such that knowledge of the internal arrangement of the centre of force inside the atom may be obtained.

The resemblance between the motion of molecules and that of these rays is not only that they both move in straight lines and are darting about to and fro with great speed and are undergoing frequent encounters, but also it appears that in each case the sum of the energies of the colliding particles is the same before and after impact. An α particle, for instance, collides with an atom—the particle is moving with such velocity that although the atom abstracts part of the energy of the particle, yet the α particle (whether it be the same or another) emerges in the same direction, and with a kinetic energy equal to that of the original particle, less the energy absorbed by the atom. The latter quantity is proportional to the square root of the atomic weight—a remarkable fact. Eventually the α particle is so slowed down by collisions that it is easily deflected from its course on an encounter with an atom and moves in a more random fashion, splitting up the molecules of the gas it encounters into electrically charged "ions."

It appears that the secondary rays produced by X-rays are formed according to the same law of equal energy before and after impact, and it would follow, thus, that their nature is probably discrete; and further, since they are undeflected by magnetic and electric fields, that they are neutral particles.

But ultra-violet light has the power of setting free β particles from metals on which it impinges, and it has long been considered to consist of waves of short length.

Professor Bragg's theory cannot yet be considered to be quite complete.

THE ULTRA-VIOLET RAYS.—Professor R. W. Wood has come across a curious phenomenon which he has recently described in the *Philosophical Magazine*. He finds that if a condenser spark is passed between aluminium terminals and the direct light is shaded from the recipient of the light, whether it be the eye or a quartz photographic lens, that a violet glow is visible in the air in the neighbourhood. It appears that this glow cannot be accounted for by either fluorescence of the gas in which the spark occurs, or by the scattering of the light by dust or moisture particles. The phenomenon is very curious.

The ultra-violet rays are obtained in profusion from the mercury arc, provided the walls of the tube are of Jena "Uviol" glass or quartz: in fact, the rays from these lamps, unless cut off by glass, by which they are absorbed, are most injurious to the eyes. It appears that one single wave-length of the light is capable of penetrating the cornea of the eye and of doing the mischief.

MM. Urbain, Seal and Feige have devised a mercury lamp which gives a pure white light. Taking advantage of the high melting-point of tungsten they have employed an arc between mercury as kathode and tungsten as the positive pole of the arc. The arc is maintained in a vacuum, and the tungsten is only slightly separated from the surface of the mercury. The tungsten gets white hot, while the usual good efficiency of the mercury vapour lamp is attained.

AFTERGLOW IN VACUUM TUBES.—The Hon. R. J. Strutt has been investigating with great skill the glow obtained in "vacuum" tubes containing air, which sometimes occurs after the electric discharge is turned off. He removed the air from the neighbourhood of the discharge, and passed it into a tube, where he could observe the glow and examine the conditions which prevented or improved it. He found that those substances which destroy ozone prevented the production of the glow, and, further, that it was necessary to send a discharge through the air before the glow would appear, even if ozone had been added. In this way he has shown that the effect is due to both ozone and nitric oxide, and is merely a luminescence due to chemical combination, presumably of the nature of the glow obtained on the oxidation of phosphorus.

Mr. Strutt has found more recently that similar most striking glow phenomena are obtained with nitrogen, a blue glow being obtained in the presence of iodine, while metals exposed to this nitrogen give out their line spectra.

THE ANNUAL GENERAL MEETING OF THE PHYSICAL SOCIETY.—Professor Callendar, F.R.S., at the Annual General Meeting of the Physical Society, on Friday, February 10th, read a most interesting address on the "Caloric Theory of Heat." He dealt with the much-overlooked and misrepresented work of Sadi Carnot. Carnot began his investigations with the purpose of finding what advantage would be gained by using working fluids other than steam in engines. He was led to the consideration of an ideal heat engine, and showed that if no direct transference of heat occurred between bodies at different temperatures, the transformations of heat and motive power were reversible in such a "cycle." He found that the efficiency of such an engine (or the ratio of the motive power to the quantity of heat which produced it) was the maximum possible, and was independent of the working fluids used. By applying the Caloric Theory of heat, Carnot was able to deduce all the relations between heat and work in reversible processes, and to forestall the subsequent determinations of the mechanical equivalent of heat, by utilising the somewhat rough experimental data which were at his disposal.

The idea of Caloric is similar to the idea of quantity of electricity; if all electrical calculations had to be made from considerations of electrical energy, instead of picturing a quantity of electricity passing from one potential to another, there would be much complication. In the same way, a conception of quantity of caloric passing from one temperature to another, besides that of the energy equivalent to such an operation, would be valuable in simplifying the underlying notions of that somewhat abstruse subject, thermodynamics. Caloric is only another name for Rankine's "Thermodynamic Function," or Clausius' "Entropy." It would be well to point out that the "Calorie" is a measure of thermal energy, which must not be confused with the "Carnot," or unit of quantity of caloric.

Professor Callendar's stud[illegible] work will make it possible to give the student a [illegible] conception of heat.

The addresses of the officers [illegible] previous to the reading of the President's address [illegible] the flourishing condition of the Society and to its [illegible] while it was hoped that many would be led to sh[illegible] advantages and become members.

ZOÖLOGY.

By Professor J. Arthur Thoms[illegible]

RIGHT AND LEFT-HANDEDNESS.—A[illegible] the discussion on this subject it is rather surprising t[illegible] an anatomist of the rank of Karl von Bardeleben say[illegible] that our ignorance on the matter is shameful. We cannot [illegible] percentages for different races; we have done little in the way of distinguishing different degrees of left-handedness; and we do not know how it is that right-handedness has become so predominant in mankind. Perhaps, one sometimes thinks, each species has its particular asymmetry, just as many great types have. The gibbon and orang are right-handed; the gorilla and chimpanzee are left-handed. To point to asymmetry in the brain, e.g., the stronger backward protrusion of the left cerebral hemisphere, except in typical left-handed people, shifts the problem without solving it. Professor von Bardeleben gives the interesting piece of information that there were last year (1910) in the German army ten thousand three hundred and twenty-two left-handed men. Only 3·88 per cent., however!

FERTILE HYBRIDS BETWEEN BISON AND DOMESTICATED CATTLE.—E. Iwanoff refers to the estate of F. E. Falz-Fein, "Askania Nova," where a number of half-breeds have been produced by crossing *Bison americanus* with domestic cows and with the European Bison (*Bison bonasus* or *europaeus*). Others have been produced—"Three-quarters American Bison and one-quarter domestic *Bos taurus*, and one-quarter American Bison and three-quarters *Bos taurus*." The fertility of the half-breed bison females has been proved. They produce offspring to both American bison and European bison. The male half-breds have sexual instincts, but there is no proof of fertility. But the male of three-quarters bison blood seems to be fertile with the domestic cow.

OVIPAROUS AND VIVIPAROUS.—It is said that some snakes, such as the grass snake, normally oviparous, may become viviparous in the comfortable conditions of captivity. That is to say (for the old terms are as bad as they are difficult to dislodge), the eggs may hatch inside the body instead of outside. E. Roubaud has recently reported an interesting parallel case in insects, namely one of the flies, *Musca corvina* Fabr. In tropical Africa this fly is constantly viviparous all the year round, and at intervals of four days or so. It can continue this reproductive régime as long as the average temperature is not less than 30° C. Now the interesting point is, that according to Portchinsky, the fly is always oviparous in the north of Russia, laying twenty-four eggs, while in the Crimea it produces a large larva viviparously at the end of spring and in summer. The author calls this "seasonal and climatic poecilogony."

BRAIN OF A SILVER-FISH.—Comparatively little has been done in the way of comparing the brains of different kinds of insects. One, therefore, welcomes the study which Otto Böttger has made of the brain of the little wingless insect, *Lepisma saccharoides*, not uncommon in houses, and popularly known as the "silver-fish." It is something of an achievement to be able to present a picture of the minute structure of the brain of such a tiny creature, and it is interesting to notice the investigator's general result—that the brain of this type is in many ways quite peculiar. Indeed it shows parts which have not been seen as yet in any other insect.

LARVAL MANTIDS MIMICKING ANTS. — From a pale emerald-green, walnut-sized nest, sent to the Zoölogical

Society from the Gold Coast, there emerged a crowd of young mantids, about four millimetres in length, which, "when crawling about the case, looked exactly like a crowd of black ants, their rapid darts and pauses recalling irresistibly the busy method of progression so characteristic of these Hymenoptera." Mr. R. I. Pocock, the Superintendent of the Gardens, observed them carefully, and noticed that it was only when in motion that they resembled ants. When at rest they were seen in their true colours—as Mantises, "raising the fore part of the body and head, folding up their fore-legs, and every now and then swaying gently from side to side, as if rocked by the wind. While thus employed they were seen to be procryptically coloured." That is to say, they were inconspicuous. Mr. Pocock has analysed the resemblance to an ant, and finds that it is partly due to the blackness of the underside of the abdomen, and partly to the habit the moving insect has of curling the posterior half of the abdomen up like a scorpion's tail. This altered the proportions and shape, and in a curious way a white spot on the prothorax simulated an ant's waist. When the young insects attained a length of seven millimetres they lost their ant-like look. Mr. Pocock also directs attention to the conspicuous larva of a Ceylonese leaf-insect, closely resembling a distasteful beetle (*Lycostomus gestroi*), which is also mimicked by two bugs and a moth.

COPEPODS AND ALCYONARIANS. — Colonies of Alcyonarians often harbour small parasitic Copepods, which are known as Lamippids. They are very distinctive little creatures, characteristic in their buccal armature at one end, and in their caudal fork at the other. They have been recently studied systematically by A. de Zulueta, and the result shows, what is so often true of parasites, that each species of *Lamippe* has its particular host. Some hosts may harbour two or three species, but no species occurs on two different hosts. It is impossible not to wonder whether in these cases, and for others like them—Nematode worms, for instance—there may not be "modification species," whose characters are directly due to their immediate environment. It would be interesting to transplant some young Lamippids from one Alcyonarian to another.

SIMULACRA VITAE.—If a weak solution of gelatine is spread on a slide and tiny drops of ferrocyanide of potassium are put on at intervals of five millimetres by means of a pipette, beautiful simulacra of nucleated cells are produced. If fragments of calcium chloride are dropped into sixty grains of silicate of potassium at thirty-three degrees, sixty grains of saturated solution of carbonate of soda, thirty grains of saturated di-basic phosphate of soda, and distilled water up to a litre, then beautiful phantasms arise—"osmotic growths"—like mushrooms and moulds and corals and shells. Professor Stéphane Leduc has given much time to these interesting and fascinating simulacra vitae, and discusses their importance in a recent book ("Théorie Physico-Chimique de la Vie." Poinat, Paris, 1910). There are, of course, osmotic phenomena in organisms, and the more they are studied the better, but it appears to us to be giving an entirely false simplicity to the facts to declare that biology is a subdivision of the physico-chemistry of fluids. This is a survival of the discredited materialistic superstition, and to credit the artificial osmotic growths with nutrition, assimilation, irritability, and a power of development, is a bad instance of an assertion that outstrips its evidence.

THE LEONID FIREBALL OF NOVEMBER 16th, 1910.

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

THE Moon being full at the epoch of the Leonid shower in 1910, it appears to have been but slightly observed. A very brilliant member of the stream was, however, seen by various persons who were watching the total lunar eclipse on the night of November 16th.

Mr. J. Cranston, of Giffnock, near Glasgow, saw the meteor at $12^h\ 27^m$. It fell from a few degrees to the right of Algol, almost vertically downwards, bursting in Andromeda. The direction was from between Capella and Ursa Major. It left a tail visible for several minutes. The length of path was about 26°, and when bursting the meteor appeared to equal the size of the moon.

Mr. W. B. Ogilvie, at Greenock, N.B., gives the time as $12^h\ 26^m$. He saw an intensely luminous streak stretching from above the stars, 35, 39, 41 Arietis towards Capella. The streak was broken and the brighter portion lay west of Capella. It was visible to the unaided eye for five minutes.

Miss Helen M. Metcalfe recorded the meteor at Kildare, and Miss Rose Atkinson from Pitlochry, while correspondents to the *English Mechanic* also described its appearance.

There is no question but that the meteor was a brilliant Leonid passing over Scotland and the north coast of Ireland. Its height was from ninety-one to forty-five miles. The radiant point was near $150^\circ + 23^\circ$ in the well-known "Sickle of Leo."

At and near Glasgow the fireball presented a splendid appearance, and the intense light accompanying its sudden outburst astonished many persons. The apparition of this fine Leonid is interesting as proving that the shower returned in 1910, though possibly under a feeble aspect. Thirty-three years ago, viz., in 1877, November 10th to 15th, I recognised it, but it was very feeble.

Tempel's parent comet of the Leonids is now not very far removed from its aphelion outside the orbit of Uranus. Such meteors of this stream as are noticed during the few forthcoming years will, therefore, be at nearly the opposite part of the orbit to the comet. It is known, however, that the stream is an annually visible one, and that the meteors are distributed right around the ellipse, though only feebly so in certain sections of it.

Mr. J. McHarg, of Lisburn, near Belfast, reports that at midnight (Dublin time) he observed a bright flash, and looking towards the stars of Ursa Major he remarked a short, broken meteor-streak, about 1° above the stars δ and γ. The direction of this streak was from the radiant of the Leonids, and a small Leonid shooting star passed through Ursa Major at the time the streak from the fireball was suspended there. It remained three minutes, the portion near the star δ Ursae Majoris moving downwards to below δ, while the westerly section formed a small patch of nebulosity, and continued stationary about 1° above γ.

The position of the streak was evidently influenced by air currents of different velocities and directions in the upper regions of the atmosphere. The singular streak left for three hours by a fireball on February 22nd, 1909, exhibited similar phenomena; while the ends appear to have retained nearly the same position for the long time, the central parts drifted N.W. at the velocity of ninety or one hundred miles per hour.

Mr. C. L. Brook, of Meltham, near Huddersfield, obtained an excellent view of the fireball, and as he is an experienced and accurate meteoric observer his record is of special value. He places the beginning of the luminous course in the region of α Draconis and the whole path as from $205^\circ + 60^\circ$ to $295^\circ + 38^\circ$. The meteor burst at $293^\circ + 44^\circ\ 20'$ and a small section of the streak remained visible without drifting much for five minutes. The meteor ended with a minor explosion before it reached η Cygni.

In deducing the height and length of path of the object, I have had to revise some of the observations. I think the best real path obtainable is that the meteor passed over the sea near Berwick, to nearly above Edinburgh and Glasgow, and westwards over Kintyre, ending north of Rathlin Island off the north coast of Ireland. Several of the observers place the end further west, while Mr. Brook's record indicates that it began earlier in its flight and decidedly east of Berwick. However, a length of flight of one hundred and sixty-five miles and a velocity of thirty miles per second satisfies the observations and cannot well be far from the actual course.

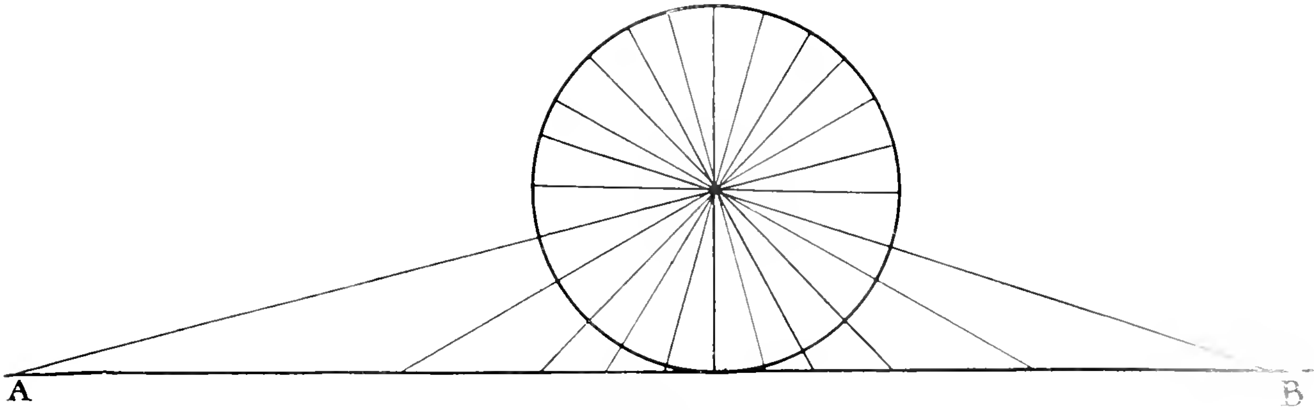


FIGURE 1.

(NOTE.—The line A.B. may just as appropriately be drawn below the circle, or cutting through it. It is here made tangential merely to simplify the measurements to which reference is made.)

A SIMPLE METHOD OF CONSTRUCTING A HORIZONTAL SUN-DIAL.

By CHARLES E. BENHAM.

STRIKE out a circle on a piece of paper. The size is not important, but as some guide it may be mentioned that it will be found that the height of the gnomon of the dial will be a little less than the radius of this circle.

Divide the circle very carefully into 24 equal parts, and at right angles to one of these radii draw a horizontal line (AB, Figure 1) tangential to the circumference. Cut the paper along this line, and produce the 11 nearest radii to the cut edge as shown.

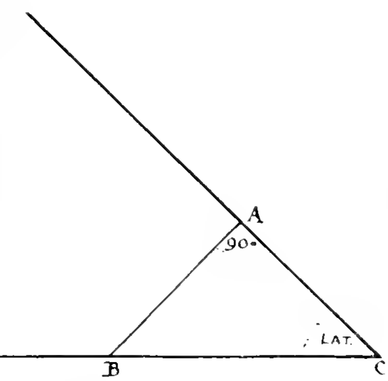


FIGURE 2.

On a larger piece of paper draw two lines at right angles in the form of a ⊤, and to the top line of this ⊤ apply the cut edge, so that its central line touches the centre of the top of the ⊤. Mark off on the top line of the ⊤ all the points where the produced radii meet the cut edge.

Draw two lines meeting at an angle equal to the latitude of the place for which the dial is to be constructed, and form a right-angled triangle (ABC, Figure 2) with this angle for its acute angle C, and with the length of the side AB exactly one radius of your circle. Mark a point on the upright line of the ⊤ exactly the length of BC from the top. Rule lines through all the points on the top line of the ⊤ to this point on the other line, and produce them on through the point. These will be the hour lines of the dial plate and must be numbered—12 for the central one, with 11, 10, 9, and so on, in order on the left, and 1, 2, 3, and so on, in order on the right. A line parallel with the top of the ⊤ will form the hour line for the two sixes. Of course it is not necessary to number the hours further than 8 in the evening or before 4 in the morning. If half hours are required the original circle must be divided into 48 instead of 24; if quarters, 96 parts.

The gnomon must be a triangle of metal corresponding with the triangle of Figure 2, the base being BC, the point B at the head of the ⊤ and the point C where the hour lines intersect.

This simple method of dialling will incidentally suggest the curious form necessary for a dial at the latitude of the equator—0 degrees.

In this case, the angle at C being 0 degrees, the line AC, instead of sloping downwards, would have to be parallel with the dial face, so that a rectangle would take the place of the triangle for the gnomon. The hour lines, having no point to converge to, would also run parallel with the top of the gnomon, and the dial would take the form shown in Figure 3.

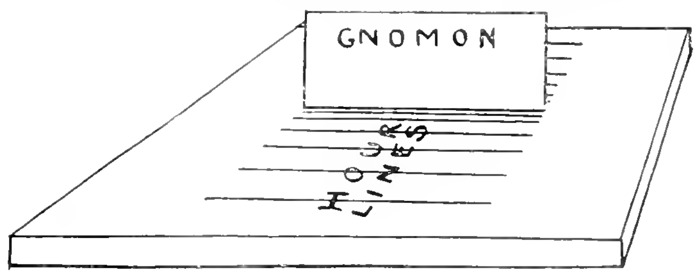


FIGURE 3.

Form of Horizontal Dial adapted to the latitude of the Equator.

THE CENTENARY OF URBAIN JEAN JOSEPH LE VERRIER.

By E. A. BELLAMY, Hon. M.A., F.R.A.S.

On March 11th, 1911, the centenary of the birth of this most eminent astronomer of the last century will be celebrated. A few words upon this man may not be amiss to the present generation, seeing the time that has elapsed since his death. He was a student at the Ecole Polytechnique at Paris when from twenty to twenty-two years of age. His early work was in the domains of chemistry and engineering; but his first astronomical paper was not communicated to the Academy of Sciences until 1839, on the important subject of the Secular Variations of the Elements of the Orbits of the Seven Major Planets. Further researches upon the same subject were made in the next year or so: the papers are printed in the *Connaissance des Temps* for 1843 and 1844. These memoirs seemed to have excited his energies; for, from 1843 until 1877, he produced an incessant stream of highly-important researches, entailing prodigious labour upon the Theory of Mercury, 1843 (revised in 1859); the Theory of Uranus,—the three famous memoirs were presented to the Academy in 1845 and 1846 (reinvestigated in 1874); Theory of the (Earth) Sun, in 1853 and 1858; Theory of Venus, 1861; Theory of Mars, 1861; Theory of Jupiter and Saturn, in 1872 and 1873; and the Theory of Neptune, 1875 and 1877; these memoirs and the tables based upon them are to be found in the *Annales de l' Observatoire de Paris*, tome IV–XIV, and form an imperishable monument to him: the movements and positions of these bodies given in the nautical almanacs of various nations have for many years depended upon these tables. Of all these separate investigations, those relating to Uranus stand out most prominently before the world, whether it be considered astronomically or generally. Bouvard's tables of Uranus, printed about 1821, were generally used; and it was the increasing difference between those calculated places and the observations which caused Le Verrier, it is said by Arago's request, to commence his researches which ultimately led to the discovery of a new and more remote major planet, Neptune, in the September of 1846. (These memoirs were published in the *Connaissance des Temps* for 1849.) The subject of the visual discovery by Dr. J. G. Galle was recently referred to by the writer, in "KNOWLEDGE" for last August and September, wherein it was shown that the receipt, by Galle, of a letter from Le Verrier in September, 1846, asking him to look for a planet in a particular region, which he indicated closely, Galle was soon able, on September 23rd, 1846, by the aid of one of Bremiker's star maps, assisted by d'Arrest's suggestion and help, some say, to detect an object which had a disk and which proved to be the new body sought for by Le Verrier; Le Verrier's letter of October 1st, thanking Galle, is delightful to read.

This triumvirate, Bremiker, Le Verrier, and Galle, all assisted in the discovery; and the following facts are worthy of attention being drawn to them. Bremiker, the star-map maker, was born in 1804, and died almost suddenly on March 26th, 1877, a generation ago. (Parenthetically, it may be added that Heis, also a star-map maker was born in 1806 and died on June 30th, 1877, also suddenly). Le Verrier, born on March 11th, 1811, died exactly thirty-one years after Galle had visually discovered the planet Neptune, September 23rd, 1877. Galle, born a year later than Le Verrier, on June 9th, 1812, lived for sixty-four years, or nearly two generations of astronomers, after the discovery of Neptune, and for a generation after Bremiker and Le Verrier. Bremiker and Galle were both elected Associates of the Royal Astronomical Society on the same day, May 12th, 1848.

In addition to these immense and laborious investigations Le Verrier's attention was particularly attracted to the study of the orbits of comets, especially those of Lexell (though discovered by Messier), Faye, and De Vico (the memoir on Lexell's Comet is considered a classic work); he gave much time to these calculations and achieved what others had hitherto failed to accomplish.

For his grand work he was twice awarded the gold medal of the Royal Astronomical Society; upon the first occasion it was in 1868 for his researches on Mercury, Venus, Earth, and Mars; and in 1876, the year before his death, when his eminent colleague in similar work on the planet Uranus, Professor J. C. Adams, gave a fine address in presenting the medal for researches on the next four major planets. It is a strange fact, looking down the list of medallists from 1846–1876, that neither the theoretical nor the visual discoverer of a new *major* planet should be thought worthy, by the members who formed the R.A.S. Councils during that period, of the award; it is even more strange when one sees the comparatively trivial or almost forgotten work for which some obtained the medal. Was it jealousy? Certainly in 1848 they obtained a clean slate by giving *testimonials* freely, but the merits of the others pale before the immensely superior claim of Le Verrier; it was small honour to him to see his name in that 1848 list, and why were not Galle's and Adams' included?

Le Verrier was appointed Director of the National Observatory, at Paris, in 1853, when Arago died, but left in 1870, owing to difficulties with his colleagues there; he, however, was re-appointed in 1872, and remained Director until his death in 1877. His health was poor for some months before his death, but he was cheered greatly by Gaillot's assistance in getting the computations and in printing the tables of Neptune completed shortly before his death. He was a Grand Officer of the Legion of Honour, and so had a semi-military funeral to the cemetery of Mont Parnasse, Paris.

REVIEWS.

ARCHAEOLOGY.

British Costume during Nineteenth Centuries.—By Mrs. CHARLES H. ASHDOWN. 376 pages. 459 engravings. 119 plates. $9\frac{1}{2}$-in. × $6\frac{1}{4}$-in.

(T. C. and E. C. Jack. Price 18/6 net.)

We do not pay enough attention in this country to that side of archaeology which deals with the development of the industries of the people, especially as these are concerned with the details of everyday domestic life. It is true that considerable interest is taken in the history of dress, and this, perhaps, for special reasons, but we still have no folk museum in which we can refer to the actual clothes themselves. The task of getting a proper series together becomes increasingly difficult as the years go by. When, eventually, a serious attempt is made to repair the deficiency in our national collections we shall, no doubt, have to depend a great deal on careful reconstructions such as Mrs. Ashdown has made for the purpose of producing the coloured illustrations which embellish her book. As these have been taken, with the help of photography, from real people—and we cannot imagine that the features of English men and women have changed greatly in a few hundred years—we get from the pictures a better idea as to the effect of the costumes than is possible in any other way.

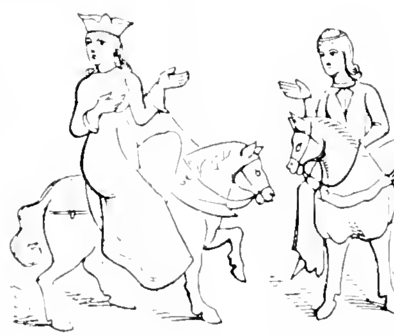
An Anglo-Saxon lady riding on a side saddle.

It is very interesting to the student of the past to study old costumes that survive at the present day—say, like those of the Sister of Mercy and the Blue-coat Boy, and see from what chapter of history they are taken.

A lady riding astride when hunting in the reign of Richard II.

The exaggerations in dress that are so common throughout history are amusing to us, but those of olden times cannot seem to us to be any more idiotic than pictures of those of the present will appear to our descendants. When the clothes are seen on living persons their ridiculousness is not always quite so obvious as it is in the illustrations of a book or it is possible that the Goddess of Fashion would not have quite so many worshippers.

Clothes proper are not the only things which are presented to us by Mrs. Ashdown, and the method of riding by ladies which we have chosen for illustration is a good instance. Women of the lower orders, and ladies when hunting or in a hurry, rode astride, but the side saddle was used from Anglo-Saxon times onwards by the quality.



Ladies using the side saddle (14th Century).

ASTRONOMY

Researches on The Chemical Origin [illegible] *ines in Solar and Stellar Spectra.*—By FRA[illegible]NDALL, A.R.C.Sc. 77 pages. 12-in.

(Wyman & Sons, for the Solar Physics Committe[illegible] 4/6.)

A collection of six papers, the first giving the [illegible] a comparative study of the spectra [illegible] the sun and lower type stars, in relation to the sunspot spectrum. During the seven years the work has been in progress, several papers bearing on the subject have been published from Mount Wilson Observatory and are referred to, and the results compared with those obtained at Kensington. The stars compared with the sun are Capella and Arcturus. The former yields a spectrum very like the general solar spectrum, but the latter is found to be very similar to sunspot spectra. The elements which appear to have the largest share in producing the distinctive spectrum are vanadium and titanium. The conclusion is drawn that there are probably nearly similar conditions either as to temperature or electrical excitation in sunspots and stars of the Arcturian class. Further it is considered that the Sunspots and Arcturus are lower in temperature than the general photosphere and Capella.

Part II. gives the results of an investigation of the spectrum of ϵ Ursae Majoris, a star of Sirian type, but having certain peculiarities. One result is that the lines of proto-chromium are found more pronounced than in the spectrum of any other known star.

Part III. deals with the presence of nitrogen lines in stellar spectra, detailing the relative intensities of the stronger lines in the stars β, γ, κ, ϵ, δ, and ι Orionis. It is noticeable that in spectra of stars of a higher class than ι, or a lower than β, no nitrogen lines are found.

Part IV. consists of lists of enhanced lines in the spectra of some metals not published previously.

Part V. gives tables of wavelengths of known lines of use in studying the radial velocity of stars.

Part VI. brings together in order of wavelength a number of pronounced lines, met with in various celestial spectra, but, so far, not identified with any known terrestrial substance. The contribution is distinctly a useful one; the last part very specially may be helpful to the laboratory worker—a list of eighty-two lines to be watched for. Helium is now a well-known gas, yet for many years it was only known as a bright line in the solar chromosphere, very occasionally recorded dark on the disc. What may not these eighty-two lines, as yet unknown, mean? F. C. D.

These illustrations are reproduced by the courtesy of Messrs. T. C. and E. C. Jack.

Norton's Star Atlas and Telescopic Handbook.—By Arthur P. Norton, B.A. 20 pages. 16 maps. 11¼-in. × 8¾-in.

(Gall and Inglis. Price 5/- net.)

This is a star atlas on good paper of convenient size and weight. The author has evidently taken great care and spent much time in attaining the production of a useful atlas suitable to possessors of telescopes of moderate size. A map of the moon is given as a frontispiece, and various information relating to the relative magnitudes of stars, terms and abbreviations used in astronomy, notes on star nomenclature, sun, moon, planets, stars, nebulae, comets, and meteors; care and use of the telescope, hints on observing, and Arabic names, are given on the first nineteen pages; then follow sixteen maps, or rather eight double maps, for the northern sky is given on the right-hand side, and the southern sky is continued on the left-hand side. On the back of each map is abundant information concerning the principal double stars, variable stars, clusters and nebulae. There is also, at the beginning, a replete index of contents and, at the end, an index to the constellations with the dates of culmination for 9 p.m. and midnight. The obvious faults are three: (*a*) the maps err by containing too much information in giving star catalogue references, no doubt convenient for day use, but tending to render the stars on the maps less conspicuous in a dim light at night; (*b*) giving the maps for epoch 1920·0 is needless for such small scale maps; much better have made the epoch 1900·0, they would then have agreed with the International Survey maps and catalogues, and still have been sufficiently accurate for general use for many years to come; (*c*) binding the equatorial portion of each map in the back of the atlas is a serious inconvenience and loss of an important part of the sky; a different form of binding, an unprinted space in the fold of each double map, or the mounting of the maps on guards would have prevented this loss. F. A. B.

BIOLOGY.

Survival and Reproduction—A New Biological Outlook.—By Hermann Reinheimer. 410 pages. 8½-in. × 5½-in.

(John M. Watkins. Price 7/6 net.)

This book is a continuation of "Nature and Evolution," in which the writer claims to have propounded a broader and more apposite theory than that of "natural selection" to explain evolution, and in the introduction we are given ninety-eight points and propositions which are contained in the previous volume. Mr. Reinheimer, so far as we are able to make out, seems to have set up in his mind some sort of rules of behaviour to which he considers that creatures should conform. For instance, after comparing beetles with the less numerous lepidoptera, he says:—"Now the construction that I wish to place on these facts is to the effect that as soon as the law of animal alimentation is seriously infringed—as soon as animals habituate themselves to feed on animal instead of vegetable matter—multiplication of individuals and frequently of groups termed species proceeds at a dangerous and chaotic rate (pathologically), involving violent clashes and struggles between organisms which are of their own making." If this be true we should not expect a declining birth-rate among meat-eating people. In another place he presents the case of cannibalism among whelk embryos as a "striking picture of parasitic retribution," and with this we are asked to compare "the rectitude of life" in the higher organisms.

Many interesting biological facts are mentioned in the book, but we are not convinced by the arguments.

BOTANY.

Alpine Flowers and Rock Gardens.—Described by Walter P. Wright, with notes on "Alpine Plants at Home," by William Graveson. 292 pages. 4 coloured plates. 15 figures. 9¼-in. × 6½-in.

(Headley Brothers. Price 12/6 net.)

Garden lovers will welcome another helpful volume from the pen of Mr. Walter P. Wright. Of late years Alpine plants have greatly gained in popularity, probably owing in no small degree to increased facilities for travel, and consequent interest in mountain flora. A rock garden has many obvious advantages, not the least being that the space required need not necessarily be extensive, and hence, given the requisite knowledge, it is quite possible to possess a successful and very interesting rock garden even in the suburbs.

Apart from the wealth of information contained in this book, its great charm lies in the beautiful coloured photographs of rock plants in their native haunts, which occur every few pages, the brilliant colouring of the flowers on the brown mounts making the volume exceedingly attractive.

GEOLOGY.

Smithsonian Miscellaneous Collections. Vol. 53. No. 6.—*Cambrian Geology and Palaeontology. Olenellus and other Genera of the Mesonacidae.*—By C. D. Walcott. Pages 231–422. 22 plates.

No. 7. *Pre-Cambrian Rocks of the Bow River Valley, Alberta, Canada.*—By C. D. Walcott. Pages 423–431. 3 plates.

Vol. 57. No. 1.—*Cambrian Geology and Palaeontology, II. Abrupt Appearance of the Cambrian Fauna on the North American Continent.*—By C. D. Walcott. Pages 1–16. 1 Map. 6½-in. × 9½-in.

(Washington: Smithsonian Institution, 1910.)

These three publications are in continuation of the lifelong work of Dr. C. D. Walcott on Cambrian and Pre-Cambrian geology and palaeontology. The first is a complete monograph on Olenellus and its allies. Under the family Mesonacidae are included the genera *Nevadia, Mesonacis, Elliptocephala, Callavia, Holmia, Wanneria, Paedeumias, Olenellus, Peachella,* and *Olenelloides,* with thirty-three species at present known. *Nevadia* is the most primitive form: from it spring two lines of descent, one through *Callavia, Holmia,* and *Wanneria,* probably leading on to the Middle Cambrian *Paradoxides;* the other through *Mesonacis, Elliptocephala, Paedeumias* and *Olenellus,* becoming extinct in Lower Cambrian times with the degenerate form *Olenelloides.* All known species of the Mesonacidae are confined to the Lower Cambrian. This fine monograph is illustrated by twenty-two excellent plates, containing two hundred and fifty-eight figures.

In publication No. 7, Dr. Walcott describes his field work on the Pre-Cambrian of the Bow Valley, Alberta. These rocks are unaltered sediments lying unconformably beneath the Cambrian, and, as far as known, are unfossiliferous. The formation names Hector and Corral Creek (in descending order), are proposed for them, and they are correlated with the Camp Creek and Kintla-Sheppard series of Montana, South-Western Alberta, and South-Eastern British Columbia.

The fascinating topic of the abrupt appearance of indications of life in the Cambrian period is discussed in the last publication under review. This paper is Dr. Walcott's contribution to the debate on "The abrupt appearance of the Cambrian Fauna," at the eleventh International Geological Congress, at Stockholm, this year. Brook's views as to the origin of life in the open ocean are adopted. This pelagic life is believed to have become adapted to littoral and shore conditions during the period of Algonkian continental elevation, which was of sufficient duration to permit of the development of the types now found in the basal Cambrian rocks. The sediments and fossils of the Lipalian era (i.e., the period between the formation of the Algonkian continents and the earliest encroachments of the Lower Cambrian sea), are absent from our present land areas, the continents having been high above sea level during the development of the Pre-Cambrian fauna. The Lipalian sediments are probably still buried beneath the oceans. This theory depends primarily on the absence of a marine fauna in the known Algonkian rocks, most of which, such as those of the Cordilleran geosyncline, are believed to have been deposited in fresh or brackish waters. It appears to depend also on a rigid acceptance of the theory of the permanence of ocean basins and continental areas.

A Textbook of Geology.—By P. LAKE, M.A., F.G.S., and R. H. RASTALL, M.A., F.G.S. 494 pages. 134 figures. 32 plates. $5\frac{1}{2}$-in. × $8\frac{3}{4}$-in.

(Edward Arnold. Price 16/- net.)

Geological students have long needed a textbook to bridge the gap between the elementary manuals and such detailed works as Sir A. Geikie's great treatise. They have their need satisfied in the book under review, which meets a distinctly "felt want." In its five hundred pages the student will find most geological topics dealt with in clear concise paragraphs informed with the latest results of research. The book is divided into two parts: the first, dealing with physical geology, has been written by Mr. Rastall; the second, on stratigraphical geology, by Mr. Lake. The treatment adopted, as acknowledged in the Editor's preface, is frankly Lyellian. In accordance with this method, petrology and palaeontology are necessarily dealt with only to such an extent as is required to appreciate their place in geological science. Their modern development is regarded as altogether too extensive to be included in a work on the principles of geology.

We have nothing but praise for that portion of the book which deals with physical geology. The arrangement and selection of material is good. Some of the latest results of research on British rivers, and on North American glaciers, to mention only two subjects out of many, are here rendered in an easily accessible forms, for the first time in an English text book. The whole section gives evidence of very careful and extensive reading on the part of the author. Similar praise must be accorded to the stratigraphical part of the book, which is headed by a good chapter on the often-neglected principles of stratigraphy. A welcome feature to British geologists is the incorporation of the latest results of stratigraphical work in Wales, Cornwall and elsewhere. Only British stratigraphy is dealt with, as the scope of the book does not permit the consideration of foreign deposits. The work is in general so thoroughly done that it is surprising to find no account of the recent material development of our knowledge of the great Dalradian series of the Scottish Highlands by the Geological Survey officers and others. The plateau lavas of the Carboniferous in Scotland, except in the Garleton Hills, are mostly very basic olivine basalts, not andesites, as stated on page 371. In spite of minor defects, we have in this section the best, fullest and most modern account of British stratigraphy. The text is illustrated by many excellent plates and informative diagrams. There are two misprints in a single paragraph on page xii., and a transposition of lines on page 140, but these are the only blemishes we have been able to discover in a well-printed book. The authors are to be congratulated on this excellent and important summary of geological science, which should be in the hands of all geologists.

MEDICINE.

Induced Cell-reproduction and Cancer.—By HUGH CAMPBELL ROSS, M.R.C.S., L.R.C.P. 291 pages. 125 plates. $9\frac{1}{2}$-in. × 6-in.

(John Murray. Price 12/- net.)

In this large and interestingly-written book the author describes researches which he has recently carried out by a special and, for the most part, original method, upon the white blood corpuscles. A small quantity of blood is spread out on the surface of a film of jelly, containing stains and other substances dissolved in it, and the whole is then covered with a cover-slip and examined. The stain is slowly taken up by the leucocytes and lymphocytes and various changes are observed to take place in these cells, depending on the nature of the dissolved substances. What the writer describes as division of the white blood corpuscles can be watched on the stage of the microscope. In the case of the lymphocytes it is quite possible that these changes may at times constitute a true physiological division; but it would appear probable that the leucocytes never really divide, as they are fully formed and specialised cells, and that what the author has observed are really degenerative changes taking place in cells that are slowly dying. At any rate, as the writer very justly points out, no one has previously observed [illegible]sion of the ordinary polymorphonuclear leucocyte, the[illegible]s been searched for during half a century. Among [illegible]stances, extracts of decomposing animal tissues have [illegible] inducing the above changes in the white blood cell[illegible] suggestion is very reasonably brought forward that [illegible] of these substances may be the determining factor [illegible] proliferation that takes place in a healing wound. [illegible] last few chapters are devoted to some theoretica[illegible]ations regarding the cause and cure of cancer.

The book is well written and well illustrated [illegible] micro-photographs. Some of the observations described [illegible] have already appeared in the journals, but do not appear to have been well received by pathologists generally.

METEOROLOGY.

Southern Hemisphere Surface-Air Circulation.—By WILLIAM J. S. LOCKYER, M.A. (Cantab.), Ph.D. (Gottingen), F.R.A.S. 110 pages. 15 plates. 12-in. × $9\frac{1}{2}$-in.

(Wyman & Sons, for the Solar Physics Committee. Price 6/-.)

A most interesting and instructive study of air movements in the southern hemisphere during the winter—April to September—months. There appear to be a series of anti-cyclones, or high pressure swirls or eddies, travelling constantly eastward. The areas of these vary somewhat, being larger in winter, and smaller in summer. The centres in winter travel nearly along parallel 34° south, the circulation of the eddy being in the direction S.E.N.W. They appear to travel over land at the mean rate of about 11°·5 daily in longitude, but over the oceans at about 9°·2, giving a mean rate of 10°·7 per day around the earth, completing the circuit in 33·6 days. The path of these systems is instructive. They seem to follow almost truly along the line of latitude across the wide expanse of the Pacific Ocean, then, when met by the Andes chain near the west coast of South America, they turn very abruptly south, and after breaking through the mountains curve north again, and travel direct over the Atlantic, but follow the coast-line south of Africa. Thence direct across the Indian Ocean and Australia. Again, over the South Pole there is another anti-cyclonic region, not indeed having the pole quite central, but crushed down, as it were, directly below South America. Between the anti-cyclonic systems there travel in the same direction, but rotating S.W.N.E., a series of low pressure eddies or cyclones. The path of these is near latitude 60° south. For the "reason why" of these movements we cannot do better than advise those interested to study the memoir. The results are obtained from the observations made at about fifty stations, supplemented by the work at eight stations occupied by Antarctic expeditions. In going through the volume it seemed unfortunate that there could be no report from Tristan Da' Cunha, which would be like a connecting link between America and Africa.

PHYSIOLOGICAL CHEMISTRY.

Practical Physiological Chemistry.—By R. H. ADERS PLIMMER, D.Sc. 270 pages. 10-in. × $6\frac{1}{2}$-in.

(Longmans, Green and Co. Price 6/- net.)

Physiological Chemistry, it will be remembered, deals with the composition and properties of those carbon compounds which are constituents of living matter, and are concerned in vital processes. The Chemistry of the chief organic constituents of the human body and its secretions, and of the principal food-stuffs, are dealt with, from the practical standpoint, in the work before us. The present volume was, in fact, as we are reminded in the preface, originally compiled as a handbook for the practical work in Physiological Chemistry at University College, London. The text is conveniently arranged in paragraphs with headlines, while the descriptive matter is printed in large, and the practical work in smaller, type, and the author's name is a sufficient guarantee that every statement therein contained is in accordance with the most recent researches in this rapidly extending science.

A good many excellent illustrations of the microscopic appearance of crystals of various organic substances are reproduced in the volume, and a coloured plate of the spectra of haemoglobin and allied compounds forms a useful frontispiece. A list of reägents of use in Physiological Chemistry, with the exact strength and mode of preparation of each, is given in the appendix, and there is also an excellent index. The volume is destined to become the standard class-book of Practical Physiological Chemistry.

PHYSIOLOGY.

Preliminary Physiology.—By William Narramore, F.L.S. 220 pages. $7\frac{1}{2}$-in. × 5-in.

(Methuen & Co. Price 3/6.)

Nowadays every elementary teacher of every elementary subject regards it his duty or his privilege to bring out an elementary text-book in which to display his elementary knowledge of that subject. Such a book we have now before us. The elementary error that "at the moment of swallowing . . . . the epiglottis closes over the glottis," is repeated throughout its pages and even figured. Again, on Page 72 we read that, "Many of the white corpuscles contain more than one nucleus," the truth being that, while all the white corpuscles are uninucleate, most have a more or less branched nucleus, which might appear multiple to the casual observer. In the preface we read that, "The illustrations for the book have been prepared especially to help the teaching in the text." In this they succeed admirably, for many of them are equally inaccurate. The diagram of the nose on Page 172 gives one an entirely false idea of its bony structure, and the imaginative picture of the epiglottis neatly closing over the glottis, shown on Page 97, has already been referred to.

The one redeeming feature of the book is the series of micro-photos of animal tissues beautifully reproduced in the form of plates. Some of these, notably those representing the minute structure of skin, bone and muscle, are really excellent and worthy of a place among better surroundings. There are so many admirable text-books of elementary physiology, that we find it impossible to recommend the example now before us.

The Physiology of Reproduction.—By Francis H. A. Marshall. 706 pages. 154 illustrations. 9-in. × 6-in.

(Longmans, Green & Co. Price 21/- net.)

This book is a carefully-written and most exhaustive treatise, dealing with the times at and periods during which various animals breed, and the changes that take place in the reproductive organs, including those of the female when pregnant. Comparisons are drawn between man and other animals, and the birth-rate is discussed. An interesting chapter deals with the factors that determine sex, and the book concludes with a consideration of the phases in the life of the individual.

Of Distinguished Animals.—By H. Perry Robinson. 234 pages. 50 illustrations. $7\frac{3}{4}$-in. × $5\frac{1}{4}$-in.

(William Heinemann. Price, 6/- net.)

Portions of this most interesting volume appeared in the *Times* during 1909, under the title of "Studies in the Zoological Gardens." Those who enjoyed the articles then will welcome their publication in book form, more especially with the addition of the very excellent photographs taken in Regent's Park. All lovers of animals will read with great pleasure the racily-told anecdotes concerning the wild creatures, while the amount of information given anent them will cause future visits to the Zoo to be more enjoyable than ever.

Reptiles of the World.—By Raymond L. Ditmars. 373 pages. 89 plates. $9\frac{1}{4}$-in. × $6\frac{1}{4}$-in.

(Sir Isaac Pitman & Sons, Ltd. Price 20/- net.)

In this book, which is at once remarkable for the value and beauty of the illustrations, the classification of Dr. Boulenger has been generally adopted, and from it it is possible to get an excellent idea of recent reptiles. Various families are considered and tables are given of the genera, with the number of species known. Habits are touched upon and some details are included as to methods of feeding the animals. Besides the excellent pictures of the complete animals various parts are illustrated, such as the spurs of the Indian Python, which are the external portions of the well-formed hind legs possessed by members of the family Boidae. Another most striking illustration is of the head of the Pit Viper (a New World rattlesnake) showing the fangs.

The Airy Way.—By George A. B. Dewar. 253 pages. $7\frac{1}{4}$-in. × 5-in.

(Chatto & Windus. Price 6/- net.)

This book is a series of essays, written in Mr. Dewar's well-known manner, which deal principally with flight; and such various creatures as butterflies, birds and bats are discussed because they are all endowed with wings. There is, however, much dealing with rural life and natural history, which goes to make an interesting volume.

NOTICES.

LESSONS IN NATURE STUDY.—A great deal of good might be done if schools would take advantage of the specimens of a seasonable character, accompanied by outline notes, which Mr. J. F. Rayner, of the Botanical Garden and Laboratory, Highfield, Southampton, is now sending out for the use of schools and teachers generally.

FORTHCOMING BOOKS.—Messrs. Bailliere, Tindall and Cox announce that they are publishing immediately the following books:—"Atlas of First Aid," by B. Myers; "Military Sanitation," by L. B. Knox; "Micro-organisms," by M. Herzog.

The English translation of Professor Henri Bergson's most important work, *Creative Evolution*, will be published on March 3rd, by Messrs. Macmillan & Co. The book is arranged in four chapters, with the following headings: I. The Evolution of Life—Mechanism and Teleology. II. The Divergent Directions of the Evolution of Life—Torpor, Intelligence, Instinct. III. On the meaning of Life—the Order of Nature and the Form of Intelligence. IV. The Cinematographical Mechanism of Thought and the Mechanistic Illusion—A Glance at the History of Systems—Real, Becoming, and False Evolutionism. The translator, Dr. Arthur Mitchell, refers to the help he received through the friendly interest and assistance of Professor William James, who, had he lived to see the completion of the English edition, had intended himself to introduce the work to English readers in a prefatory note. The author has himself carefully revised the whole work.

SPECTROSCOPIC APPARATUS.—We have received the revised and enlarged edition of Messrs. Adam Hilger and Co.'s general catalogue, in which there are illustrated and described a large series of spectrometers, spectrographs, polarimeters, and refractometers, together with the accessories that are required, and a list is given of the special sensitive plates manufactured for spectrographic work by Messrs. Wratten and Wainwright. A sectional list has also been issued by the same firm, dealing with Echelon diffraction gratings and Lummer-Gehrcke parallel plates.

A NEW TYPE OF PHOTOMETER.—Messrs. R. & J. Beck have brought out an instrument (The Holophane Lumeter) which they claim to be the first made for measuring the intensity of light as seen by the eye and not emitted from a light source. It is a small portable instrument, containing an illuminated disc with an aperture in the centre through which the object to be examined is looked at. The illumination of the disc is then adjusted until it is the same as that of the object to be tested when the brightness of the latter can be immediately read off on a scale of candle-feet. There are many uses to which such a photometer may be put—for instance, it can be used to ascertain whether the light on a book is sufficient to read by without straining the eyes.

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, 1911.

SOIL BACTERIA AND CROP PRODUCTION.

By H. B. HUTCHINSON, D.Sc.

During the last thirty years the methods of estimating soil fertility have undergone considerable change. The crude chemical method of determining total soil constituents has given place to one more nearly approximating that of the plant itself, and the value of the results so obtained has been considerably enhanced by the consideration of the mechanical composition of any given soil.

Within the same period the old conception of the soil as being merely a store-house of plant food has given way and soil is now regarded rather as a medium in which myriads of micro-organisms exist and exert their influence. The dissolution of plant and animal remains and the consequent production of substances capable of subserving plant growth is the work of soil bacteria. Since nitrogen is the most valuable soil constituent, it is not surprising that the organisms responsible for various reduction and oxidation changes such as ammonification, nitrification, nitrogen-fixation, and so on, have received most attention, while those inducing cellulose fermentation and changes in sulphur and iron compounds have been less studied.

FIGURE 1.
Wheat Growing in Partially-sterilized Soils.
Left to Right: Untreated, Toluened, and Heated Soil.

Although the activities of this micro-flora result in the production of plant food, it would be fallacious to assume that this represents in any adequate measure the total changes occurring in the soil. Decomposition of highly-organised nitrogenous bodies may be accomplished, nitrates formed, and nitrogen may be fixed, but a portion of this elaborated material may be lost again by the action of other organisms. Symbiosis and antagonism between soil organisms have been observed in many instances, and recent investigations indicate in a striking manner the far-reaching effect of another factor inimical to bacterial growth.

The extent to which this factor exerts an influence is shown by results obtained from experiments on the partial sterilisation of soils. Numerous workers have shown that if a soil is subjected to the action of heat or of mild antiseptics, an increase in the fertility of that soil ensues. In the former case high temperatures (95° to 100° C.) were adopted, and no doubt led to a certain amount of chemical decomposition of some of the soil constituents. Direct chemical action, however, is insufficient to account for the increase in fertility.

The use of volatile antiseptics seems to have been first introduced by Oberlin for the destruction of the phylloxera disease of the vine. The favourable results obtained by the use of carbon disulphide led to trials with other crops with equally good results. Obviously, the benefit could not be due to any diminution of plant diseases, but to a stimulation of processes concerned in the nutrition of the plant, or of those occurring in the soil itself. Koch regarded this increased fertility as being due to a stimulation of the plant by small quantities of the antiseptic remaining behind in the soil after treatment, while Hiltner and Störmer attributed it to the destruction of nitrate-decomposing bacteria, and to a subsequent growth of humus decomposers—the various species of Streptothrix. Further it was supposed to be due in part to an increased growth of those bacteria which produce nitrates or assimilate atmospheric nitrogen.

For some time this problem has been studied by Dr. E. J. Russell and the Author, and the probability of the existence of an altogether different factor has been indicated. Our initial experiments were designed to show the actual increase in fertility as measured by plant growth. Samples of soil were carefully sieved and filled into glazed pots, which were then divided into three sets. One set remained untreated, a second set was heated to 100° C. for three hours, while a third was partially sterilised by the addition of four per cent. toluene and afterwards freed from this substance by exposure to the air. Various crops were grown in these soils—buckwheat, rye, mustard and wheat—and the results obtained with rye may be taken as typical. Table A gives various data as to the weights produced, while Figure 1 is from a photograph of some young wheat plants growing in the respective soils.

The use of partially sterilised soils for plant experiments has two distinct effects: there occurs a striking increase in the weight of crop, varying from twenty to over two hundred per cent. and, further, there is almost invariably an increase in the nitrogen content of such crops. Other experiments have shown that the latter is due to an assimilation of nitrogen as ammonia instead of as nitrates as is normally the case; mild antiseptics and moderate heat are sufficient to destroy the nitrifying organism. In order to follow the various chemical and bacterial changes, samples of the respective soils were stored in sterilised bottles and analysed at certain intervals. Chemical analyses revealed the fact that a rapid decomposition of the nitrogenous constituents of the treated soils, with ammonia production, was taking place, while the untreated soil slowly produced nitrates. Bacteriological analyses demonstrated an initial drop in the number of organisms present, with a subsequent rapid increase, until at the end of a few weeks the toluened soils contained five to eight times the number of bacteria as the untreated soils. These changes are shown in Table B.

The connection between bacterial activity and the production of plant food is obvious from the above

Soil.	Weight of Green Crop.	Weight of Dry Matter.		Percentage Composition of Dry Matter.		
		In Grams.	Relative Weights	N	P_2O_5	K_2O
Untreated	103·95	37·14	100	·698	·59	1·05
Heated	162·10	59·30	160	1·147	·64	1·28
Toluened	120·07	44·76	120	·742	·54	1·01

Table A.

Treatment of Soil.	Total Nitrogen as Ammonia and Nitrate. Parts of Nitrogen per Million.			Bacteria per Gram of Soil. In Millions.		
	At beginning.	After 23 Days.	Gain.	At beginning.	After 23 Days.	Gain.
Untreated	13·8	17·7	3·9	6·76	9·81	3·05
Heated (98° C.)	19·5	55·8	36·3	·000007	5·23	5·23
Toluened	17·0	39·8	22·8	2·84	40·62	37·78

Table B.

results, and the assumption that increased fertility was due to a bacterial rather than a chemical cause, appeared justified. Such being the case, a closer study of the bacterial flora of the various soils was undertaken and an attempt was made to account for the enormously increased numbers. Definite quantities of the soils were introduced into solutions containing peptone, urea, hay-dust, and so on, and the amount of ammonia produced after certain intervals was estimated. In almost every case it was found that the cultures containing toluened soil were more capable of decomposing the substances supplied. This result could be induced (*a*) by a greater virulence of the toluened soil bacteria, or (*b*) the presence of some inhibiting factor in the untreated soil. Experiments where toluened soil was inoculated with bacteria from untreated soil gave, however, a more vigorous decomposition, and a higher bacterial content than a toluened soil alone, thus showing the superiority of normal soil bacteria over those persisting after

FIGURE 2.

Gelatine Plates showing relative numbers of Bacteria in Untreated, Toluened, and Heated Soils. Bottom, Left-Hand: Untreated Soil. Top: Heated Soil. Bottom, Right-Hand: Toluened Soil.

Treatment of Soil.	Bacteria per gram of Soil.			Total Gain in Nitrogen as Ammonia and Nitrates after 57 Days.
	After 38 Days.	After 61 Days.	Gain.	
1.—Untreated Soil	7,500,000	9,500,000	2,000,000	2·5
2.—Toluened Soil	31,800,000	60,100,000	28,300,000	24·3
3.—Toluened Soil + sterilised extract of untreated Soil	31,600,000	67,000,000	35,600,000	23·4
4.—Toluened Soil + non-sterilised extract of untreated Soil	45,200,000	166,600,000	141,400,000	43·7
5.—Toluened Soil + 5% untreated Soil ...	46,900,000	48,000,000	1,100,000	20·3

TABLE C.

treatment with the antiseptic. This point having been cleared, it became necessary to search for a limiting factor in normal soils. It was not possible to demonstrate the presence of injurious bacteria nor that of any toxic body. On the contrary, an extract from untreated soil, that is, liable to contain any soluble toxin or toxic organisms, produced a vigorous decomposition, but similar experiments where toluened soil was inoculated with small quantities of untreated soil, showed the limiting factor to be transmissible in soil itself. When, for instance, toluen[illegible]s mixed with five per cent. of untreated soi[illegible]ed an initial increase in bacterial growth and [illegible]roduction, but these changes were retarde[illegible]rse of a few weeks. [illegible]le C.)

It is app[illegible] the above, that [illegible]der-able bacterial grow[illegible] pro-ceeded in three [illegible] the five soils, it has [illegible] stationary in the un[illegible] soil and toluened soil [illegible] five per cent. untreated soil. This condition, however, only begins to be evident some weeks after the beginning of the experiment. In fact, during the period up to the thirty-eighth day, the toluened soil receiving untreated soil possessed the highest bacterial content. In brief, the limiting factor appeared to be of a biological nature, possessing the following properties:—(*a*) destroyed by heat and volatile antiseptics, (*b*) incapable of passing through filter paper, (*c*) contained in small quantities of soil, (*d*) capable of growth, and of reducing the numbers of bacteria. It appeared to exert a limiting effect either by competition for nitrogenous foodstuffs, or by destroying the bacteria in the soil. A search was then made for organisms larger than bacteria, and, by the aid of special media, protozoa were found in the untreated, but not in the treated soils. The influence of soil protozoa upon bacterial change was demonstrated by adding cultures of these organisms to flasks containing extracts of untreated and toluened soils and peptone solution, and estimating the amount of ammonia produced after a given period. In this manner we were able to depress the activity of the toluened soil bacteria to a point below that of the untreated soil bacteria.

Many different species of soil protozoa have already been isolated, chief among which may be mentioned Pleurotricha, Colpoda, Vorticellids, Amoebae, and Monads. A large number of soils have been examined, and these organisms would appear to be of universal occurrence; their number varies with different soils, and at different depths of the same soil.

A study of their behaviour towards various physical and chemical agents has suggested fresh lines for investigation in connection with soil fertility. Experiments have shown the thermal death-point of protozoa to lie between 43° and 48° C., and it has been found that if a soil be heated to 50° C. instead of 100° C., as formerly, a change occurs similar to that produced by toluene. The relations of protozoa to intense cold or thorough desiccation are still being investigated. It is commonly believed by practical agriculturists that a sharp hard frost conduces to increased crop production and in the light of the above results it would appear to be justified, as extreme cold for a short period is sufficient to kill many protozoa. The Indian practice of cultivating and pulverising the soil during the hot dry season would appear to rest upon a similar foundation.

FIGURE 3.
From a Photo-Micrograph (Pleurotricha, one of the Protozoa occurring in Soil).

In this country where extremes of cold, heat, or dryness scarcely ever prevail for any considerable period, any effectual method of partially sterilising the soil would necessitate the use of cheap antiseptics or the application of temperatures easily obtained in market gardens and glass houses.

Whatever success may be gained in the adoption of the methods of partial sterilisation on a large scale, it becomes evident from the above results, that a fresh factor must be recognised in the estimation of soil fertility. In the meantime much work remains to be done in the study of the relations existing between bacteria and protozoa and the conditions governing their growth in the soil.

METEORIC ASTRONOMY.

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

The claims of meteoric astronomy as an attractive field of observation, and as a subject of investigation likely to expand our knowledge, are great—yet it must be confessed that it is not studied as it should be.

A large amount of useful work was accomplished by the British Association Committee on luminous meteors, between 1848 and 1880, and certain individuals have contributed a considerable amount of data to this department, but much more remains to be done. The southern sky is still practically unexplored.

Meteors not only permeate our solar system but probably circulate far outside that and may indeed pervade the whole universe of stars. If the latter are suns with planetary satellites then fragmentary atoms probably abound, some in the form of cometary swarms, others in more tenuous streams. In fact, wherever planetary systems exist we may take it that meteoric particles, forming as it were the dust of such systems, are also present in considerable numbers. And across the wide and incomprehensible abyss separating one sun from another meteors may roam in hyperbolic or parabolic orbits. The far-reaching relations of these objects, their vast numbers, and cometary associations render them of extreme interest and importance. We must learn more of the phenomena which they present in our terrestrial skies, so that we may judge of their character and behaviour in the remoter regions of space.

For the present it seems that the photography of meteors has failed to supply us with an effective and accurate means of recording their flights on ordinary nights of the year. We must continue therefore to follow the old and rough method of registering paths and determining radiants. When we consider, however, that radiation forms an area not a point, and that eye-estimates of the directions of flight may, after sufficient practice, be made with a precision almost equal to photographic trials, the latter has really only a slight advantage.

The chief periodical showers of the year have been watched for many years, and a large amount of evidence concerning their displays has been accumulated. Still the materials existing are far from being of the character or extent required. We want more data as regards the long duration of showers and as to their stationary or shifting positions of radiation. The radiant points of the principal streams should be determined on ten or more nights near the date of maximum in cases where the showers are active so long as that.

RECENT INVESTIGATIONS ON AURORA BOREALIS.

By OUR BERLIN CORRESPONDENT.

ACCORDING to a hypothesis suggested by Professor Birkeland of Christiana University, auroras are due to cathode rays given out from the sun, and which on their way through the cosmic space would converge towards the magnetic poles of the earth, thus producing a bright fluorescence in the surrounding air.

FIGURE 1.

FIGURE 2.

The Aurora Borealis.

In fact, when arranging below a Crooke's bulb a very strong magnet, the cathode rays are seen to converge towards this, like light rays converging towards the focus of a lens. This phenomenon Professor Birkeland denotes by the name of "suction effect" of the magnetic pole.

When a discharge bulb with a minute "magnetic earth" suspended in its interior is lined with a layer of platinum-barium cyanide, any spot struck by the cathode rays becomes distinctly visible.

By varying this experiment, there are obtained the most manifold fluorescent forms reminding in all details of auroras. In order to test his theory, Birkeland also undertook three voyages of discovery to polar regions, from which he brought home many valuable data on the aurora borealis and the concomitant magnetic disturbances.

His colleague, Professor Carl Störmer, of Christiana, in a memoir recently submitted to the Fourth International Congress of Mathematicians, then established a theory of the phenomenon, showing all its details to be perfectly accounted for on the above hypothesis. He also worked out a new method of aurora investigation by photographic records.

In view of the inadequate luminous intensity and great mobility of auroras, it had so far been considered impossible to fix the phenomenon photographically. Professor Störmer, however, realized that by choosing a proper combination of objectives and photographic plates, sufficient sensitiveness could be insured. By means of a cinematographic objective one inch in diameter and two inches in focal distance and violet-labelled Lumière plates, he then succeeded, on a voyage to Bossekop (Finmarken), in February and March 1910, in obtaining four hundred satisfactory aurora photographs out of a total of eight hundred, with exposures varying between a fraction of a second and twenty seconds, according to the luminous intensity of the phenomenon.

One of the most valuable uses these photographs can be put to, is measuring the altitude of auroras and ascertaining their accurate position in the cosmic space. To this effect the position of the aurora in regard to the surrounding stars should be compared on two photographs taken simultaneously from two stations connected by telephone. A systematical application of this method (a report on which was recently presented to the French Academy of Sciences) will doubtless give the most valuable results.

SCIENCE IN EVERY-DAY LIFE.

By Rev. H. N. HUTCHINSON, B.A., F.G.S., F.Z.S.

In the opinion of the present writer, one of the first things to be done by women of the upper and middle classes, is to abolish the private kitchen. Such a plan would save space in the house: a sitting-room for domestics is highly desirable, and the kitchen could be made into such a room. It would save a vast amount of trouble, anxiety and worry. In every street there should be a large kitchen and confectioner's shop. The lady of the house could, each day, order her meals by telephone, and the food could be sent out in wooden boxes for each meal, just as dinners and suppers are provided by the college kitchens of Oxford or Cambridge. The writer has advocated this plan for thirty years; but the habits of a nation are not easily changed. The waste involved in private kitchens is enormous. Food would be of the best under this plan, and it would afford a much greater range of choice. Companies could be started to supply this great want, and contracts might be made quarterly or yearly. Let the ladies seriously consider this proposal, for it is certainly within their power to devise ways of carrying it out.

The danger of fire is considerable, and yet few householders take any precautions to diminish the risk. There is no need to go to any great expense; for hand fire extinguishers can now be obtained at reasonable prices. Two or three fire-buckets might be placed on a landing. A hose-pipe from the bath-room might be effective at the beginning of a fire. In tall London houses, a good plan is to provide one of the top bedrooms with a long rope, so that the inmates could let themselves down to the ground. A stout hook should be fixed just above the window.

Young people are inclined to be careless about their clothing, and in this matter parents should see to it that their sons and daughters do not risk their lives by wearing thin garments in the spring time, or in the cool evenings of May and June. By such simple precautions much lung disease, rheumatism, and so on, might be avoided. It need hardly be said that certain fashions, *i.e.*, high-heeled boots, are scientifically wrong and absurd. But probably no considerations of this kind will have the slightest influence in modifying a foolish fashion, involving serious danger to the human body. We therefore pass on to the subject of "air." People talk much about ventilation, especially in public rooms and places of entertainment, but at the same time such people often pay little attention to the ventilation of their houses or flats, or it may be lodgings. In all our big towns thousands of people live much of their lives in stuffy little rooms, where they cannot possibly get all the air they need to keep in health and to digest their food. Of late years there has been marked improvement in this matter, owing to the greater use of electricity for lighting purposes. But one still sees many rooms (often of but small size) lighted by gas. Now this is really a grave evil, and the cause of an immense amount of ill-health and suffering. Those who live in such rooms are simply breathing poisoned air, all the time that the gas is burning! What it means those who have learned a little chemistry can readily comprehend. Each gas-burner is pouring into the room a constant stream of carbonic acid and sulphur dioxide, two poisonous gases. Fortunately a little air enters from under the door, drawn by the heat of the fire, otherwise the inmates of the room would be suffocated. Such a use of gas ought to be strictly forbidden. By a simple plan, which the writer has often advocated, this grave evil can be avoided. Any plumber or builder could easily devise a method of drawing away all gaseous products of decomposition. One plan would be to have the lights in the ceiling, but enclosed, as is often seen in railway carriages. Another way would be to provide a fairly large glass or metal funnel to hang over each gas bracket—to the top of this funnel a pipe could be fixed of sufficient diameter to take away all the foul air, either into the chimney or through a hole in the wall. Central chandeliers might be taken away altogether, and their place supplied by the ceiling light, as described above. A third device would be small brackets on the walls, each enclosed in an artistic glass case, with pipes to conduct the bad air to the chimney, or through the walls to the outside. In this simple manner the air of our rooms might be kept just as pure and fresh as in cases where electricity is the lighting agent. No matches need be used, for every burner would be provided with a by-pass, for lighting and for turning down, and, of course, incandescent mantles should be adopted on account of the increased light they afford. Builders of small houses should be compelled by law to provide for some such plan, or, at least, gas-fitters should be forbidden to fit gas-burners in such a way that the products of combustion cannot be led away from the rooms. If householders would adopt this simple plan they would not only get their rooms lighted cheaply, but they would help to make it more largely used, and so, before long, obtain a considerable reduction in the price thereof; also explosions would be almost impossible.

With regard to the heating of houses we are working on wrong lines. The usual method is unsatisfactory in every sense (except artistically) and quite unscientific. So here is a matter in which reform is greatly needed. The use of coal in fire-places not only causes smoke with all its grave evils, but involves a waste that is truly prodigious! We must consider not only the waste of useful carbon and so of heat—that is bad enough, especially in its indirect results—but we have to consider the loss of those extremely valuable bye-products that might be obtained if the same fuel were heated in retorts and made to yield up its gas. The wealth of England is partly due to its splendid coal-fields. Coal being part of the national wealth, it should be the aim of all good citizens to prevent the waste of it. But as things are we allow a large part of our wealth to escape up the chimney. This is bad science and worse political economy; it means we are spending capital as well as income; but unless the women will approach the subject in a different spirit there is not much prospect of reform.

To make the matter clear, it will be necessary to explain very briefly what happens in the manufacture of coal-gas. Coal is heated in closed vessels called retorts and the gases driven off led away into gasometers, and thence to the mains that supply our houses. Now the three chief residual products of this process are: coke, an ammoniacal liquor, and coal-tar. The coke is principally used in manufactures; its value depends on the kind of coal from which it is got; some kinds yield a coke of great value commercially, the gas companies deriving a large income from its sale. To some slight extent it is used in domestic grates, especially in kitchen ranges. But the second product, ammoniacal liquor, is still more important. A ton of cannel coal will yield eighteen to twenty pounds of ammonia (in the form of sulphate), ordinary coal yields about sixteen pounds. The chief use of the sulphate of ammonia is as a fertiliser of soils, and for this purpose it realizes good prices. The third bye-product is tar liquor. This substance yields, by distillation, a wide range of products of great and increasing industrial value. In the process some highly volatile products are given off—consisting principally of benzol and afterwards a large amount of light oil called "naphtha" (a mixture of hydro-carbons). At this point the residue in the retort is called "artificial asphalte," and as such has a commercial value. But if the heat is forced and distillation continued a large amount of heavy oil is obtained, and the mass left in the still is hard pitch. The heavy oils are a mixture of naphthalin, phenol (carbolic acid), cresol (cresylic acid), and anthracene and so on. The benzol obtained in the first stage of distillation is the basis of aniline and its various dyes. Naphtha is used as a solvent and in other ways. Carbolic acid is largely used as a disinfectant and also is the basis of many valuable dyes. Anthracene is the basis of a very valuable dye called "artificial alizarin" and most of the above substances have other applications of minor importance. The following figures, kindly supplied by the secretary of the Gas Light and Coke Company, may be quoted here. For the year ending June 30th, 1910, this company purchased coal to the value of £1,052,000. The revenue from coke was £536,000. Sulphate of ammonia and cyanogen products yielded £184,000. From the latter are obtain[illegible] cyanide, largely used in gold mining, Pruss[illegible] and so on, used for other chemical processes. [illegible] bye-products e.g., tar, pitch, creosote, b[illegible] anthracene brought in a revenue of £95,0[illegible] [illegible] thus be seen that the total revenue f[illegible] products amounted to the large sum of £[illegible], over three-quarters of the value of the coal [illegible]

The above very brief account suffices [illegible] that several important industries depend upon [illegible]ing. Consequently the more gas is used for "[illegible]" heating, cooking and lighting, as well as pr[illegible] motive-power by working gas engines, the more men and women will find employment in these industries, thus at the same time earning a living for themselves, and increasing the natural wealth of the country.

In the last ten years or more, enormous improvements have been made in the domestic fire grate; it is now not only more artistic, but much more effective and economical, and thus a further step has been gained in diminishing smoke production in large towns. Many attempts have been made to construct a smokeless domestic grate, but this is almost impossible; for when once the heavy carbonaceous smoke has been produced, it is very difficult to burn away the carbon particles completely, on account of the large volume of nitrogen present with the oxygen in the air passing up the chimney. So that the best method of preventing smoke is to put on the coal in very small quantities. Another good plan is to burn wood or coke with the coal. The use of anthracite coal would result in a smokeless and very hot combustion, but it is difficult to light and also requires a special stove. Consequently the initial cost largely stands in the way of the general use of anthracite for domestic use, and also it is obvious that any great demand for such coal would create so great a rise in prices as to render its use prohibitive, the supply being limited. The use of half-baked coal is not a new idea, but since "Coalite" was put on the market attention has once more been turned to this method. The "Coalite" process has one advantage, viz., that the fuel is of greater uniformity, and the yield of tar is doubled, instead of being decreased. In the opinion of a leading chemist, "Coalite" will be the ideal fuel for home use, but to the present writer it seems that the only satisfactory solution of the problem lies in the abolition of coal-fires, their place to be taken chiefly by gas-fires and gas-stoves. This is, undoubtedly, the proper scientific way of solving the smoke problem, and of preventing the waste of precious coal. Not that it is the only solution, for in larger houses, hotels, public buildings, colleges, and such places, hot water heating is almost a necessity. The furnace in those cases might be constructed to use gas instead of coal. Electric radiators might with advantage be used in small rooms, and for warming odd corners. At present, however, they are expensive. For some years past, as all Londoners thankfully recognise, London fogs have been much fewer and far less dense than was formerly the case, and it is generally recognised that this welcome improvement is chiefly due to the more general use of gas-stoves and gas-fires. Having used gas-stoves for many years, the writer has no hesitation in recommending them. If properly fixed up by a competent fitter, there is an entire absence of smell in the room. At the back is a flue-pipe to carry away the gaseous products of combustion. This should be fairly long—say, three feet at least—and carefully fixed on the stove in such a way as to avoid any leaky joints. This is most important. It is best to fill up all the space between the stove and the surrounding fireplace. Ladies appear to have a prejudice against the gas-stove, which is a pity. They must, however, admit that an immense amount of labour is saved by their use, and that dust is entirely avoided. There is this further advantage (especially in bedrooms), that a gas-stove can be regulated to a nicety, and turned off when no longer required.

Professor Vivian B. Lewes, lecturing on December 8th of last year before the Royal Institution, said: "The principal cause of the cloud which hangs over our big towns, cutting off the direct rays of the sun and ruining health, varies with the locality. In the South of England it is the domestic grate, using bituminous fuel, which is responsible for the major portion of this pollution of the atmosphere; whilst further north, in the great manufacturing centres, it is the factory shafts which emit the pall of black smoke that aids in shortening life and killing vegetation, and which begrimes and finally helps to destroy our public buildings."*

One frequently hears London ladies complaining of the dust and dirt that blackens windows, ceilings, pictures, hangings, clothes, and so on. But it is in their own hands that the remedy lies. Let them abolish coal-fires!

SOLAR DISTURBANCES DURING FEBRUARY, 1911.

By FRANK C. DENNETT.

Although meteorological conditions have been very unfavourable during February, it has been possible to obtain a fairly regular record. Somewhat greater activity has been noted. The surface appeared to be quite free from disturbance upon February 2nd, 3rd and 25th, and none was seen on the 8th and 23rd. Only faculae were visible on the 1st, 22nd and 24th. On February the 1st, at noon, the longitude of the Central Meridian was 246° 18′.

No. 2.—First seen on February the 10th as a fair-sized spot a few degrees from the eastern limb, solitary, with faculae around, but mostly to the east. Upon the 11th and 12th it contained three or four umbrae; the diameter was 14,000 miles. From the 13th until the 15th the spot seemed shrinking, and its umbra crossed by a bridge, with three tiny pores close north to east on the 14—15th. The dwindling spotlet was last seen as a pore on the 20th.

No 2*a*.—A pore amid the faculae about 52,000 miles to the rear of No. 2 upon the 11th. Three or four pores upon the 12th, and next day a curve of pores like part of an elliptical ring, and containing one of a larger size. On the 14th, this group presented a somewhat peculiar appearance—a double umbra partly surrounded by penumbra, and further east, a group of umbrae almost like a capital F, and two or three pores. On the 15th the rear spot was 9,000 miles in diameter, with a bridged umbra and a curve of pores from east to south, whilst ahead four pores outlined the form of a lozenge, and three others remained to the north-east. On the 17th the spot had shrunken to a pore, whilst larger spotlets had developed ahead; making the total length about 66,000 miles. Only one or two pores continued until the 19th and 20th, when last seen. The group was close to the faculic area C, in the chart for January.

No. 3.—On the 11th a group of pores 40,000 miles in length. A double pore acted as leader, having three tiny pores forming a triangle in the rear. On the 12th two pores only, in a faculic setting, which formed pretty curves. Not seen again. It was closely south-east of the place of No 1.

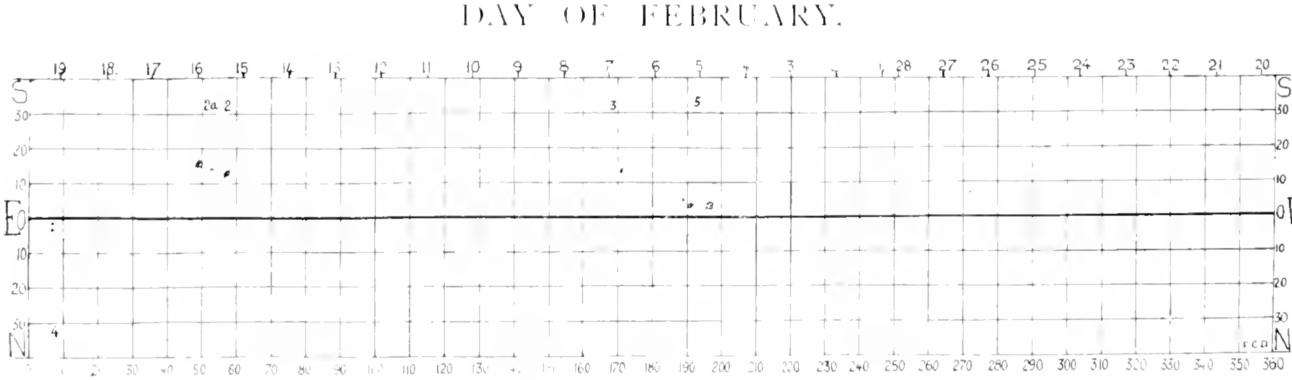
No. 4.—At 9.30 a.m. on the 20th two pores were easily seen and measured, both on longitude 7°, and some 11,000 miles apart. By 2 p.m. both had disappeared.

No. 5.—A single spot amid faculae, first seen near the eastern limb on the 26th. On the 28th there were two spots, and a few pores. The western spot contained four umbrae on March 1st, and during the day pores began showing farther east; on the 2nd the length of the outbreak was 57,000 miles. Only a few pores remained on the 5th, when last seen, but faculic disturbances marked the area as it drew near the limb on 8th and 9th.

On the 24th, on the south-western limb, in latitude 36°, there was a splendid prominence form some 110,000 miles in height.

The chart is constructed from the observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and the writer.

DAY OF FEBRUARY.



* See *Nature*, vol. 85, page 290, December 29th, 1910.

NOTES UPON THE FUNDAMENTAL SYSTEM OF STARS.

By F. A. BELLAMY, Hon. M.A., F.R.A.S.

OWING to the unfortunate delay, mentioned in the last number of "KNOWLEDGE," Professor Boss' arranged second visit to San Luiz, with the other members of the observing staff, Mr. A. J. Roy, Mr. Sanford, Mr. Zimmer, Mr. Fair, Mr. Gibble and Mr. Delavan, and with the instruments, was postponed to January, 1909, by which time it was expected that the observatory buildings would be ready for the instruments. Among the instruments were the Olcott meridian-circle, clock, chronographs, photometer, and other necessary apparatus. Immediately on arrival at San Luiz the various instruments were erected, and preliminary work was started. When the necessary adjustments were effected the actual programme of work, carefully arranged at Albany, was begun by the observers, and will be continued until completion; the whole work of observation was then expected to take about three years from the time of commencement (April, 1909). Professor R. H. Tucker will be left in entire charge of the observatory and work. This astronomer, who is probably the most skilled observer in meridional astronomy, is the assistant in charge of the meridian-circle at the Lick Observatory, and has been granted leave of absence from there for the express purpose of assisting in this important investigation. Professor Tucker was an assistant at the Albany Observatory thirty years ago; he was also the chief assistant for many years at the national observatory at Cordoba, Argentina, later on joining the staff at the Lick Observatory, where he has been for ten years engaged in important meridian work. Mr. Roy and Mr. Varnum are the two senior assistants at Albany, and are experienced observers with the particular instrument which is being used at San Luiz; moreover, it was they who largely contributed to the Albany observations of 1907–8; so we may hope for excellent and homogeneous results.

Owing to the extremely dry climate of San Luiz, the vegetation is scanty, except in places where resort is had to irrigation. The plot upon which the observatory stands is under irrigation and is covered with a luxuriant growth of *alfalfa**: the effect of this is of great importance, as it protects the soil and reduces the variations of radiation to a minimum, a most essential point to be considered in astronomical observations at low altitudes. The soil, under the rich surface layer of vegetable mould, is a sandy loam from three to five feet in thickness; under this is a layer of gravel of similar thickness, and below that a dry and hardened clay; this is considered to offer an ideal foundation for the piers of a meridian-circle. Within a week the true meridian was settled, plans were made for foundations, and the site was soon covered with bricks and mortar. The transit room, 22-ft. × 23-ft., is of brick, with a wooden roof; the office rooms, of one story, are of brick with a galvanized iron roof; the exterior dimensions are about 80-ft. by 60-ft., the central portion being arranged on the usual Spanish method with an interior court, or patio. The first stone was laid on October 5th, with a little ceremony, in the presence of officials and friends.

Having given a brief and general account of the causes which made this great piece of astronomical work necessary, and how it became possible to accomplish it, we will complete this article by giving a translation, containing more details, of a paper in Spanish read by Professor Tucker, before the American International Scientific Congress, held at Buenos Aires, Argentina, printed at the expense of the Department of Meridional Astrometry of the Carnegie Institution of Washington, U.S.A. American astronomers are greatly indebted to the munificent generosity of Mr. Carnegie for providing the money, without which this, Pasadena, and other astronomical researches could not be made, or, at least, could not be carried out so speedily or effectively.

THE FUNDAMENTAL SYSTEM OF STARS.†

There are two great and permanent problems in astronomy. One concerns the positions of the bodies visible in the Universe, and the other relates to the form, history, and constitution of those bodies. Of the second problem, the chemical constitution and the history of the evolution of the stars, the sun, planets, nebulae, and comets, are keeping the great telescopes, the photographic plates, and the spectroscopes, and other instruments well employed for their investigation; these instruments are of modern form.

For the first problem the Meridian Circle, though much older, has until now been the most perfect and most used instrument, though of less power, for the determination of the positions of these bodies. For the regular observations of transits of the stars, an instrument of this form has been erected in every case in the great observatories of the world.

* This is a species of lucerne.

† *El Sistema Fundamental de las Estrellas*, para R. H. Tucker, Observatorio de San Luiz, 1910, June 30th: translated by F. A. Bellamy.

The determination of the positions of the stars is the basis of all that we know of the movements of the sun, moon, planets, and, in fact, of the earth.

To fix the position of the system of the sun and our family of planets among the stars it is necessary to know, with every exactitude, the positions of the stars which serve as landmarks or guide posts in our journey. Not only is it necessary to know the positions now, in the year in which we live, but to compare them with the observations of former years from the earliest times of exact astronomical research. All the stars move: there is no exception according to the laws of our science; the difficulty is to distinguish between all these movements and the proper motion of the solar system. It is necessary to study the movements in all parts of the sky, and observe many stars in every part, in order to resolve the problem of the movement of the solar system. There is not a single place on the earth where all stars may not be observed with the necessary accuracy. At one observatory on the equator of our earth one could observe nearly all the stars; but here difficulties would arise owing to the small altitude of the poles, and one could not make exact observations under such conditions.

For a complete system of stars it is necessary to have at least two places for observation, one in the Northern hemisphere and one in the South. There will be many stars which it will be possible to observe in both places, and those observations will serve to bind or connect the results, and for comparing the conditions and results of a system which shall include all the sky. Already many thousands of observations of stars exist in the southern as well as in the northern sky; those observations were made in the early days when the first observatories were erected in the south. But errors of various kinds appear in all the observations. Some are explained by errors of the instrument, some by errors in the positions of the fundamental stars, others by the methods used in the calculations, others by the methods of observation. In general, these are a class of systematic errors peculiar to an instrument, to a star catalogue, or to an epoch: it is necessary to investigate all their sources.

The observations of the northern sky include similar kinds of systematic error as well; but the observations are much older, and there has been much more time for the study of the errors of method, and for comparing the results with the fundamental methods in use.

Each time that one employs these methods, it is possible to adjust or correct the observations to the same epoch, and likewise we are able to improve the results of the old observations. There is nothing new in that process; it has been used at various times for connecting the results of all observatories in the world, both in the north and south hemispheres. But, in general, the zone of stars which can be observed in both hemispheres has served to adjust or connect the system of the north with the system of the south. It is difficult to extend the range so as to embrace the positions from this zone, without deviation, from one pole to the other. Other difficulties exist and arise when various instruments are used, and when different methods of observation and calculation are employed in obtaining the data used in such a comparison.

Now we have a more complete plan for adjusting or connecting the observations of both hemispheres, by a fundamental method, and we hope that the results of this plan will serve to improve the positions of the stars in all the sky. It will be the foundation from which to compute new positions for our epoch, and the base for studying the old positions.

The Plan.

The plan includes:—

(*a*) The observations, *with one instrument*, of all the principal stars in the sky;

(*b*) the use of a fundamental method to fix afresh the positions of those which serve for the basis of the calculations;

(*c*) the investigation of the results of all observations by a uniform method;

(*d*) the comparison with the results of old observations by the use of these new positions;

(*e*) and the binding together into one system all observations from pole to pole.

One Instrument to be Used.

This is the plan which forms a part of the work of the San Luiz Observatory in Argentina. It is the first occasion on which one has used a single instrument for observations of this class of work in both hemispheres. The observations for this extensive plan were commenced in the city of Albany, U.S.A., some years before taking the instrument to San Luiz, and, after the conclusion of the observation of the more southern sky, the same instrument will be mounted, at another time, in its old place (at Albany) in order to complete the rest of the observations. The observations of the south will be made, therefore, in the middle of those in the north, so far as relates to the mean epochs. With the results of these observations made upon this plan, it will be possible to correct some of the systematic errors of the old catalogues; as also to form a new basis for a complete system of positions of the principal stars, and a connecting link for other stars which one may include in the same system.

With this object, it is necessary to form a plan of work which will be general and comprehensive, avoiding, as far as possible, the effects of systematic errors in the observations and in the calculations.

It is also necessary to study all the errors of the instrument and apply the proper corrections. Of these the most important are, the division errors or graduation of the circles, errors or inequalities in the form of the axes or pivots of the instrument, and the flexure of the telescope. There are also the corrections of the position of the instrument as in other classes of meridian observations. Besides these, it is necessary to investigate the personal errors: one that depends upon the magnitude of the various stars, and the other which depends upon the direction of movement of the stars in the field of view in the telescope. These errors are to be studied for every one of the observers of the commission.

Fundamental Method.

Of great importance is the use of the fundamental method, in the determination of the meridian line and for the correction of the astronomical clock. In the usual method the principal stars have served for these objects. One used one of the equatorial stars for determining the correction of the clock, and two of the circumpolar stars served for fixing the azimuth of the instrument or direction of the meridian. But in this simple use of the positions of the stars the errors of the positions adopted come into the calculations.

In the fundamental method, however, one does not adopt the positions of the stars, though they are better determined. In all there are some systematic errors: the errors of the observations, and the proper motions of the stars, during the years since they were revised, come in.

Each time that there is a new revision it is probable that the data is more exact. The object of the revision is to adjust all parts of the area of positions in such a way that no differences have entered into the results of the observations when they are made in the various regions of the sky, though it is necessary to use the positions of the stars in opposite parts. In the measurement of small arcs there are no great difficulties, the errors are unimportant; but in the fundamental method it is necessary to measure great arcs, even a complete circumference. In general the errors will be greater, and only by much attention to the observations and calculations can we avoid the increase of these indeterminable differences.

This is the first time that the fundamental method has been employed, to its fullest extent, in a South American observatory. In the fundamental method the direction of the meridian will be fixed by the transits of the same stars made above and below the pole. In this case the error of position adopted will have no increasing influence in the computations.

Instrumental Corrections.

The latitude will be determined by the same circumpolar stars. Other stars which come above and below the pole will serve for a fundamental determination of refraction. For this purpose the stars more distant from the pole, which transit at a small altitude, are selected. It is necessary to study the refraction at each place, especially when the observatory is at a considerable altitude above the level of the sea. For this study we have the combination of the observations at Albany with those at San Luiz. At one place it will be possible to observe the stars which pass in the zenith of the other, and verify, or ascertain, the effects of atmospheric refraction. We u[illegible]me instrument with the same circle-divisi[illegible]d the tube will be subjected to the same eff[illegible] when we measure it in the two places. [illegible]ossess the results of the measures extendin[illegible] north to the south pole in a complete sy[illegible]shall be certain that they will be indep[illegible] of the errors of the positions adopted fo[illegible] stars observed. The errors of observations in th[illegible]nith will be minute: and it will be possible to correct the observations of the circumpolar stars, by means of the new refraction, in such a manner that those will be more accurate. Also, we shall have a system of fundamental stars in all parts of the sky for adjusting the various parts. These fundamental stars will be observed in conjunction with the zenith and circumpolar stars.

Basis of Right Ascensions.

The elimination of the systematic errors in the right ascensions is another problem. A fundamental system should be based upon the position of the sun, finally: but there is no necessity to observe the transits of the sun in connection with all the observations. It is possible to fix the positions of the stars with that of the sun by means of the observations which have been made, and the observations which may be made, without adopting the position of any star whose position is well determined. Observations of the declination of the sun, combined with the observations of the stars, in any epoch, will serve to determine the difference of right ascension of these.

We adopt a system of right ascensions as the basis and with this proceed to the determination of the systematic corrections in the various parts. These corrections have a periodic character; so that, when they occur opposite star groups, with a difference of twelve hours in right ascension, the sum of the corrections will be almost equal, with contrary or opposite effect. From this periodic error the results, when the correction of the clock is determined by the observations of the stars in two groups, at an interval of twelve hours, can be freed of the periodic effect, if not completely, at least in a great measure.

For the change or rate in the correction of the clock, one uses the stars in the same group each day. Between the stars of the same group there is little variation, the positions will be very exact and greatly improved, but all those of a group can have the same systematic error.

For verifying the true meridian-line one can observe by day and by night an electric light, well fixed in the meridian, as an artificial star at a distance of one hundred meters to the north. The position of this light has been determined by observations of circumpolar stars, and one will pursue the determinations of this until the end of the work.

For ascertaining the amount of flexure of the tube of the instrument, one will make observations of the stars by the two methods, by direct and reflected vic . . using a trough of mercury for the reflected image. The use of this method is of great importance in the discussion of fundamental observations. For this class of observations calm nights are requisite, or those with extremely little wind.

Old and New Work.

These remarks aim at explaining the reason of the plan of the fundamental work, the study of all the instrumental and personal errors, the determination of the position of the instrument without using an adopted position of any star, and the determination of the correction and the change or rate of the clock's error by groups of stars in opposite parts of the sky.

This method entails more work, in order to measure from one star to another, than the method mostly in use. It is necessary to continue the observations at least for thirty-six hours, in order to include three groups of stars. The calculations are very heavy.

The corrections of the position of the instrument in a long period may alter sensibly, and it is necessary to study well the progress of all errors. The arcs between the stars are large and the errors of the observations are relatively increased. Finally, it is necessary to observe in the day time when the brighter stars only are within the limits of vision.

For these reasons, and because one can observe the small or fainter stars only at night, the method mostly used is to fix, by differential means, the positions of these fainter objects with reference to the principal stars in their vicinity.

In this manner we have had the principal catalogues, which have been made by degrees, from one part of the sky to the other, just as one has fixed the points on the earth by the difference of longitude between each point and another point about the first or primary. All the longitudes have a single base at last: though all the differences have not been directly measured from the base, it is adopted as the origin of the system of longitudes.

The errors of the differential method can be small in exact observations, yet they have some systematic corrections which increase from one epoch to another.

Now and then it is necessary to revise the scheme, compare the fundamental data, and rectify all the area, with results of great precision and with more complete calculations. In this way the results of the old observations are improved, and these then enter into the modern calculations with less systematic error. Astronomers whom we succeed used those results in the calculations of the movements of the stars and in the movement of the solar system.

Fundamental Method Extended.

The stars which we observe by the fundamental method are now reckoned among those that are better known or determined in the sky. In the first class are included the stars used in this method for clock corrections. The positions of those in the first class, when once well revised are used for fixing the positions of the second class, which is of greater extent, containing the principal stars of all parts of the sky. A third class, in our plan, includes a great number of stars, until now of less value in fundamental work, all well fixed or connected by simultaneous observations. In these classes we shall have altogether 1600 fundamental stars.

By means of the positions of the fundamental stars, one calculates the positions of all the other stars which one observes on this plan. We include the greater part of the stars which have been observed before the epoch 1875·0. The positions of these stars serve to compute many proper motions, and for fixing the direction and quantity of the motion of the solar system. We estimate that we shall observe on our plan 15,000 stars in all.

They are of all degrees of brightness from the first magnitude, besides those more difficult to observe with a telescope of this power. Observations of all are to be found in the catalogues of the past forty years and in the older ones. So, as the old catalogues serve as a basis for the present work, so also will the observations on our plan similarly serve for future calculations.

Climate and Work.

The development of this project has given good results in the observations obtained since the commencement of our scheme of work. In the first complete year we have made more than sixty-two thousand observations. This number has never been reached, for this class of observations, by any other observatory. As the greater part of the work has already been concluded, the task will be easier now.

For the most part the climate of San Luiz has been good. In the first year we had three hundred nights during which one could observe for some hours at least. More than two hundred nights were clear during all hours. Under the usual condition of the sky we could generally reckon upon seventy per cent. of the time for suitable astronomical observations.

A series or cycle of fundamental observations is one-hundred-and-twenty hours, as a general rule, but the observations are continued without intermission. One makes six observations successively of a group of stars and six observations of another group at a distance of twelve hours from the first. These groups are usually made in the evening and early dawn. The same observer continues during some hours at night in order to include the stars which passed in those hours. Other observers follow during the last part of the night for fixing other stars with the principal stars. They are occupied from twelve to ten and six hours for the observations during the twenty-four hours.

The commission has consisted of ten persons for four months only: during the greater part of the work we had six or eight. We are occupied with the computations as well, but these will require many years before being accomplished, and the results of the preliminary calculations are sent to North America, where they will be concluded at the Albany Observatory.

The Erection of the Observatory at San Luiz.

The construction and the installation of the observatory has been rapid and without any misfortunes. In September of 1908 we commenced the construction of the building of the observatory in the grounds of the State school. The National Government gave facilities for acquiring the area necessary for the observatory and for a house. Five months later all was established ready for the installation of the instruments, and for lodging the members of the commission.

After the preliminary examination and the determination of some instrumental corrections, we commenced the observations for the scheme in the month of April, 1909.

It is the first occasion upon which an instrument of this class has been erected upon artificial stone, made with Portland cement, grit, sand, or fine gravel, and strengthened with iron.

The two large piers which support the axes of the instrument are joined into one base extended two or three meters, and this base, of two meters in depth, is fixed with the fou[illegible]ich is extended beyond the base of the piers [illegible] all is as one block by this modern metho[illegible]ion. The height of the pillars, with the [illegible]ls to five meters above the foundation, wh[illegible]nd and other materials.

There are also two piers of the sam[illegible]ction for auxiliary instruments in the larg[illegible] and another pillar at a distance of one hundr[illegible]rs, for indicating the meridian mark.

The two astronomical clocks are installed within a small room constructed for the work rooms; [illegible] clock is arranged on an artificial pillar of the same concrete material.

This is the history of the Observatory of San Luiz. No one here speaks of a work being in progress; it is an act almost completed.

Up to the present we have verified more than seventy-five thousand observations; according to this, five thousand per month since the beginning of our project.

As all has gone off well until this day, we may hope that the work will be completed within a year from the date of 1910, June 30th.

QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are printed on this page.

QUESTIONS.

32. THE GENUS LINARIA.—Is it possible to obtain a complete list of the species and varieties of the genus Linaria; if so where, and at what price?

G. R. W.

33. "HALLEY'S COMET."—In the March issue of "Knowledge" it is stated that Halley's Comet is still visible: and of about the 14th magnitude.

Can any of your readers inform me whether the distance of the comet from the Sun can be found by calculation at any particular time, and also whether its speed can be determined?

As an example, how far will it be from the Sun, and how many miles will it move a day, two years after passing perihelion, that is, on April 19th, 1912?

Interested.

34. ORIENTATION OF THE GREAT PYRAMID.—In the articles on "The Great Pyramid" contributed by Proctor to "Knowledge" Vol. I., he lays great stress on its careful orientation, and devotes considerable space to the method of obtaining a true north-and-south line by means of the descending passage pointing to α Draconis and the ascending passage equally inclined towards the south; but he makes no mention of the means of obtaining a true east-and-west line which must also have been necessary for the construction, perhaps because there is nothing to show what method was actually used. Could a true east-and-west line be laid out by observing a suitable star near the eastern horizon shortly after sunset, and the same star near the western horizon shortly before sunrise? If so, between what latitudes is this method available, and what considerations must be taken into account in selecting a suitable star? What other methods, astronomical or otherwise, are likely to have been available to the Pyramid builders?

W. L.

REPLIES.

24. DREAMS.—Much observation leads me to believe that a large majority, at the very least, of dreams are instantaneous, occupying only an infinitesimal part of the moment of returning consciousness from sleep, and that a noise which wakes a sleeper is itself the cause of the dream which fits it. That, in fact, the dream is an instantaneous "snap-shot" of a commingling of subconscious impressions with those due to external objectives. We must, most of us, be aware how frequently a mere dozy shutting down of the eyelids is productive of a very definite panorama of the mind.

While in dreamland I may say that I doubt strongly the occurrence of the repetition of the same dream in successive slumbers, except as an exceedingly rare event. I believe that the dream itself furnishes the thought of the supposed first dream. Has anyone ever made a note of a dream, and then referred to it when the repetition is believed to take place?

L. J.

30. FINDING THE TIME BY THE HEAVENLY BODIES.—For (1) The determination of the time would depend on the solution of a spherical triangle connecting the hour angle, *i.e.*, the time, with δ, α and λ, the declination and altitude of the sun, and the latitude of the place, α being the angle which has for its tangent the ratio of the lengths of the stick and its shadow. The result might appear rather complex to anyone unfamiliar with spherical trigonometry, and some calculation with trigonometrical tables would be required to obtain numerical results.

The solutions of (2) and (3) are very simple, (2) requiring no calculation, and (3) only the determination of a single angle from the known value of its tangent. Generally if λ is the latitude of any place, and α and δ the altitude and declination of the Sun at noon on any date, then $90° - \lambda = \alpha - \delta$ is always true.

For (2) $\lambda = 52°$; $\alpha = 45°$; therefore $\delta = 7°$. The declination of the Sun will be very nearly 7° at noon in London on April 7th and September 5th.

For (3) α will be the angle which has for its tangent the ratio of the length of the stick to the length of its shadow, and the latitude of the place will be $90° - \alpha + \delta$.

The declination of the Sun can, of course, be obtained for any date from the Nautical Almanac; the sign before δ must be reversed if the Sun has South declination.

J. H. G.

FINGER PRINTS: A CHAPTER IN THE HISTORY OF THEIR USE FOR PERSONAL IDENTIFICATION.

By HENRY FAULDS.

THE famous Tichborne case gave a great impulse to the study of identification as a question in jurisprudence. I was leaving this country for Japan in 1873 and the vast crowd around the old Court at Westminster impressed me greatly with the importance of the subject. Craniology seemed to many to have had its day, and the complexities of constantly varying methods had induced almost complete scepticism. If a race could not be distinguished on anatomical grounds, how could we ever hope to identify a single member of the human family on the basis of anatomy with confidence and precision? It had been decreed, *nemine contradicente*, except Virchow — an important exception — that all the soft tissues, hair, skin, and the like, were now useless for such a purpose. I had studied photographs most carefully, but found them to be traitorous, the same people being made to look quite different in a changed light, by another mode of developing, with the varying psychological moods of the sitter. They were useful but not precise. After certain illnesses, too, the living face was found to change, as in typhoid fever, and more temporarily in ague. The tragic effects of small-pox are well known to novel readers. Our police in England used not long ago to keep an indexed record of tattoo-marked persons who had once been convicted. I doubt if they ever had a case like that of a Japanese once employed by me in their collection. (See plate.) This man's case was unique, I think, his whole skin surface being one finely-wrought pattern, not only intricate but really beautiful. Now such a case might be copied, at great trouble and expense, to win a fine estate. But no one can produce to order the simplest finger-print pattern in living tissue. It may be destroyed, whereas, on the other hand a complex tattoo pattern can be created but can hardly be destroyed. It would be quite impossible by any known means to destroy one like that now figured. Sir Edward Henry says of finger-patterns that they are out of all proportion more numerous than such measurable features as tattoo marks, but I think he cannot have contemplated such cases as that just described.

FIGURE 1.
Enlarged Finger Print showing Sweat Pores.

Along the great populous beach of the Bay of Yedo, where the hospital was which I had charge of, were many shell-heaps or kitchen middens. Some of them were ancient, while others had an almost unbroken history coming down to our own day. Amid the oldest heaps I often found fragments of sun-baked pottery, on which finger-marks had been impressed when the clay was soft. These seemed to have been made by children, perhaps young girls, whose ancient fingers had dinted the edges of the soft ware as pie-crusts are still moulded by the thumb of baker or pastry-cook. Similar articles were then (1878) made and sold as toys, and I purchased many of them in the bazaars of Tokyo. Ancient ware, baked in the sun but never fired, and marked with finger furrows is in high repute for the ceremonial tea-drinking of Japan, but it is quite incorrect to say, as has been said and written, that no other is ever used in those depressing festivities. Sometimes the furrows or ridges of those ancient finger-marks came out sharp and clear, but much oftener they were blurred or smudged by movement during the act of impressing. In the modern toys, however, the imprints were better impressed and were obviously intended for ornament. Had early men some faint knowledge of the ornamental qualities of finger-patterns? One fancies one can detect some glimmerings of that conception in crude savage designs, but I must not dilate on that tempting theme here. Endowed, or afflicted, with myopic eyes I was led very early to notice how, in the modern ware, one peculiar pattern of lineations would reappear with great persistency, as if the same artist had again left her sign-mark on her work.

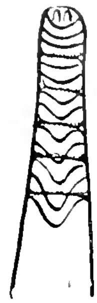


Figure 2.

Rugae or ridges on the under surface of the prehensile tail of *Ateles ater* (Spider Monkey).

I examined directly many thousands of living fingers, then passed on to consider impresses on putty, bees-wax, sealing-wax, clay, and other substances, taken from my own fingers, those of students under my care, and medical men, native and foreign, and out-patients who might visit the hospital. These were at first very roughly classified and analysed. I am quite sure that at this point the conception of a wide and general method of identification flashed upon me with suddenness. Almost immediately followed a most depressing sense of moral responsibility and danger. What if someone were wrongly identified and made even to suffer innocently through a defective method? It seemed to me that a great deal had to be done before publicly proposing the adoption of such a scheme. Till then we had used wax and other plastic substances (and on the whole paraffin was found to be best), but now I remembered lessons on botany I received in Anderson's College, Glasgow, as a lad attending business. The course—an evening course—cost two shillings and sixpence for the session. We used to print the leaves got in Saturday afternoon excursions with an oily mixture of burnt cork. Using good printing ink in Japan, then, we got large numbers of clear and excellent finger impressions. Their variety was wonderful, and we could study details with much greater ease and delicacy than in *relievo* impressions. From that stage onward I made steady observations, seeking specially to determine whether the patterns characteristic of [illegible] had ever varied from time to time, ei[illegible] [illegible]ral arrangement or in linear detai[illegible] [illegible]time I had noticed that the pigment [illegible] freckles and in the skin affection [illegible]*oderma* (supposed by some to be the [illegible]osy" of the Hebrews) migrated, [illegible] [illegible]her, Lord Lister, had shown to be [illegible] with the pigment on a frog's foot. [illegible] I took to test whether the ridges eve[illegible] [illegible]d their situation or changed their form [illegible] shaving away their elevations or rubbing them down with various powders to smoothness, having first taken careful imprints of the patterns. After the skin grew up again fresh imprints were taken and compared with the old ones. These were scrutinised very carefully for changes, but in many hundreds of cases, tested thus three or four times, not one solitary example of a variation in pattern was detected.

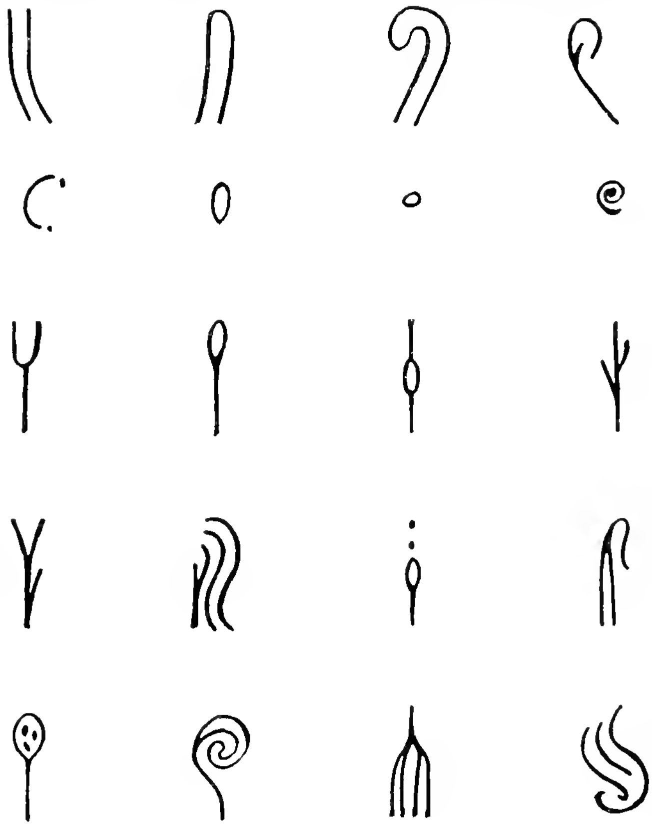


Figure 3. Skin Lineations (diagrammatic).

The patterns always came up with perfect fidelity to the old standard. Arrangements were made for a still more extensive test extending also over a greater period, but exhausting illness from climate and overwork caused my return to England, and broke for a time the thread of my investigations. I returned to Japan after a rest, but had again to come back to England in 1886. The firm conviction, however, was established in my mind, which nothing has occurred to change, that skin furrows for the purposes of identification are invariable throughout adult life. Observations of select cases from that period—thirty-two years ago—till now have been made from time to time only to confirm my early results. Figure 1 is one of my earliest prints. In fourteen years it had not changed in the living person. From time to time I have watched cases of fever, and have drawn medical attention to the subject, thinking the great activity of the skin shown by peeling or desquamation might be accompanied with some changes of pattern, but no case has yet been observed by myself or recorded by others so far as known to me. The subject of classification now presented itself. Those who talk glibly about comparing a single "thumb print"—the favourite digit—with, say, four millions of single finger prints, do not seem, as a rule,

Figure 4.

Smudge from a Finger.

to perceive the difficulty. The supposed numbers of the Russian army were often discussed in Japanese journalism in the seventies, and it seemed that a good system should be able to face such numbers. Five years of early life had been spent in learning a trade—that of Paisley shawl manufacture—which almost vanished before the end of my time. It seemed to have been an utterly wasted time, leading to nothing and helping no one: but it had drummed into my dull head how to deal with patterns. What I intend to convey by a pattern in finger prints may best be understood by looking at a few enlarged diagrams of the central or most characteristic portion of the *rugae*, or skin-ridges, with their complementary furrows or *sulci*, which are found running over the sole of the foot (*planta*), the palm of the hand (*vola*), and front or palmar surface of the fingers. Indeed, they are even found in the prehensile tail of the spider-monkey, as in the diagram. (See figure 2—spider-monkey's tail.) Near the middle of the last joint of each finger there are usually lineations in the skin of much complexity, which form the basis of identification by finger prints. (See figure 3).

Without going into details, which would require a wealth of illustrative figures and would probably interest but a few, my system proceeds on the conception that an elementary pattern is like a character in a foreign fount of type. So the classification is that of a syllabic dictionary, each syllable standing for a single finger-pattern as a Chinese character is printed in many dictionaries, and as Japanese is now printed. Each vowel may be a syllable in this sense, but no consonant stands alone, and the vowels associated with consonants always preserve their original pattern significance. The consonants go in related pairs, as t, d; p, b; f, v; s, z; l, r; m, n; k, g. The elements that compose patterns of any complexity are similarly related in pairs, and thus the association of sound and sense soon becomes complete in the mind of the dactylographer. But the syllable, after all, only denotes a class which may contain several—usually not a great many—individuals, all differing in minute details. With my system the whole strain of the original translation into the finger-print vocabulary, which is never great, lies upon the shoulders of one or perhaps two experts, but all the rest of the work can be done by any school-boy who can turn up a word in a dictionary. To give an example offered to the War Office Committee by me when being examined as a witness: the expert, reading off a new set of say five finger-prints in one hand which has come in, calls for all old records filed past containing *Abracadabra* (a fanciful word of five syllables). That word in syllabic form might read

A–bra–ca–da–bra, or

Ab–rac–ad–ab–ra, or

Ab–ra–cad–a–bra, and so on.

Under any of these forms there might be several people indicated. But it would be found that only one, if any, would correspond exactly with the person to be identified. At all events, that is the belief, not easily to be shaken, of some hundreds of experts working for now about a decade, in different countries. This means quite an extraordinary security, beyond anything hitherto conceived, in regard to personal identification, but its efficiency does not depend on any one method of classification.

Having got a trustworthy method of arranging the records, I now had made copperplate forms to receive impressions of the fingers in consecutive or serial order of both hands, with spaces for a lock of hair, information as to race, sex, and so on, that some ethnographical purpose might be served as well. At the close of 1879, and in January, 1880, I wrote out a hundred or so of circulars enclosing a number of my copperplate forms with outline hands to receive imprints. One copy made by me on 30th January, 1880, reads thus:—

"Dear Sir,—I am at present engaged in a comparative study of the *rugae*, or skin furrows, of the hands of different races and would esteem it as a great favour if you should obtain for me nature-prints from the palmar surface of the fingers of any of the (blank) race in your vicinity, in accordance with the enclosed forms. The points of special interest are marked (red cross) and no others need specially be attended to. Each point must be printed by itself separately. Printer's ink put on very thinly and evenly, so as not to obliterate the furrows of the skin, is best. It can easily be removed by benzine or turpentine. In place of that, burnt cork mixed with *very little* oil will do very well. One or two trials had better be made before printing on the forms. If printing should be found too difficult, sketches of leading lines at the points indicated would still be of very great value, taking care that the directions corresponded with the furrows, and not in *reverse*, as when a simple impression is taken. If any one finger, and so on, comes out badly a piece of paper can be printed and pasted on at the proper place. I enclose as a specimen a filled-up form. The fingers printed in the proper spaces and the important "points" each marked with a red cross. As novel and valuable ethnological results are expected from this enquiry, I trust this may form a sufficient excuse for asking you to take so much trouble. Please return any forms which may be filled up to the above address.

"I am, &c.,

"H. Faulds."

The response was quite disappointing. Some thought it was an advocate of palmistry looking for cats' paws: most took no notice whatever. I tried in the same way to get imprints from lemuroids, apes and anthropoids. On the 15th February of the same year (1880), I wrote to Charles Darwin, sending specimens of prints and an outline of my first results, and requesting him to aid me in obtaining access to imprints from lemurs, monkeys and anthropoids, as I had found them to show lineation patterns which I hoped might be serviceable for the elucidation of man's lineage. I had failed to find any trace of previous notices of the subject in anatomical or recent biological works. The few early notices which have yet been found I hope to deal with pretty fully on some other occasion. The great naturalist's reply, two years before his death, was as follows:—

The back view of a Japanese labourer most elaborately tattooed in colour.

Via BRINDISI.
April 7th, 1880.

DOWN,
BECKENHAM, KENT
RAILWAY STATION,
ORPINGTON, S.E.R.

DEAR SIR,—The subject to which you refer in your letter of February 15th, seems to me a curious one which may turn out interesting; but I am sorry to say that I am most unfortunately situated for offering you any assistance. I live in the country and from weak health seldom see anyone. I will, however, forward your letter to Mr. F. Galton, who is the most likely man that I can think of to take up the subject to make further enquiries.

Wishing you success,
I remain, dear Sir,
Yours faithfully,
(Signed) CHARLES DARWIN.

The original of the above holograph letter, with envelope addressed by Mr. Darwin and duly postmarked, along with the proof sheet of the first copperplate form made for me in Japan, is now in the Library of the Royal Faculty of Physicians and Surgeons, Glasgow. On October 28th, in *Nature* appeared a contribution by me, "On the Skin-furrows of the Hand," which was printed in the *Index Medicus* of the United States as the first recorded contribution on that subject. At the International Medical Congress about ten months afterwards, Dr. Billings, then editor of the *Index*, said in a speech—"Just as each individual is in some respects peculiar and unique, so that even the minute ridges and furrows at the end of his forefingers differ from those of all other forefingers, and it is sufficient to identify," and so on (Report in *The Times*, August 5th, 1881). My proposal was certainly the first public suggestion to establish a scientific method of identification on the basis of finger-prints. Sir William Herschel wrote soon afterwards to *Nature*, admitting my priority of publication, but stating that he had used a method of finger-prints in India before this. There is no dispute between Sir William Herschel and myself, as each had reached his own conclusions quite independently. This little personal matter was discussed in *Nature* (October, 1894) and in *Gegenbauer's Jahrbuch* for 1905, in which the date of my first contribution is considered the starting-point of recent study of the subject. The copious literature which soon sprung up was of every kind, with some appalling journalistic varieties in America. In 1881, Monsieur Bertillon, of Paris, brought out his delicate anthropometric system, to which the independent finger-print method from England was superadded. It therefore began to appear to the official, and even to the infallible encyclopaedic mind, that finger-prints were merely an element in the French system of identification, or Bertillonage. The finger-print method alone was used in a United States expedition in 1882, and it was tried in San Francisco, as afterwards in South Africa, to identify the fluctuating population of Chinamen. In the year after my final return to England greatly renewed interest was aroused in the subject. Herbert Spencer tried to explain the origin of the ridges in an article in *The Nineteenth Century*, May, 1886. Sir Francis Galton, to wh[illegible] Charles Darwin wrote to me in 1880 that he w[illegible] r the matter, began the study, as he states [illegible] of "Finger Prints," in 1888. In that sa[illegible] Inspector Tunbridge from Scotland Ya[illegible] officially appointed to investigate my prop[illegible] report has ever been made public, but Mr. T[illegible] told me that he feared the method was too fine [illegible]rk, and said that nothing could be done at least with[illegible] fresh legislation. Some years afterwards he was appointed to New Zealand, where he was the means of inducing the prison authorities and police to apply the method, which has been now in successful operation all over Australasia for some years; so Mr. Tunbridge wrote to me in 1907.

In 1894, a committee appointed by Mr. Asquith met and finally, after some rambling conclusions, adopted Bertillonage with finger-prints as some help, the former being used as the basis of classification. The proposal was absurd, and it was soon found, as might have been foreseen, that finger-print patterns yield a far firmer and more searching basis of classification in themselves than the other method, and need no auxiliary crutches.

In 1897, the two associated methods began to be applied in British India; while in civil cases there, as in attestations, pension claims, and so on, the finger-print method was used by itself.

In 1901, the ten-finger method in serial order, exactly as originally advocated by me in 1880, was finally adopted in England, after other trials, and has met with an immediate and triumphant success in giving rapid and easy identifications of recidivists or old professional criminals, often living under aliases. Monsieur Bertillon, who at first did not use finger-prints at all, wrote to me officially that since 1894 the two methods had been jointly used in Paris, and that greater security was now felt in identifying. In 1902, finger-prints took the place of bodily measurements in Austria-Hungary, being easier of application, and less likely to give varying results. Two years afterwards Spain followed suit, our Inspector Arrow taking some charge. The method had been worked before that period in Buenos Ayres with success. A private service for identification by the finger-print method was, I believe, instituted in Belgium by Dr. de Laveleye, but I have heard no report of results.

It is a curious fact, but true beyond question, that the effectiveness of the method has proved to be the chief obstacle to its more extensive application. In short its miraculous effect in tearing the mask from old criminals who try to veil their identity by an *alias*, has created a horror of it amongst the class from which many recruits used to be drawn for Army and Navy.

In conclusion, I should like to point out that there are five distinct ways in which Dactylography, or the scientific study of finger furrows, may be serviceable:—

(1) In relation to the problem of human lineage. Much tentative work has been now done in this field

by many workers, and a scientific pathway begins to open up before us.

(2) In elucidating the relations of front and hind limbs: Professor Bowditch, of Harvard, wrote to me that he had early begun an enquiry into this subject. It promises to yield results of interest, but more workers are required.

(3) In identifying for life insurance, pensions, passports, affidavits, cheques, signing deeds, and so on. Again, in identifying the dead by former records, after battle, flood, fire or earthquake.

(4) In identifying old convicted criminals who have assumed other names.

(5) In testing evidence of bodily presence at a scene of crime by bloody finger-marks, sweaty or greasy smears on glass windows, wine glasses, lamps, or cash boxes and the like, or indented impressions on putty, wax, paraffin and so on. Faint impresses can be revived; invisible ones quite clearly brought out by chemical means; imprints *in relievo* may be photographed and made clearly intelligible to a jury. (See figure 5—a smudge from a finger.)

The last, and I think by far the least, of these once potential, now actual, utilities has taken the deepest hold of the popular imagination, and has seemed, to me at least, to threaten some danger to the innocent by its often ignorant and unscientific application. The method is not "mathematical" as certain officials are never tired of repeating, but demands common sense and the use of their own eyesight and mother wit by the plain men in the jury box. It is essentially English, and every accused person in the dock is as able as a judge, or counsel, or official witness, to test its validity.

WOUNDS IN TREES.

Some interesting illustrations are given in the March number of *The Country Home* of wounds in trees that have successfully closed over, and others which will never properly heal. We are enabled to reproduce some of the pictures here. Figure 1 shows a well-healed wound. In Figure 2, the process of healing having been slow, the exposed wood has rotted away and, there being nothing to keep the healing tissues in their proper place, they are turning inward, with the result that if the wound is left to itself it will never heal. Figure 3 depicts a branch on which a snag has been left, and, so long as it remains, it will prevent the edges of the healing tissue from meeting. The article emphasises the need for more attention to be paid to trees, on account of the danger caused by their unexpected fall. Mention is also made of the work of the tree doctors, whose advertisements are seen in the columns of American newspapers. Their services would be useful at a time when the trees are lopped in the first instance, and also to repair the damage caused by ignorant labourers, who are only too commonly employed to cut trees, regardless of the fact that they are living creatures.

By the courtesy of The Country Home.

Figure 2. A wound that will not heal.

By the courtesy of The Country Home.

Figure 1. A well-healed wound.

By the courtesy of The Country Home.

Figure 3. A snag which prevents healing.

CORRESPONDENCE.

ORIGIN OF THE FINGER PRINT METHOD.

To the Editors of "KNOWLEDGE."

SIRS,—Kindly correct an error in your February number, Page 45, about Fingerprints. You quote Sir Francis Galton as saying in his Reminiscences "that Sir William Herschel in India had experimented with them since 1887." I do not know where you got this date from, but Galton never gave it. As a matter of fact before I left India in 1878 I had been experimenting for twenty years (Galton says "many years"), and had successfully established, not only the individuality, but the practical persistence of the pattern, as an unfailing method of identification, before any one else had entertained the idea. When I left India the system was in public use with the knowledge of the Heads of the Registration Department, and of Gaols, as well as for Pensioners, and in my own Court, and was matter of common knowledge in Bengal. The Government of Bengal had known of it from me many years before 1878, as a means of preventing forgery during the Indigo disputes in 1861 and 1862.

I trust you will do me the justice to insert this letter in your next number.

I am engaged at present in arranging my records for publication in facsimile by the Clarendon Press.

W. J. HERSCHEL.

A METEOR.

To the Editors of "KNOWLEDGE."

SIRS,—A beautiful meteor was seen here (Sunderland, February 16th) about 6.33 p.m. The head was almost as bright as Venus, but larger in appearance. It left a trail of light behind it which appeared to be reddish in hue; it was visible several seconds.

I am not an astronomer, but think that the note would be of interest to your readers.

F. H. S.

THE SUN'S REVOLUTION.

To the Editors of "KNOWLEDGE."

SIRS,—As a student of Astrological lore, I sometimes draw a figure for my birthday anniversary. But I find the time for the sun's return to its place at birth varies from year to year. For instance, at the time of my birth the sun was in Pisces 24·41, which occurred at 10 a.m. on March 15th, the year of my birth. But in 1910 the sun came to that point sixteen hours later, or at about 4 a.m. on the 16th, and this year later still, viz., about 9.30 a.m. on the 16th. Can any of your readers kindly explain how it is that the sun does not return to the same point in the Zodiac at the same time every year?

H. A. B.

IS SPACE INFINITE?

To the Editors of "KNOWLEDGE."

SIRS,—The following extracts from Professor Pickering's Article in ***Popular Astronomy*** of August last are of special interest in connection with Mr. Barclay's letter on the subject of the "Eternal Return." The suggestion that space is curved may be welcomed by many of your readers as an alternative theory to that of Laplace and others who have assumed that space and time are necessarily infinite.

H. PERIAM HAWKINS.

"Everyone wa[illegible] is the question [illegible] along a straight line must [illegible] impossibility of [illegible] where there is no space beyond, and yet at the [illegible] feel that infinite space is itself an impossibility. T[illegible] it has been suggested that space is curved, with [illegible] direction of curvature at every point. In other words we [illegible] the idea that plane triangles and rectangular coordinates [illegible] close approximation to fact, but that all figures are really [illegible] spherical co-ordinates.

"Now it is a property of infinite space, of any number of dimensions, that if it be properly curved, and inserted in space of one higher dimension, it will become finite. Thus if infinite space of one dimension, represented by a straight line, be properly curved and inserted in a plane it will become the periphery of an ellipse; if uniformly curved it will become that of a circle. Similarly, if space of two dimensions, represented by a plane, be properly curved and inserted in three-dimensional space, it will become the surface of an ellipsoid. Similarly, if ordinary or three-dimensional space be properly curved, and inserted in space of four dimensions, it will become finite in volume and represent what would correspond to the surface of a fourth-dimensional solid. Thus, if we should go far enough east, we should reach the west, if far enough north we should reach the south, and if far enough into the zenith we should reach the nadir."

"If it is difficult for us to imagine infinite space, it is still more so to comprehend infinite time. As we go back eternally through the ages how is it possible for there to be still an infinity of time before that? Yet we cannot conceive of an actual day or instant before which time did not exist. In graphical solutions time is represented by a straight line, and may be compared to space of one dimension. But suppose that time, too, is curved, and has another dimension that we have not yet detected. Time then may be represented by an ellipse or a circle, and if we go back far enough into yesterday, we shall arrive at to-morrow. *Of course, we should not live our lives over again, because matter in the meantime would have changed, and when the present day again arrived it would be upon a very different universe.* Both infinity of time and a return of time seem to us now impossible. If the latter is the more difficult to comprehend, may it not be simply because it has not occurred to us before?"

THE NEW MAP OF THE MOON.

To the Editors of "KNOWLEDGE."

SIRS,—Our nearest companion in space has, ever since the invention of the telescope, attracted a good deal of attention. Many have been the attempts to map its surface. Perhaps the first really useful map was that of Beer and Mädler, thirty-seven-and-a-quarter inches in diameter, published in 1834, those previously issued by Hevel and Tobias Mayer being much behind in detail, as also were those of Russell and Blunt. Lohrman's work was on the same scale as Beer and Mädler's, but, owing to the failure of his vision, was not completed until produced under the editorship of Schmidt, some thirty years ago. In 1876, Neison issued a useful book on the Moon, containing a capital map two feet in diameter. But in 1878, Schmidt's great map, six feet in diameter, was published, the labour of thirty-five years. Since these maps were issued a new era has dawned in selenography; the telescopist is reinforced by photography. The latter, whilst it misses the sharpness of telescopic vision, puts detail in its accurate place. The new map has been constructed from combined telescopic and photographic observations, on a scale of seventy-seven inches to the moon's diameter, by Mr. Walter Goodacre, the director of the Lunar Section of the British Astronomical Association. It has taken seven years to accomplish this noble work. Its accuracy may be judged when it is considered that it is based "mainly on 1,443 measured points on the lunar surface, made by Mr. S. A. Saunder, M.A., F.R.A.S., and published in the Memoirs of the Royal Astronomical Society, Volume LVII." The sketches of many of the best observers, including the late Major P. B. Molesworth and Mr. Goodacre, have been used in the construction. This monumental work, which has been exhibited both before the Royal Astronomical Society and the British Astronomical Association, is now being reduced to a scale of sixty inches, and divided into twenty-five sections. Each section is twelve inches square, with an overlap of half an inch, making the actual size thirteen inches. The map is undoubtedly the best one yet issued, and should prove a real incentive to the study of selenography. The fact that the moon's surface has been mapped far more accurately than has much of our own world does not alter the other fact, that there is very much more to learn concerning it. Mr. Goodacre has kindly given permission for the reproduction of one section (see Figure 1), and this shows how well he has accomplished his work. It is being produced by subscription at the really too low price of 22s. 6d., about a quarter the price of Schmidt's. It is to be hoped that the number of subscribers may very soon be found to permit of the publication being completed.

FRANK C. DENNETT.

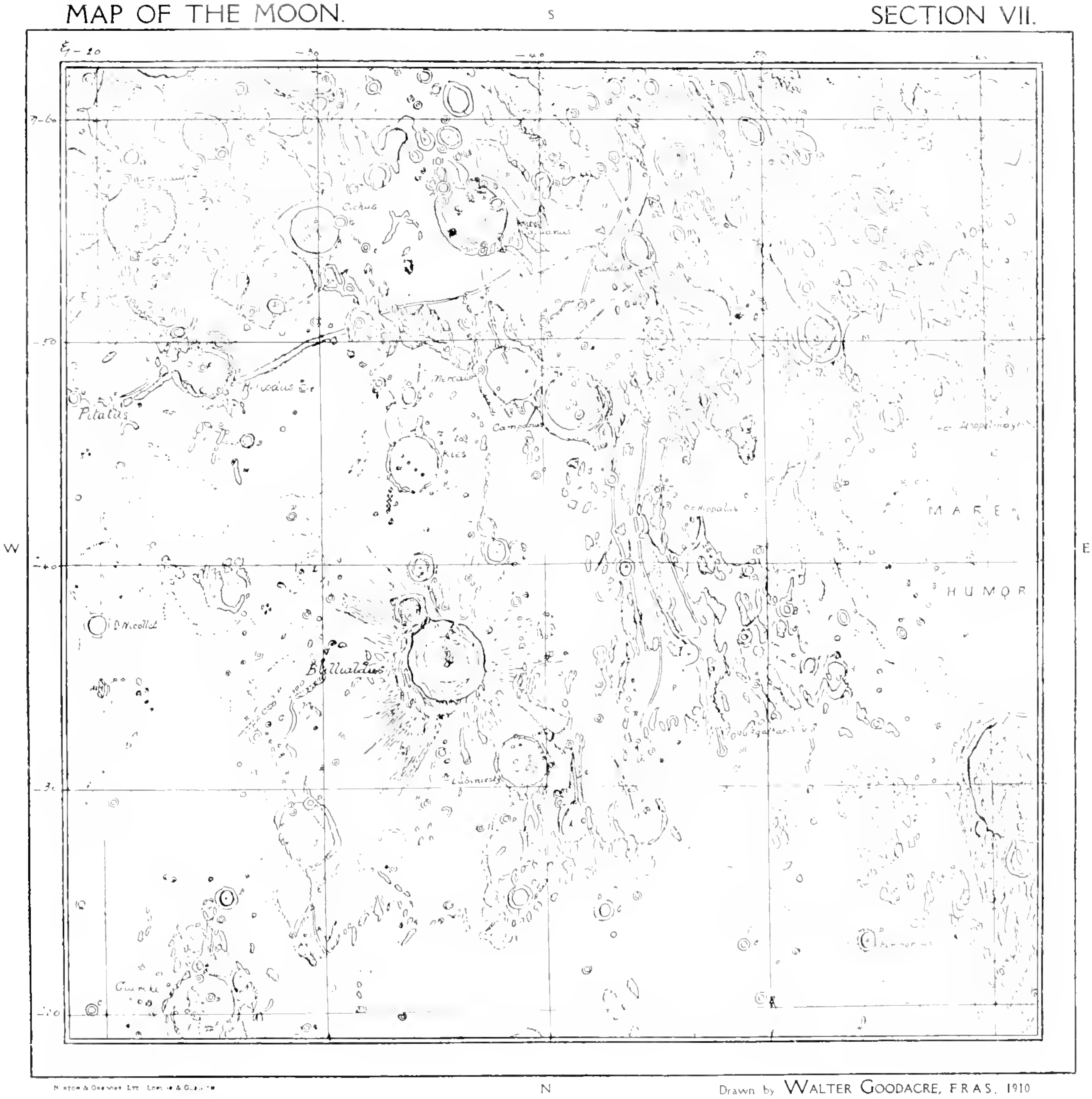


FIGURE 1. A reduced facsimile of one of the sections of a New Map of the Moon.

THE MOON AND THE WEATHER.

To the Editors of "KNOWLEDGE."

SIRS,—May I make a few notes on letters in your correspondence columns of July and September of last year, as a contribution towards discussion concerning the influence of the moon on the weather.

Mr. Strickland, in July—page 269—says: "Nasmyth believes it to be demonstrated that as a rule the sky is clearer at full moon than at the quarters." (If fewer clouds, then less rain; what do the rain-gauges say to this?) "Effect of moon is strongest in Winter in England." (Are tides highest in Winter?) "Equatorial regions are, *par excellence*, solar regions and lunar influence is reduced to a minimum." (What about height of tides there compared with temperate regions?)

Remarks on height of tide in Bay of Fundy, and in Mediterranean.—The almost absence of tide in the Mediterranean, is dependent upon the small inlet from the Atlantic, and the high tides in other localized places upon the special configuration of the coast—the narrowing of the waterway, as also in the Severn and the Wye in England.

If the moon raises tides in the ocean, a much higher tide should she raise in the lighter air; if so, does her attraction counteract the effect of the increased weight of air on the barometer?

At the commencement of his letter Mr. Strickland says: "I hold that the negative they (the official meteorologists) think they have proved, is not proven." (Do not their statements rest on *facts* observed at Greenwich?)

In your September number,—page 372—Mr. Ditcham writes to show that the high tides in the Fraser River bring up warmer water from the sea, and so warm the climate, but is not that almost as indirect a result as it would be if they brought up a log of wood which he cut into firewood and warmed his house with? Or again, if the river were dammed back, the warming effect of the moon would be prevented to those above the dam. I live on the watershed between the Thames and the Channel where there are no tidal streams, and can find no sign of the moon's influence on our weather.

There is also a letter from Mr. Ditcham, in your February number of this year, the figures of which, I am sorry to say, I cannot understand, whether they give the height of tides, or some barometric weights. I do not know, nor can I see any connection between the figures and the dates.

L. J.

PODURA SCALES.

To the Editors of "KNOWLEDGE."

SIRS,—Mr. Plaskitt, in his courteous reply to my letter, has almost entirely ignored the point I tried to drive home, that the available aperture of any wide apertured micro-objective is limited to the back lens being three-quarters filled with white light only. That I filled up the whole of mine with such light, I never asserted. Indeed, I could not have done so had I tried, my condenser being a dry one. For all that, I could always break down the image in my objective, of 1·40, upon any object mounted in balsam, by using the largest stop of the condenser. What I did claim, however, and do claim now, was that I worked the objective with the largest aperture it would stand—rather a different matter.

Upon the points he has raised, save one, I have nothing to fight; the laws of refraction are fixed. It is only upon the application we differ. Neither is it necessary on my part to try the experiments he suggests in the last paragraphs of his letter, for already I agree.

This question of full *versus* available aperture is a very old one with me—twenty years old, in fact. On referring to the back numbers of the journal of the Quekett Club, I find that Mr. Ingpen raised exactly the same point in 1891, in connection with some objects exhibited by myself. He said that he "wanted to employ the greatest powers of the objective to be obtained between 1 and 1·4, and did not see how they could be made use of upon a dry object,"—at the same time advocating the use of a dense medium.

To this, Mr. E. M. Nelson replied that he "found, on the other hand, if the object was dry [illegible] over glass, it would bear the test better than if in a medi[illegible] So long as it was in optical contact with the front of the len[illegible] could get in all the spectra. . . . . . Photographs of [illegible] mounted in the denser medium looked all smeared over. [illegible] had never seen a decent critical image produced from [illegible] in a dense medium. He did not know the reason, unless [illegible] might be that the treatment undergone by such might ha[illegible] effect of spoiling them.

This appears to be a question of theory *versus* practice, and reminds me of the German Professor who forbade his students to adopt a certain formula, because, though it worked out well enough in practice, in theory it was all wrong. In the present instance the theory was that an oil-immersion objective must have an oil-immersion condenser of the same aperture to develop it. Workers bought the oil-immersion condensers and then innocently stopped them down until they got the working image, thinking all the while that they were utilising the full aperture of the lens. My challenge to them was to produce something under an oil-immersion condenser I could not show equally well with a dry one; a challenge never taken up. This, however, is very old history now.

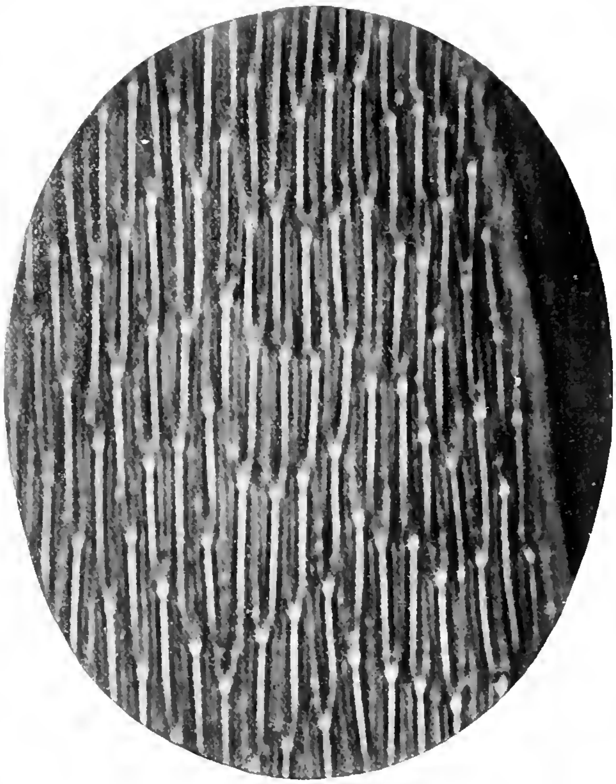


FIGURE 2.

Part of a Podura Scale, showing a portion of the right hand side of the Scale reproduced in "KNOWLEDGE," Volume XXXIII, page 333. Figure 2, enlarged $2\frac{1}{2}$ times to show intermediate lines.

I shall be only too pleased for the Editors to send Mr. Plaskitt my address, and equally pleased to receive the enlarged prints promised. I know how easy it is to miss little points in a small print which are perfectly obvious when they are further magnified. May I suggest, however, that with the Editors' permission, Mr. Plaskitt sends one enlargement to be reproduced for the benefit of the readers of "KNOWLEDGE." I am sending one with this letter hoping for that permission, because, I take it, the truth is what we both want. If this be granted, that is, the Editors' consent, the one of his to go best with mine would be the one with the oblique lighting across the scale.

Yet, even then, the credibility of appearances will still remain an outstanding question. I, at least, am not prepared to state with certainty what the secondary lines denote, and I do not suppose Mr. Plaskitt is more positive. We can only judge of the relative truth by the method of production. Leaving my own opinion out of the question altogether, the weighty authority of Mr. E. M. Nelson and the late Dr. Dallinger cannot be ignored, who both advocate the central cone of illumination, as opposed to oblique light. The last, in his presidential address to the Quekett Club, in 1891, speaking of the new apochromatism, says: "It gives certainty and precision to all work done . . . . but we must be careful not to re-introduce the ghostly element by false interpretation. I am increasingly convinced of the possible danger of employing shafts of oblique light only in one azimuth. The peril of misinterpretation is enormous."

Again, of the new apochromatic of 1·60 N.A., it is claimed that "it is a triumph of the optical firm which produced it. . . . . But I would hasten to say, that I would not trust a single result produced by its means, when oblique light in one azimuth is employed. . . . . It is fatal to its truth. We can absolutely get almost any desired result with it. It is a very optical Witch of Endor for calling up ghosts and ghostly visions." Surely here is evidence enough, and as for this one lens, all the result of direct experiment.

Mr. Plaskitt contends that if when using an oil-immersion of 1·40 with the full aperture, that is, with the back lens filled with white light, I then stopped it down until only three-quarters was full, I should be getting much nearer ·75 than 1·40, an aperture not so much as a good dry quarter as to resolving power. Well, that is a matter easily settled. I still have the scale from which the photograph with my apochromatic was taken, and shall be most happy to wait upon him with it, if his home is in London. If he can then, with a dry glass, produce the same appearances upon it, I will concede his point. This, at least, would be a short way out of the discussion.

T. F. SMITH.

THE ETERNAL RETURN.

To the Editors of "KNOWLEDGE."

SIRS,—Mr. H. D. Barclay, in the February issue of "KNOWLEDGE," raises the oft-recurring and apparently insoluble question of Eternal Return, but the precise difficulty he is in is not altogether clear.

That time and space are infinite will admit of little doubt; that the sum total of forces in the Universe is also infinite is, though open to question, probably also true. The fact of their being constant need not necessarily impair their infinity. (Can infinity itself not be constant?) Their sum total may be constant, but their component parts are subject to perpetual changing and interchanging. It is this continual changing and lack of equilibrium that is of the very essence of force. Pre-suppose equilibrium, and our conception of force is gone. We might, indeed, say that this lack of equilibrium is a permanent and essential factor in the Universe. It is, as it were, the attribute of force or energy itself, and, in this sense, is infinite and eternal.

The argument, as stated by Mr. Barclay, pre-supposes this permanence:—" If these forces could ever attain a position of balance it would have already happened, as an infinity of time has passed." Not having happened, it follows that this condition of out-of-balance is infinite, and force, therefore, is also infinite.

It is curious to note that Dr. Le Bon is brought in as a supporter—indeed as one of the discoverers—of the eternal return hypothesis, but on what ground it is difficult to understand; for, in Dr. Le Bon's view, matter is constantly "dissociating" and slowly but surely returning to the ether from which it was originally derived. Once it has all returned, there is an end of matter and energy alike. This is a subject I happen to have alluded to in the January issue of the *Westminster Review*, and if Mr. Barclay will refer to it he will see that Dr. Le Bon's teaching (if I read him aright) is not that of "eternal return" but of "no return." It is true that here and there he lets fall a phrase which betrays a doubt on the subject; but in spite of these lapses it is clear that his doctrine of dissociation is closely bound up with the doctrine of "no return,"—matter and energy are constantly being dissipated, and apparently are lost for all time. It is not an inspiring doctrine, and seems purely gratuitous; for there is nothing in his experiments that necessarily leads to any such inference, while the operations of Nature in general point altogether the other way. Nothing is clearer than that Nature, within the bounds of our experience, works, both on a large and on a small scale, in cycles of some sort. Almost all her operations are rhythmic. There is a constant ebb and flow: an evolution and a devolution. If this is the case in regard to phenomena within our limited experience, is it not a reasonable inference that this evolution and devolution extends far outside our experience and beyond our conception?—that it is, in fact, infinite and universal.

The following quotations from Dr. Le Bon's "The Evolution of Matter" (Book VI, Chapter VIII.) sufficiently indicate his views on the subject:—" We now know that matter vanishes slowly, and consequently is not destined to last for ever." . . . "What is the fate of the atom of electricity after the dissociation of matter? Is it eternal while matter is not?" . . . . "Once it (the electric atom) has radiated away all its energy, it vanishes into the ether and is no more." . . . . "This last, therefore, represents the final nirvana to which all things return after a more or less ephemeral existence."

One saving clause (in the same chapter) is as follows:—" Nothing leads to the belief that they (*i.e.*, things in general) had a real beginning or that they can have an end."

Thus we see that Dr. Le Bon's teaching is unmistakably in the direction of the final destruction of matter and energy, although the last quotation I have given betrays something of an open mind on the subject,—a subconscious admission though it possibly may be.

As often as we recur to this problem we are inevitably met with this consideration: that, from the nature of the case, the finite cannot grasp the infinite; and whatever our speculations may be, we must, of necessity, always labour under this disability. As Wallace has said: "Of infinity, in any of its aspects, we can really know nothing, but that it exists and is inconceivable."

This, however, is no reason for withholding our speculations, so long as they have a substantial basis of fact: for it is only by pressing them forward that we can ever hope to in any degree qualify our present limitations.

W. E. LISHMAN.

NOTICES.

THE ZOÖLOGICAL SOCIETY, ADDITIONS TO THE MENAGERIE.—During the month of February no less than one hundred and twenty-three additions to the Zoölogical Society's menagerie were registered. Among them are the following animals which are new to the collection:—A Dwarf Mongoose (*Helogale varia*), from Mombasa, presented by the Rev. W. Douglas Braginton, on Feb. 27th; a Black-footed Polecat (*Putorius nigripes*), from North America, received in exchange on Mar. 16th; two Dybowski's Deer (*Cervus hortulorum*), from Manchuria, presented by Sir Edmund Loder, Bart., F.Z.S., on Feb. 23rd; and an Aldunati's Finch (*Phrygilus aldunatii*), from Chili, presented by Miss Phillis True, on Feb. 13th.

ROYAL INSTITUTION.—The following are the Lecture Arrangements at the Royal Institution after Easter:—Mr. J. E. C. Bodley, Three Lectures on (1) Cardinal Manning; (2) The Decay of Idealism in France, and of Tradition in England; (3) The Institute of France; Professor Frederick W. Mott, Two Lectures on the Brain and the Hand; Professor W. W. Watts, Two Lectures on (1) The Ancient Volcano of Charnwood Forest (Leicestershire); (2) Charnwood Forest and its Fossil Landscape; Professor R. W. Wood, of the Johns Hopkins University, Three Lectures on the Optical Properties of Metallic Vapours (Illustrated); Dr. W. N. Shaw, Two Lectures on Air and the Flying Machine: (1) The Structure of the Atmosphere and the Texture of Air Currents; (2) Conditions of Safety for Floaters and Fliers; Mr. T. Thorne-Baker, Two Lectures on (1) Changes effected by Light; (2) Practical Progress in Wireless Telegraphy (Illustrated); Professor Selwyn Image, Three Lectures on (1) John Ruskin; or, the Seer and Art; (2) William Morris; or, the Craftsman and Art; (3) Walter Pater; or, the Connoisseur and Art; Mr. W. P. Pycraft, Two Lectures on Phases of Bird Life: (1) Flight; (2) Migration; and Mr. W. L. Courtney, Two Lectures on Types of Greek Women; Nausicaa and the Homeric Women; Sappho and the Aeolian Poets; Aspasia and Pericles. The Friday Evening Meetings will be resumed on April 28th, when a Discourse will be given by Professor W. M. Flinders Petrie on The Revolutions of Civilization. Succeeding Discourses will probably be given by Professor Martin O. Foster, Professor William Stirling, Professor R. W. Wood, Professor Gilbert Murray, Commendatore G. Marconi, Professor Svante Arrhenius, and other gentlemen.

THE FACE OF THE SKY FOR APR

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

THE SUN.—On the 1st the Sun rises at 5.39, and sets at 6.29: on the 30th he rises at 4.37, and sets at 7.17. The equation of time is negligible on the 16th and 17th, hence these are convenient days for the adjustment of sundials, as only the longitude correction is needed. Sun-spots may usually be seen on the solar disc, but they are small, and not numerous. The positions of the Sun's axis, equator, and heliographic longitude of the centre of disc are shown in the following table:—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Apl. 1 ...	26° 18′ W	6° 31′	188° 56′
" 6 ...	26° 26′ W	6° 13′	122° 58′
" 11 ...	26° 23′ W	5° 52′	56° 58′
" 16 ...	26° 10′ W	5° 29′	350° 56′
" 21 ...	25° 45′ W	5° 3′	284° 54′
" 26 ...	25° 9′ W	4° 35′	218° 51′
May 1 ...	24° 22′ W	4° 6′	152° 46′
" 6 ...	23° 24′ W	3° 35′	86° 41′

On April 28th, a total eclipse of the Sun takes place. It is invisible in this country; the path of totality lies almost entirely over the Pacific Ocean, no large piece of land falling in the shadow. A party of observers left England in February for Vav-au, one of the islands in the Tonga or Friendly Group, in Mid-Pacific, where totality lasts for about three-and-a-half minutes.

THE MOON:—

Date.	Phases.	H. M.
Apl. 6 ...	First Quarter	5 55 a.m.
" 13	Full Moon	2 37 p.m.
" 21	Last Quarter	6 30 p.m.
" 28	● New Moon	10 25 p.m.
May 5	First Quarter	1 14 p.m.
Apl. 2	Perigee ...	8 12 a.m.
" 18	Apogee ...	6 42 a.m.
" 30	Perigee ...	0 0 a.m.

OCCULTATIONS.—No bright stars are occulted before midnight either in April or May.

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
Apl. 1 ...	1 24	N 9° 25′
" 11 ...	2 25	16° 52′
" 21 ...	2 58	19° 55′
May 1 ...	2 55	18° 11′
" 11 ...	2 35	N 13° 48′

Mercury is an evening star throughout April. The planet is at greatest Easterly elongation from the Sun of 19° 42′ on the 15th, when he sets W.N.W. about 8.55 p.m. This elongation is a favourable one on account of the high declination, and there should be no difficulty in seeing the planet from the 15th to the 25th, as he sets about two hours after the Sun.

On May 5th, Mercury is in inferior conjunction with the Sun.

VENUS:—

Date.	Right Ascension.	Decln.
	h. m.	
Apl. 1	2 31	N 15° [illegible]
" 11	3 10	19° 7′
" 21	4 0	22° 15′
May 1	5 0	24° 25′
" 11	5 51	N 25° 29′

Venus is a brilliant object in the evening sky, looking W.N.W. after sunset.

The planet is well placed for observation, appearing fairly high above the horizon at sunset, and not setting till 9.20 p.m. on April 1st, and 10.50 p.m. on May 1st.

As seen through the telescope the planet appears gibbous, 0·8 of the disc being illuminated, whilst the apparent diameter of the disc is 13″. On account of her brightness the planet is fairly easy to pick up with the naked eye before it is dark, and this is the best time for making observations with the telescope, for Venus is a severe test for the achromatic qualities of any refractor if observed on the dark background of the sky; seen in a lighter sky the outstanding colour, in the telescope, due to want of perfect achromatism, is not so obtrusive, and a better view of the planet is obtained. The Moon will appear near the planet on April 1st, being only 0° 14′ to the South as illustrated in the March issue, whilst on May 1st the Moon will be 1½° to the North.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
Apl. 1	21 6	S 17° 51′
" 11	21 36	15° 42′
" 21 ...	22 5	13° 19′
May 1	22 34	10° 45′
" 11 ...	23 2	S 8° 3′

Mars is a morning star rising E.S.E. about 3.30 a.m., near the middle of the month. He is situated first in Capricorn, then in Aquarius. The planet is unfavourably placed for observation and since his apparent diameter is only 6″ telescopic observations are difficult except in large instruments.

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
Apl. 1 ...	14 44	S 14° 28′
" 11 ...	14 40	14° 9′
" 21 ...	14 36	13° 47′
May 1 ...	14 31	13° 23′
" 11 ...	14 26	S 13° 0′

Jupiter is a brilliant object in the late evening sky looking South-East. The planet is in opposition to the Sun on May 1st, hence about this date he appears South at midnight. On April 1st the planet rises at 9.20 p.m., and on May 1st at 7 p.m., and is visible throughout the night. The equatorial diameter on the 15th is 43″·6, whilst the polar diameter is 2″·8 smaller; this polar flattening is a conspicuous feature of Jupiter, and is readily observable in small telescopes; also the attendant bright moons and belt markings on the planet's disc form interesting objects of observation. The smallest telescope magnifying about 40 times, shows the planet of the same apparent diameter as the Moon seen with the naked eye, and the surface markings may readily be observed.

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

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.
Apl.				Apl.				Apl.			
4	III.	Tr. E.	[illegible]	15	I.	Ec. D.	10 4[illegible]	23	I.	Sh. E.	11 57
7	I.	Sh. I.	11 [illegible]	16	I.	Sh. E.	10 [illegible]	24	I.	Oc. R.	0 22
7	I.	Oc. R.	11 [illegible]	16	I.	Tr. E.	10 22	29	III.	Ec. D.	9 27
11	III.	Sh. I.	10 15	22	II.	Sh. I.	9 35	29	III.	Ec. R.	0 40
11	III.	Sh. E.	11 50	22	II.	Tr. I.	10 1	30	I.	Sh. I.	11 30
15	II.	Sh. E.	9 [illegible]	23	I.	Sh. I.	9 45	30	I.	Tr. I.	11 40
15	II.	Tr. E.	10 18	[illegible]	I.	Tr. I.	9 50				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn:—

Date.	Right Ascension.	Declination.
	h. m.	
Apl. 1	2 18	N 11° 28′
„ 16	2 25	12 6′
May 1	2 32	N 12° 43′

Saturn is observable for a few evenings during the early part of the month, when he appears in the W., between Venus and the horizon. During the greater part of the month the planet appears in too bright a portion of the sky to be observed. On May 1st the planet is in conjunction with the Sun and hence will be unobservable for some weeks following.

Uranus:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Apl. 1	20 4 34	S 20° 53′ 48″
May 1	20 6 29	S 20° 40′ 7″

Uranus is visible in the mornings, rising at 3.18 on April 1st and 1.21 on May 1st. The planet is situated about 2° S.E. of σ Capricorni: he is in quadrature on the 20th April and at the stationary point on the 4th May.

Neptune:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Apl. 1	7 20 55	N 21° 31′ 41″
May 1	7 22 5	N 21° 30′ 19″

Neptune is on the meridian at 6.45 p.m. on April 1st and at 4.47 p.m. on May 1st, and sets at 2.46 a.m. and 0.49 a.m. on these dates. The planet is situated in Gemini about $3\frac{1}{2}$ degrees S.E. of the star δ Geminorum.

Meteor Showers:—

Date.	Radiant. R.A.	Radiant. Dec.	Name.	Characteristics.
	h. m.			
Apr. 17–May 1	16 0	+47	τ Herculids	Small; short.
„ 20–21	17 24	+36	π Herculids	Swift; bl. white
„ 20–22	18 4	+33°	*Lyrid Shower*	Swift.
„ 30	19 24	+59	o Draconids	Rather slow.

Algol may be observed at minimum on the 3rd at 8.52 p.m. and on the 23rd at 10.35 p.m. Its period is $2^{d}\ 20^{h}\ 49^{m}$, from which other minima may be deduced.

Telescopic Objects:—

Double Stars.—γ Virginis, XII.^{h} 37^{m}, S. 0° 54′, mags. 3, 3; separation, 6″·0. Binary system; both components are yellow, though one is of a deeper hue than the other. An eyepiece of magnifying power of 30 or 40 is required on a 3-in. to effect separation.

π Boötis, XIV.^{h} 36^{m}, N. 16° 53′, mags. 4, 6; separation 6″. Requires a power of about 40.

ϵ Bootis, XIV.^{h} 41^{m}, N. 27° 30′, mags. 3, $6\frac{1}{2}$; separation 2″·6. Very pretty double, with good colour contrast, the brighter component being yellow, the other blue-green.

ξ Boötis, XIV.^{h} 47^{m}, N. 19° 31′, mags. 5, 7; separation 2″·4. Binary; one component being orange, the other purple.

Clusters.—M 3 (*Canes Venatici*) XIII.^{h} 38^{m}, N. 28° 48′. This object, though really a globular cluster of myriads of small stars, appears more like a nebula in small telescopes. It is situated between Cor Caroli and Arcturus, but rather nearer the latter.

NOTICES.

PLASKITT'S SIMPLEX CALCULATOR.—We have received from Mr. F. W. K. Plaskitt, F.R.M.S., a copy of a series of tables, printed on a handy card, for finding the day of the week of any particular date. The tables are easy to work with, the amount of calculation is small, and so far as the results have been tested they have always been correct. The price is $6\frac{1}{2}$d. post free, from the Author at 12, Woodbeech Street, E.C.

APPARATUS FOR USE IN PLANT PHYSIOLOGY.—Our botanical readers will be interested to know that Messrs. Bausch and Lomb are now able to supply sixteen important pieces of apparatus from among those which have been designed by Professor Ganong, of Smith College. To a new catalogue of these, Professor Ganong contributes an introduction, in which he says that it diverts time and energy from the phenomena of the plant to centre them on a somewhat slovenly kind of mechanics, and a wholly wrong ideal is inculcated of the nature of scientific work which is based on precision, logic and quantation. What is there peculiar in plant physiology, he asks, that in it alone of all the sciences it is better to do imperfect work with self-made tools than to exact work with good tools made expressly for the purpose.

The apparatus includes a clinostat, a photosynthometer, light screens, potometers, and smaller but equally useful contrivances.

The list can be obtained on application to Messrs. Bausch and Lomb's London address, 19, Thavies Inn, Holborn Circus, E.C.

MESSRS. NEWTON & CO.'S NEW CATALOGUE.—We have received a copy of Messrs. Newton & Co.'s new catalogue of X-Ray and Electro-Medical Apparatus which runs into 167 pages. By an ingenious arrangement it is possible to turn at once to any section of the catalogue, whether it be that concerned with X-Ray work, or apparatus dealing with medical electrical currents, light, or high frequency.

THE MICROSCOPE AND SOME HINTS ON HOW TO USE IT.—Mr. E. Leitz has issued a useful little pamphlet under the title given in our side-heading. It should be especially useful to beginners, as it describes the parts of a microscope in detail and explains the terms such as aperture, resolving power and so on, which are applied to it. There are paragraphs on such topics as focussing, and the making of measurements under the microscope, while three pages are devoted to general hints as to the treatment and care of the instrument.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, D.Sc.

DIAMETERS OF STARS.—The question of the diameters of the stars is at once a most interesting and a most difficult one. Both the late Mr. R. A. Proctor and Major Macmahon have suggested using occultations of stars by the Moon for this purpose, the former by putting the star image into rapid rotation and noting the arc over which fading extended, the latter by trying to record the disappearance on a photograph of large scale. However, it is improbable that either of these schemes is workable, and they would be limited to stars near the Ecliptic. M. Charles Nordmann has attacked the problem in another manner, (*Comptes Rendus de l'Académie*, 1911, January 9th.) It is clear that the problem would be soluble if we knew the distance of a star, its brightness compared with the Sun's at an equal distance and the ratio of its surface brightness to that of the Sun. The first datum is known with tolerable accuracy for the nearer stars; the second follows from it; the third is the most difficult, but M. Nordmann has given a formula for the "intrinsic effective brightness" based on a study of the relative intensity of different positions of the visible spectrum. (Thus it is generally admitted that the stars with the Sirian type of spectrum have a greater surface brilliance than those with the solar type, and still more than those of a decided red colour). This is obviously the most open to doubt of the assumptions, but we may take M. Nordmann's list as giving at least a rough idea of the dimensions of some of our stellar neighbours. He takes the Sun's stellar magnitude as −26·83, which is the result of recent Harvard measures and is in good accord with the mean of the best previous results.

Star.		Mag.	Assumed Parallax.	Effective Temperature.		Diameter Sun's 1
Sirius	...	−1·58	0·″37	12,200° (Cent.)		1·13
Proczon	...	0·48	0·″30	6,810	..	1·35
Aldebaran	...	1·06	0·″15	3,500	..	13·50
Capella	...	0·21	0·″12	4,720	..	8·26
Vega ...	...	0·14	0·″12	12,200	..	1·57
γ Cygni	...	2·32	0·″10	5,620	..	0·92
α Persei	...	1·90	0·″08	8,300	..	1·83
Polaris	...	2·12	0·″07	8,200°	..	1·93
β Andromedae		2·37	0·″07	3,700°	..	13·0
β Persei (Algol)		2·10	0·″05	13,800	..	1·29

It will be seen that Aldebaran and β Andromedae are the giants of the list, the result for the former being entitled to more weight owing to the greater parallax. The above value would make the apparent diameter of Aldebaran 0″·018, which, as M. Nordmann points out, would require an aperture of twenty feet for its direct measurement. A direct occultation of this star by the Moon would occupy one-thirtieth of a second, which might be increased two or three times or even more, in an oblique occultation. It will be seen that, according to the figures, Aldebaran surpasses our Sun in size more than our Sun does Jupiter. The likelihood that Sirius does not greatly surpass the sun in size, in spite of its great brilliance, was already inferred from the fact that its mass is only double his, so the new value is quite reasonable. Arcturus, not included in this list, is another great sun: Miss Agnes Clerke said of it:—"Perhaps the most stupendous orb within our imperfect cognisance."

THE SYSTEM OF ALGOL.—Algol, the last star on the list, was the first to have its diameter measured by Vogel using the spectroscopic method to find the rate of motion; assuming the densities of Algol and the companion to be equal, he found 1,061,000 miles for the diameter, or [illegible] a result, independent of the parallax, and [illegible] to that independently found by M. Nordmann. [illegible] beautiful investigation of this system has recent[illegible] [illegible]ied by Mr. Joel Stebbins, of the University of Il[illegible] [illegible]*rophys Journ.*, October, 1910). He uses a selen[illegible] [illegible]meter attached to a twelve-inch refractor. An out-of-[illegible] image of the star, seven millimetres in diameter, is thr[illegible] ten seconds on a selenium plate, which is in an electr[illegible] circuit forming one arm of a Wheatstone bridge; the galvanometer deflection is measured, and corresponding readings taken on α Persei and δ Persei for comparison. The method is far more sensitive than that of visual comparisons, and reveals (what had long been visually sought in vain) a secondary minimum when the companion is occulted by Algol, the depression being 0·06 magnitude. He infers that, taking the parallax 0″·05, the side of the companion nearest Algol gives six times the light of the Sun, and the other side three times. The difference is inferred from the fact that a continuous increase in light is noted from principal minimum to secondary minimum, and the probable explanation is the tremendous radiation from Algol to which it is subjected. On different assumptions as to the distribution of density in the system, the estimates of the diameter of Algol range from 0·81 to 1·45 of the Sun, the companion being one-seventh larger than the primary, and the eclipses partial; the apparent ellipse being about 8° open. On all the hypotheses the surface brilliancy of Algol is much greater and its density much less than those of the Sun.

Mr. Stebbins is to be congratulated on his successful application of the selenium cell, which will doubtless in the future be largely employed for measuring small light changes. The idea is not new, but previous attempts have not met with equal success. One necessary precaution is to enclose the cell in an ice-box, its sensitiveness being greatly increased.

THE EIGHTH SATELLITE OF JUPITER.—This tiny body will be out of reach at Greenwich for some years, while Jupiter is south of the Equator; it is therefore a matter of satisfaction that it was photographed during February with the large reflector at Helwan in Egypt. The positions are within some 20″ of these predicted. The error can be removed by increasing the adopted period (738·9 days) by a quarter of a day, and making a very slight increase in the eccentricity. This satellite will ultimately give a very accurate mass of Jupiter, but it must be observed over a larger arc before it can be fully utilised for this purpose.

ADOPTION OF WESTERN EUROPEAN (GREENWICH) TIME IN FRANCE.—This adoption took effect on March 10th, the date of the meeting of the Royal Astronomical Society, who passed a resolution authorising their President to despatch a telegram of congratulation to the President of the French Republic. An important advance is thus made towards the attainment of the ideal universal time, the minutes to be the same everywhere, while the hours change in each zone of 15° of longitude.

BOTANY.

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

SOME RECENT WORK ON GEOTROPISM.—Giltay (*Zeitschr. f. Botanik. 1910*) has recently discussed and criticised various methods of experimentation on the problems of geotropism, and has called attention to a point which is often overlooked by students of Vegetable Physiology, namely, that we have never proved that gravitation is the *only* stimulus involved in the turning of the primary root towards the centre of the earth. Long ago, Knight (1806) showed that as the centrifugal force was increased on a centrifuge with a vertical axis, the root and stem assumed a more nearly horizontal position, but he did not show any relation between the position of stem and root and the resultant of the two forces involved—gravity and centrifugal force; that is, Knight showed that at least in part the so-called geotropic stimulus is the gravity stimulus, but he did not show that the gravity stimulus is the only stimulus involved. Giltay devised a special centrifuge in order to test whether the position taken up by the root and stem is in reality the resultant of the two forces, and found that this is the case, with slight deviations that could be accounted for by variations in the speed of rotation and the variation of the roots themselves. Hence it may be assumed that the geotropic stimulus is identical in Nature with the gravity stimulus and with that of centrifugal force.

Since 1880, when the Darwins published ("Power of Movement in Plants") the results of their experiments on the behaviour of decapitated roots, there has been a good deal of controversy regarding the perceptive region of the root. Czapek (*Jahrb. wiss. Bot.*, 1895) caused the root-tip of seedlings to grow into a boot-shaped glass cap, and showed that when the terminal portion (1.5 millimetres long) of the capped root was placed horizontally, the portion outside of the "boot" curved so as to bring the root-tip into the position of equilibrium—the vertical position. On the other hand, if the seedling was fixed so that the tip was vertical and the rest of the root horizontal, no curvature took place, the root simply continuing to grow without changing the position of the tip or of the elongating zone. These results were interpreted to mean that only the apical one or two millimetres of the root was sensitive to gravitation, and it was generally thought that the matter had been finally settled. The simple experiment of cutting off two millimetres of the root tip, though it destroyed the sensitiveness of the root, had been objected to on the ground that the wounding might have also destroyed the sensitiveness of the elongating zone behind the wound, but Czapek's ingenious experiment was regarded as final, though Jost and a few other writers have steadily maintained that the question is still open. Newcombe (*Beih. Bot. Centralb., Band xxiv., Abt. i.*), after upholding these objections and pointing out that "neither Czapek's nor any other method so far employed has or can prove the restriction of the perceptive region to the apical two millimetres of the root," proceeds to show (1) that all the phenomena observed accord equally well with the view that sensitiveness extends through the entire growing zone, but becomes diminished from the apex backwards, or the view that sensitiveness is uniform through the growing zone, but the tendency to automatic curvature—autotropism—is stronger in the hinder than in the apical region; (2) experiments on the centrifuge with decapitated roots show that geotropic sensitiveness is present more than four millimetres distant from the tip. It must be admitted, of course, that in a question of this kind the same results may be interpreted in diametrically opposite ways by different observers, but it would certainly appear that we should keep an open mind on the matter. Newcombe's paper is of importance as a reminder that even the most fundamental questions relating to reflex actions in plants are by no means settled yet, and that much further work is necessary before it will be possible to obtain a clear picture of what happens in the growing tip of a root when it emerges from the seed and grows down into the soil.

Another aspect of geotropism has just been re-investigated by Nienburg (*Flora, Band 102*, 1911) in connection with the movements of twining stems. Nienburg's work, like that of Newcombe on the root, was done largely with centrifugal apparatus, and he also has obtained results at variance with those of previous investigators. In 1881, it was shown by Schwendener that the rotating movements of twiners like Hop or Convolvulus, are not made by the stem when the plant is kept revolving on a klinostat, and later it was suggested by Noll that twining stems make a peculiar response to the stimulus of gravitation, in that growth is promoted on one flank, instead of on the upper side as in a root, or the lower side as in an ordinary stem. This response was termed "lateral geotropism," its result being a revolving motion of the shoot apex. The clasping of supports by tendrils, like those of Peas or Vines, is, of course, an entirely different phenomenon, due to contact irritability. From his experiments, Nienburg concludes that all the facts observed in the growth of twining plants can be explained as due to the combined action of autonomous rotation (nutation) and ordinary negative geotropism, and that neither Noll's experiments nor those of later writers have established the existence of any such thing as "lateral geotropism." However, it would appear that here again we have an as yet unsettled question, and one which requires further investigation with the aid of klinostat, centrifuge, and other methods of experimentation.

The curious "peg" or "heel" that grows out from the seedling of Cucumber, Marrow, and other Cucurbitaceae, and which holds down the seed-coat and helps the young shoot to escape, has been recently investigated carefully by Crocker, Knight, and Roberts (*Bot. Gaz.*, November, 1910). According to Francis Darwin, Cucurbit seedlings allowed to germinate on a slowly-rotating klinostat produce pegs completely surrounding the young shoot, and therefore appearing like a collar, and he concluded that gravity determines the lateral development of the peg, and that therefore this experiment shows that gravity is continually effective on the klinostat and is simply equalised in its action on the several flanks of the rotated object; he also used the peg as a support for the memory theory of plant response, assuming that its development and position are directly determined by gravity. Crocker, Knight, and Roberts, as the result of many experiments, conclude that there is no evidence that gravity acts as a direct stimulus to the lateral development of the peg, or that it leads to increase in size of the peg; that if the young shoot (hypocotyl) is prevented from arching, the peg develops equally all round; that the lateral development of the peg is simply brought about by the arching of the hypocotyl, the most effective factor in this arching being the contact of the seed-coat.

CITRIC FERMENTATION.—Since Wehmer in 1893 described the process of citric fermentation and showed that it is due to a mould-like fungus, *Citromyces*, several workers have dealt with the subject, and Wehmer has recently given a critical summary of their papers and of his own further researches on citric acid fermentation, and the Citromycetes (*Zeitschr. f. Bot., Heft 2*, 1911). The process is evidently in the main one of oxidation of sugar—especially of malt, cane, and grape sugars—and under favourable circumstances as much as fifty per cent. of the sugar may be converted into citric acid. The three sugars named yield the largest proportion of the acid when acted on by the fungus, but a fair yield is obtained from glycerine (nearly thirty per cent.), and much smaller quantities or merely traces from various sugars, inulin, alcohols. Up to the present it is doubtful whether the action is caused by an enzyme produced by the fungus, for negative results have been obtained with expressed sap and with killed fungus. Many interesting questions regarding the mode of action of the citric acid fungus arise from recent investigations. It has been suggested that since acid is formed, though sparingly, in the absence of free oxygen, the first step in the action must be the splitting of the sugar into carbon dioxide and alcohol—as in alcoholic fermentation. The alcohol would then be oxidised with the production of citric acid, this second action or citric fermentation proper corresponding with the analogous processes of lactic and acetic fermentation.

RECENT WORK ON THE GNETALES.—The remarkable group Gnetales includes the three genera *Gnetum*, *Ephedra* and *Welwitschia*, which differ from all other Gymnosperms in having compound inflorescences, a long micropylar tube, and true vessels, and which make a further approach to the Angiosperms in the fact that except in *Ephedra* the archegonia are reduced to isolated cells. Various writers have suggested that the Gnetales form a transitional group between Gymnosperms and Angiosperms, though it seems more likely that they had a common ancestry with the Angiosperms, and developed parallel with them. Porsch (*Ber. deutsch. bot. Ges.*, 1910) has shown that *Ephedra campylopoda*, found in the south of Europe, is not only adapted for insect-pollination, but is regularly visited by insects. In his interesting memoir on this the first established case of insect pollination among the Gymnosperms, Porsch shows that the yellowish-red colour of the inflorescences attracts insects, which feed on the sticky pollen, and that nectar is provided in the form of drops which ooze from the micropyle. The insect-visitors included thirteen species of Hymenoptera and Diptera, which were found to carry the pollen on the underside of their bodies. Since secretion of sugary liquid occurs in the flowers of *Gnetum* and *Welwitschia*, it is very likely that these genera also are insect-pollinated, though, until now, it has been supposed that the function of the liquid which oozes from the micropyle, is simply that of catching pollen blown by the wind, in much the same way as in the female cones of pines. Pearson (*Phil. Trans. Roy. Soc.*, 1909) had already suggested that the flowers of *Welwitschia* are insect-pollinated, and in this plant there are glandular outgrowths below the anthers which doubtless act as honey-glands. Pearson has also described, though not fully, the development of the ovule of this remarkable genus. The endosperm begins, as usual, in Gymnosperms, with free nuclear division, forming an embryo-sac with approximately one thousand and twenty-four free nuclei, representing ten successive divisions. These nuclei are distributed through the sac, so that when cell-walls are formed the sac is divided into multinucleate cells; those in the micropylar (upper) region contain fewer nuclei than the others, and they become the nuclei of free eggs. The cells of the lower three-fourths of the endosperm contain many nuclei, and these fuse and form a uninucleate tissue—the primary endosperm, which continues to grow both before and after fertilisation. The multinucleate cells of the micropylar region send out tubes into the overlying nucellar tissue, into which the free nuclei pass, and these prothallial tubes meet the pollen-tubes in the lower half of the nucellar cap.

CHEMISTRY.

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

COMBUSTION OF GASES WITHOUT FLAME.—A new property of copper is described by M. J. Meunier in the *Comptes Rendus* (1911, clii. 194). On heating a wire of pure copper in the luminous flame of a Bunsen burner until all surface oxide has been reduced to metallic copper, and then admitting air the wire will begin to glow. On now lowering the hot copper into the tube of the burner, the steady glow will continue without igniting the mixture of air and gas in the tube. The maximum intensity of glow is obtained when the proportion of gas in the mixture is about 30 per cent. During this slow combustion the copper is rendered exceedingly brittle and may readily be reduced to a powder of crystalline appearance.

CELTIUM: A NEW ELEMENT.—M. G. Urbain describes in the *Comptes Rendus* (1911, clii. 141), a new element for which he suggests the name *Celtium* and the symbol Ct. It was found accompanying the elements luteciun and scandium in gadolinite earth, and was isolated from the mother liquor obtained in the separation of lutecium. In its general properties it is intermediate between these two metals, and differs from both in its magnetic permeability and in its spectrum. Its chloride is more volatile than that of lutecium, but less volatile than that of scandium, while its hydroxide is a stronger base than scandium hydroxide, but is weaker than lutecium hydroxide. Its atomic weight has not yet been determined.

HELIUM IN THE AIR OF VESUVIUS.—In the only recently published proceedings of Section II of the Seventh International Congress of Applied Chemistry of 1909 (pages 83–86), Mr. A. Piutti gives an account of his investigation of different incrustations from Vesuvius which at various periods he has tested for helium. In each case the substance was heated and the gas emitted was absorbed by cooled charcoal. A specimen of sanidinite from Vesuvius yielded 0·106 c.c. of gas per gramme [illegible] ctivity was found to be principally due to the pre[illegible]con crystals, and these, like the gas, contained heli[illegible]

In like manner a specimen of pink [illegible] which yielded 0·511 c.c. of gas per gramme was foun[illegible] helium, and this element was also identified in the ai[illegible] as well as of Vesuvius.

Its presence was also proved in the zircons fro[illegible] many other localities, and in the case of large tou[illegible] from Madagascar the green outer portion was more radi[illegible] and contained more helium than the inner light pink part. In general, though not invariably so, the proportion of helium corresponded with the degree of radio-activity.

SPONTANEOUS IGNITION OF COAL.—The results of a bacteriological investigation of the spontaneous combustion of coal, by Mr. E. Galle, an outline of which is given in the *Chem. Zentralbl.* (1911, I. 48), have suggested several interesting conclusions. Cultivations were made both in the presence and absence of air, and seven species of bacteria were isolated from coal. Of these, four species (*B. nacraceus*, *B. subtilis*, *B. mesentericus*, and *B. pseudosubtilis*) were found to be capable, when grown on suitable nutrient media in the presence of coal dust, of producing combustible mixtures of gas containing from 5·4 to 27·3 per cent. of carbon dioxide, and 71·5 to 84·8 per cent. of methane, together with traces (less than three per cent.) of carbon monoxide, oxygen, and heavy hydrocarbons. Only *B. nacraceus* and *B. pseudosubtilis* produced these latter gases. The conditions under which these mixtures of combustible gases were produced were perfectly comparable with those that would occur in nature, and there is therefore every reason for assuming the possibility of their production by bacteria in coal measures.

Hence, while the spontaneous ignition of coal cannot be attributed exclusively to bacteriological activity, it is not improbable that bacteria may be an important factor in its occurrence.

FIRE-PROOF AND SUBMARINE PAINTS.—An abstract of a paper read before the Seventh International Congress of Applied Chemistry of 1909, by M. Coffignier, is published in the *Journ. Soc. Chem. Ind.* (1911, xxx., 223). In fire-proof paints the principle adopted is to incorporate with the other ingredients of the paint an ammonium salt, which under the influence of heat, will give off ammonia, and so produce an atmosphere unfavourable for combustion. The solubility of most ammonium salts renders them unsuitable for this purpose, but good results have been obtained by mixing the pigment with insoluble ammonium magnesium phosphate and a special medium consisting of linoleate of lead in oil of turpentine.

In 1895, a special submarine paint was prepared by Holzapfel, the object being first coated with an anti-corrosive deposit, and then with a second layer containing toxic substances. Owing to the reactions which occurred between the two layers, however, the paints were liable to crack, and would not last for more than about six months.

Recently this drawback has been remedied by the production of a paint in which the outer coating consists of an amalgam of copper incorporated with an earthy pigment and a waterproof medium.

As soon as marine organisms attack this coat the amalgam is exposed, and voltaic currents are produced which set free poisonous compounds of copper and mercury and destroy the intruders. Thus the action is only brought about in places where it is necessary, and the life of the paint is doubled.

GEOLOGY.

By Russell F. Gwinnell, B.Sc., A.R.C.S., F.G.S.

THE GEOLOGICAL SURVEY OF SCOTLAND.—Three colour-printed sheets of the one-inch map of Scotland have recently been issued, together with memoirs on the same districts. Two of these (Edinburgh and Haddington) are new editions; the third is the long-expected Glenelg sheet, which includes the eastern half of the Isle of Skye. This Glenelg sheet, in particular, is a splendid example of colour-printing. Nearly sixty different shades of colour (including hatched and stippled patterns) are used, and a large number of dykes and sills are mapped, so that altogether the map is very complicated: but nevertheless the use of colour-printing has made it possible to issue the sheet at the low price of half-a-crown. The issue of this sheet and memoir is opportune, as the Geologists' Association (of London) will be visiting the district this coming summer, under the guidance of one of the Survey officers, Mr. Alfred Harker, M.A., F.R.S., whose work on the Tertiary Igneous Rocks of Skye is so justly celebrated.

The ancient Lewisian and Moine rocks of the Glenelg area are dealt with in detail in the memoir and some interesting lithological types described, such as the brilliantly-coloured eclogites and garnet-amphibolites, with a garnet-fuchsite rock (containing the vivid green chrome-mica, fuchsite). Lewisian limestones occur containing various silicates, especially diopside, which sometimes forms masses up to several yards across, also abundant forsterite crystals and great poikilitic plates of phlogopite enclosing grains of calcite. As to the puzzling Moine schists some evidence appears to indicate that these were laid down *unconformably* on the Lewisian gneiss, and, while no definite conclusion is reached, various facts suggest that they may be altered representatives of Torridonian sediments.

A large relief-model of Central Skye has been constructed, which brings in most of the western half of this Glenelg sheet. There are copies of this model at the Survey Museum (Jermyn Street), at the Science Museum (South Kensington), at the coming Coronation Exhibition, and elsewhere.

The memoir on "The Geology of the Neighbourhood of Edinburgh" was first published in 1861. The new edition, the second, forms a valuable guide to this interesting district. The main geological interest lies, perhaps, in the igneous rocks, and the petrography of these forms an important part of the volume. Noteworthy are the numerous highly-alkaline types, often containing analcite, as, for example, the associated Essexites, Teschenites and Picrites, as well as Mugearite. This last peculiar type, first described by Harker from the Tertiary Series in Skye, and recorded in this memoir from the Carboniferous of Edinburgh, has also been found in the neighbourhood of Glasgow, while within the last few weeks Mr. H. H. Thomas has proved its occurrence in the Ordovician volcanic series of Skomer Island, Pembrokeshire (*Abstract of the Proceedings of the Geological Society*, February 1st, 1911). The main peculiarity of this type lies in the paragenesis of olivine with such alkaline felspars as oligoclase and even orthoclase.

The structure and age of the old volcano of Arthur's Seat, Edinburgh, has long been a subject of contention. On the one hand MacLaren, over seventy years ago, maintained that it represented two entirely distinct series of volcanic outbursts, separated by a vast interval of time, the older being of Lower Carboniferous age. This interval was marked by the deposition, subsequent upheaval and removal by denudation of at least three thousand feet of Carboniferous strata. In the first edition of the present memoir, Geikie followed this view and considered the supposed younger volcanic series to be probably of Tertiary age, but later he referred them to the Mesozoic, and then to the Permian. Professor Judd, in 1875, advocated the theory that the supposed second series of volcanic outbursts had no existence, but that all the rocks are the result of a single and almost continuous series of eruptions confined to the Lower Carboniferous period. The evidence obtained during the recent revision of Arthur's Seat by the Geological Survey has confirmed Professor Judd's contention.

ORIGINAL GNEISSOSE BANDING.—The term "gneiss" covers a multitude of rocks, which differ vastly not only in composition, but in mode of origin. Their only community lies in the possession of that foliated character known as the gneissose structure. Some have been derived from sedimentary rocks (the *paragneiss* of Rosenbusch, *epigneiss* of Reusch and *metagneiss* of Lepsius); others are of igneous origin (*orthogneiss* of Rosenbusch), while in others (the *protogneiss* of Lepsius) some see the primary crust of the earth. Yet another type, the *adergneiss* of Sederholm, is both igneous and sedimentary in origin, the foliation being the result of the injection of many veins of pegmatite into a sedimentary rock, so that the sediment becomes thoroughly permeated by igneous material. This type is described among the Lewisian rocks of the Glenelg area in the memoir already referred to in these columns.

But confining our attention to orthogneisses only, we find several distinct types, of which the most usual has—at any rate in the past—been regarded as due to regional metamorphism. Professor G. H. Williams was one of the early exponents of the school which laid great stress on this mode of origin. Another possible means of producing foliation in igneous rocks (of plutonic type) is by successive intrusions of magma of different composition into the same consolidation site. Thus Harker accounts for the coarser banding of the peridotites of Rum in the Inner Hebrides. There remain two very similar methods, the intrusion of one molten mass already heterogeneous and the simultaneous intrusion of two different magmas. The finer banding of the Rum peridotites and the foliation of gabbro in the Cuillin Hills, Skye, have been explained in this manner, as well as a perfect banding in the dioritic complex of the Island of Orno, near Stockholm.

The foliation in the Cortlandt Series—an igneous complex ranging from granite through syenite, monzonite, diorite, gabbro and norite to pyroxenite and peridotite, occurring about thirty-five miles north of New York City—has been dealt with by several authorities. Professor J. D. Dana regarded the rocks as worked-over sediments, volcanic ashes or tuffs which, on being subjected to intense local metamorphism, lost most of their bedded structure and became pseudo-massive; later he treated them no longer as paragneisses but as of igneous origin (orthogneisses), and Dr. G. H. Williams, in 1886, regarded the foliation as due to regional metamorphism. In *The American Journal of Science* for February, 1911, G. S. Rogers demonstrates the origin of these rocks (where norite and pyroxenite form alternate layers of constant grain) to be by "magmatic differentiation," as in the cases of the Rum peridotites and the Skye gabbros.

Up to the present this original gneissoid banding has not been recognized in many localities; it may, however, prove illuminating (especially if found to be more common than is at present thought) in connection with some of the puzzling structures of the ancient and obscure igneous gneisses.

THE HARDNESS OF MINERALS.—In spite of all criticisms Mohs' scale of hardness still holds its place as the standard of reference in Mineralogy. Breithaupt interpolated two extra minerals between numbers 2 and 3 and 5 and 6 respectively, converting Mohs' scale of ten minerals into a scale of twelve, in the attempt to make the intervals between successive numbers more uniform. By various methods of estimating "absolute hardness," Pfaff, Jaggar and others, shewed that the intervals are far from uniform, and thus the series of figures representing absolute hardness form a progression which does not approximate either to arithmetical or geometrical progression. But most noteworthy are Rosiwal's figures, obtained in 1892, which show that Topaz (number 8 in Mohs' scale, where 1, the softest, is Talc, and 10, the hardest, is Diamond) is softer than Quartz (number 7). Thus in detail *inversion* of the correct order is indicated.

Rosiwal obtained his figures by using a standard abrasive to grind the mineral surface, and determining the loss of weight suffered by the mineral when a given weight of the abrasive was used up. In *The American Journal of Science*, February, 1911, H. Z. Kip describes how he obtained a similar result by a different method, which depends on the force required to produce abrasion on the mineral, by a diamond-point sclerometer.

"Pfaff, Jaggar and others who arrive at the opposite conclusion, have failed to eliminate the factor of density in carrying out their tests. In other words, while regarding hardness as *resistance to abrasion*, they have sought to determine its value on the theory that it was to be measured in terms of *resistance to excavation*."

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

THE WEATHER of the week ending February 18th as detailed in the *Weekly Weather Report* issued by the meteorological office, was very warm for the time of year, with heavy rain in Scotland and Ireland and the Northern Counties of England, and moderate to scanty sunshine. The excess of temperature varied from 5°·6 in Scotland E., to 0°·6 in the English Channel. The maxima were above 50° at nearly every station, and reached 59° at Aberdeen on the 16th, and at Bawtry on the 18th. At Guernsey, however, the highest reading was only 51°. The nights were cold, and the minimum fell to 18° at Balmoral on the 12th, and to 21° at Cirencester and Swarraton on the same day. On the grass the temperature fell to 10° at Llangammarch Wells, and to 12° at Newton Rigg.

Rainfall was frequent and heavy in the North. At Glencarron it rained every day, and the total for the week was 6·94 inches; at Fort William 5·39 inches were collected. At Westminster the total was only 0·25 inch in three days.

Sunshine varied a good deal in different parts. At Newquay the total duration was only 7·0 hours, as compared with an average of 19·4 hours, while at Eastbourne it was 29·7 hours, or 11·3 hours above the average.

The mean temperature of the sea water varied from 47°·5 at Scilly to 38°·1 at Cromarty.

The weather of the week ended February 25th was very changeable. There was a good deal of rain, but bright intervals were common. Snow was plentiful in parts of Scotland, where also thunderstorms were experienced. Aurora was seen on several nights during the week.

Temperature was still unusually high in all parts. The highest reading was 59° at Dublin on the 21st, but readings of 58° were reported at several stations from Leith to Fulbeck (Lincoln) and Birr Castle. The lowest readings reported were 21° at Sunburgh Head and Balmoral. At Guernsey, however, while the maximum did not exceed 52°, the minimum did not fall below 40°, a range of 12°, as compared with a range of 28° at Sunburgh Head (49° to 21°). The lowest readings on the grass were 15° at Llangammarch Wells and 16° at Crathes.

Rainfall was in excess in all Districts except the English Channel, where it was just below the normal. In some places very heavy amounts were collected—thus at Glencarron the total was 5·01 inches, and at Fort William 5·60 inches. Including the amounts collected in the previous week the totals at these two stations for the fortnight were 11·95 inches and 10·99 inches respectively, or 8·39 inches and 7·45 inches, above the averages for the same period. In spite of the generally heavy rain sunshine was abundant in all districts. Dublin was the sunniest station with 36·9 hours (53%) but many stations reported upwards of 45%, Ventnor 47% and Torquay 48%. In Westminster the total duration was 24·5 hours or 35%. The temperature of the sea water varied from 49°—47° at Scilly to 39°—34° at Cromarty.

The week ended March 4th proved to be unsettled, with frequent rains. Aurora was seen in Scotland on the night of February 28th. Temperature continued above the average in all districts, the excess amounting to as much as 6°·7 in the Midlands, where 60° was reported as the maximum at Raunds, on March 2nd; 60° was also reported at Westminster on the same day. The maximum for the week at Jersey was 53° on the 3rd, on which day Strathpeffer reported 54°. The lowest minimum was 22° at Balmoral on the 27th. In Ireland and in the South of England no frost was experienced during the week. On the grass minima down to 19° were observed.

Rainfall was also in excess, except in England N.E. In England N.W. and S.W. the total for the week was double the average, but individual heavy falls were rare. Sunshine varied in different districts. In Scotland E. it was 11 hours (16%) in excess of the average, while in the Channel Islands it was 5 hours (6%) in defect. Crathes reported the most sunshine, 36·7 hours or 51%. At Westminster the duration was 18·3 hours, 25%. The temperature of the sea water varied from 51° at Seafield to 33° at Wick.

The week ended March 11th, w[illegible]d drier than those that had preceded it. Temperat[illegible] however, still above the average in many places, thou[illegible] great extent. In the South it was slightly in defe[illegible]ximum for the week was 57° at Killarney, on the 8th[illegible] other station in the British Isles was a reading hi[illegible] reported. In many places the maximum was bel[illegible] Frost was experienced in all Districts except the En[illegible] Channel, the lowest readings being 24° at Balmor[illegible] 25° at Fort Augustus and Llangammarch Wells. On [illegible] grass the temperature fell to 13° at Llangammarch, and to [illegible] at Kew and Tunbridge Wells.

Rainfall was variable. It was heavy in Scotland N. and in the South of England and Ireland, but not far from the normal in other parts, generally slightly below.

Sunshine as a rule was above the average, and the District percentages ranged from 46% in Scotland E. to 24% in the Midland Counties. The sunniest station was Gordon Castle, 40·5 hours or 53%. Westminster reported 10·4 hours or 13%.

The mean sea temperature was 47°·4 at Scilly and 38°·5 at Cromarty.

UPPER AIR RESULTS.—On February 14th, a kite at Pyrton Hill, when three thousand six hundred feet above the ground, entered a current of air, which, though moving in nearly the same direction, was 9° F. warmer and much drier, and had a velocity of 50% greater than that immediately beneath it.

On the 16th, at Brighton, a kite sent up by Mr. S. H. R. Salmon entered the clouds at only three hundred feet above the ground, and became unmanageable owing to the great increase in wind velocity.

ANCIENT RAINGAUGES.—It has generally been accepted that the first raingauge of which we have record was made by an Italian, Benedetto Castelli, a contemporary of Galileo, in 1639, but Dr. Y. Wada, the Director of the Korean Meteorological Observatory at Chemulpo, has given in the "Scientific Memoirs of the Korean Meteorological Observatory," Vol. I., an interesting account of the installation of a number of raingauges and the organization of a system of rainfall observation in the year A.D. 1442, or one hundred and ninety-seven years before Castelli. The account, which has been unearthed from the Korean historical records, tells how "King Sejo caused an instrument of bronze to be constructed to measure the rain. This is a vase fifteen inches deep and seven inches in diameter, placed on a pillar. The instrument has been placed at the Observatory, and each time rain falls the Officials of the Observatory measure the height with a measure and make it known to the King. These instruments were distributed to the Provinces and Cantons, and the results of the observations were sent to the Court."

MICROSCOPY.

By A. W. Sheppard, F.R.M.S.,

with the assistance of the following microscopists:—

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

TRANSMISSION OF FLAGELLATES IN FRESH-WATER FISHES.—At the meeting of the Royal Society held on February 23rd, Miss M. Robinson, M.A., read a paper on the above subject, of which the following is an abstract.

The goldfish in a pond at Elstree have for some years shown an infection of trypanosomes in their blood. Quite recently trypanoplasma has also appeared. Upon investigation it was found that the leech *Hemiclepsis marginata* occurred in the pond and effected the transmission of the parasites.

A large number of these leeches were obtained from the Grand Junction Canal reservoir, which is only a short distance from the pond. The young of these were hatched out in captivity, and it was ascertained that the flagellates are not passed from parent to offspring. The parent leeches were invariably infected with trypanosomes derived from the fish in the reservoir, which frequently showed these parasites in their blood.

The trypanosomes of perch, bream and goldfish were found to complete their cycle in *Hemiclepsis*, and could be transmitted to clean goldfish by means of leeches. The specimens used in these experiments were always young laboratory-hatched *Hemiclepsis*. The trypanosomes of pike and rudd also complete their cycle in this leech, but the opportunity of passing these two forms into goldfish did not present itself. The cycles of the trypanosomes derived from these different sources are apparently identical. The main features are as follows:—

The trypanosomes taken into the crop of the leech along with the blood multiply very rapidly, undergoing a marked change of form. After some days slender forms begin to arise. These increase in number, and at the end of digestion, some time after the blood has quite disappeared, they come forward and lie in the proboscis-sheath in very large numbers. The form found in the sheath is a very slender, long creature of quite definite type: division has never been observed in this phase.

When the leech feeds once more, these individuals are inoculated into the fish. The proboscis-sheath is always cleared of trypanosomes by one feed. After a clean feed the slender inoculative type of trypanosome disappears from the crop of an infected leech, and the infection is carried on by short, broad forms. Conjugation has never been observed.

If water is added to the blood of fish containing trypanosomes, the flagellates divide after a number of hours, probably in response to lowering of osmotic pressure in the fluid in which they find themselves.

ROYAL MICROSCOPICAL SOCIETY.—February 13th, 1911, Mr. H. G. Plimmer, F.R.S., President, in the chair. —Messrs. E. Heron-Allen and Arthur Earland read a paper illustrated by a series of lantern slides on new or rare species of Foraminifera found in the shore-sands of Selsey Bill, Sussex. The authors called attention to the identity of the fossil Foraminifera of the Bracklesham Beds with the living species found in Australian shore-sands. Recent specimens of *Bolivina durrandii* Millett and *Pulvinulina vermiculata* Brady, were shewn, the only other known records being as regards the former from the Malay Archipelago, and as regards the latter from tropical and sub-tropical seas. In addition to these, *Miliolina suborbicularis*, *M. rotunda*, *Textularia inconspicua*, *var. jugosa*, *Bolivina tortuosa*, *Uvigerina asperula*, *and Sagraina dimorpha*, were recorded as new to Britain. Schlumberayer's unique genus and species, *Hinderina brugesii*, was recorded from the Eocene clays. Also the first fossil records of *Bulimina subteres* and *Discorbina polystomelloides*. The new species recorded were *Pulvinulina haliotidea* H. A. and E., and *Nonionina quadriloculata*, H.A. and E. Specimens of these were exhibited under microscopes during the meeting.

Mr. Lees Curties described a new dark-ground illuminator which he had made to the instructions of Mr. E. M. Nelson, and which was so constructed as to work with slips ranging from 0·8 to 1·2 millimetres in thickness, and which gave a perfectly dark field with a Zeiss apochromatic four millimetres lens of 0·95 N.A. The illuminator was provided with a fixed central stop, and also with a slot for utilising the apparatus as an oblique illuminator. A small dot placed on the front lens served for the purpose of centring the condenser to the optical axis.

SOME WORKS REFERRING TO RED-SNOW.—Mr. James Murray has kindly prepared the following short bibliography on the subject of his paper (see "KNOWLEDGE," page 100): it will be of use to those readers who are desirous of carrying further the subject of "Red-Snow" and its occurrence.

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QUEKETT MICROSCOPICAL CLUB.—February 28th, 1911.—Mr. D. J. Scourfield, F.Z.S., F.R.M.S., Vice-President, having taken the chair, the President delivered his annual address dealing this year with "Some Problems of Evolution in the Simplest Forms of Life."

Taking, first, the visible world of living creatures, no deep reflection or analysis is required to grasp the fact that it does not constitute a chaos of isolated and unconnected forms, but is capable of being classified into greater or lesser categories. The first and most obvious division is into animals and plants.

But between the categories of greatest and least extent there are a number of intervening divisions, with regard to which the scientific and the non-scientific public are hopelessly at variance. The same is inevitably true in any branch of knowledge dealing with a variety of concrete objects, simply because the mind devoted to the study of any particular set of things, animate or inanimate, soon becomes perforce acquainted with so many more than ever come within the ken of the casual observer, that in order to arrange them in an orderly and intelligible system of classification, it is necessary to draw distinctions and institute comparisons which are never dreamt of in the philosophy of the mind occupied with other pursuits.

Professor Minchin then proceeded to review various systems of classification popularly recognised, as, for instance, the separation of vertebrates into two main groups, one with paired limbs, as in fishes, and the other in which the paired limbs are pentadactyle in type. Then, again, animals may be divided by their habitat into terrestrial, aquatic and aërial. But to all these systems we at once find exceptions. Many perfectly logical classifications are possible, but only one that is perfectly natural, and that one, very often, is not perfectly logical. It is now abundantly clear that natural groups can seldom, if ever, be defined by precise and rigorous verbal definitions. All that can be done is to construct for each group a more or less ideal and imaginary type of organism, possessing certain characters, none of which must be regarded as fixed or invariable. If we must have verbal definitions of groups, then logic requires the insertion of the word "typically" before each character ascribed to them.

In dealing with the Protista, the President considered that there are two well-marked types recognisable in these organisms, one more primitive and older in evolution, the other higher, and leading on to the ordinary plants and animals. The difference between these two types depends on the condition under which that peculiar substance occurs for which we may use, in quite a general sense, the term chromatin. In every cell of animal or plant, and probably in every Protist organism, there is found a certain amount of a substance remarkable for its affinity for certain colouring matters, and still more remarkable for the part it plays in all vital processes. From the first of these characteristics the name chromatin has been given to it. It is a substance, or combination of substances, of a very high degree of chemical complexity, perhaps more complex than any other substance, but it is by no means of uniform chemical composition. The term chromatin implies, in short, a biological or physiological, but not a chemical, unity.

In the lower type of Protist organisation, which is exemplified by the ordinary Bacteria, the chromatin is present in the form of scattered granules—"chromidia." In the second type a certain amount of the chromatin may still be present in the scattered chromidial condition; but the greater part, and in most cases all of the chromatin, is aggregated into a compact mass, the nucleus, and, apart from this nucleus, the remainder of the living body is made up of a distinct protoplasmic zone—the cytoplasm, scarcely recognisable in the bacterial type. With differentiation of nucleus and cytoplasm, the organism becomes a "cell." This type will be termed the "cellular grade." Reference was then made to the existence in all forms of higher life of sex and sexual differentiation, and even in the Protista we find sexual phenomena to be of universal occurrence in the cellular grade, but quite absent in the organisms of the bacterial grade. Much has been written, and many theories put forward, to explain the origin and significance of sex. Professor Minchin dealt briefly with only one, that put forward by Doflein, and founded by him on those enunciated previously by Hertwig and Schaudinn. This theory is, shortly, as follows:—Living cells are regarded as consisting of two groups of vitally active substances, the one regulating motor, the other trophic, functions. In cell-reproduction by fission, these substances are never distributed with mathematical equality amongst the descendants; hence continued reproduction of this kind brings about accumulations of different properties in certain individuals, with, as a consequence, impaired vital activity and reproductive power. Individuals are produced, some of which are richer in stored-up nutriment (female), others in motile substance (male). Since these two kinds of individuals contain aggregations of substances which have intense mutual chemical reactions, they exert an attraction one towards the other; the two individuals tend to unite, and by their union cell-equilibrium is restored and vital powers renewed. Hence syngamy is regarded as a necessity for the life-cycle, due primarily to the imperfections of cell-division and to the consequent loss of equilibrium in the cell-constituents. On this view, the general absence of sex phenomena in the lowest grade, and its existence in the higher, is readily intelligible. In the bacterial grade, the body, usually very minute, is of extremely simple structure. In such organisms, inequalities of cell-division, if they occur, can be adjusted easily by the rearrangement of the chromatin substance. On the other hand, with the evolution of the cellular grade, the body is differentiated into at least two parts, nucleus and cytoplasm, and becomes of increasingly complex structure. Consequently, an exact quantitative and qualitative partition of the body during cell-division is of extremely improbable occurrence—at least, until the mechanism of cell-division has reached its greatest perfection. The fact that in the Infusoria, the most complex in structure of all the Protista, syngamy is a frequent event and easy to observe, fits in also with the view that sex phenomena are in relation to complication of cell structure; and, conversely, the fact that in Protozoa of simple structure, such as the Flagellata, syngamy is rarer, and appears only to occur at long intervals in the life-cycle, also receives a simple explanation. From all these facts and considerations, it appears [illegible] table that sex and syngamy were "invented" when t[illegible] rade was evolved from the bacterial grade of structure [illegible] in, the speaker said, is related to another very imp[illegible] erty of living things—the more or less easy divisibil[illegible] which we now term species. No one now conside[illegible] as a fixed and immutable entity. Nevertheless, th[illegible] ins that the tendency of living things to separate the[illegible] to species more or less distinct is one of the most constant [illegible] universal peculiarities of the organic world.

From these considerations it is evident that the passage from the bacterial to the cellular grade was, perhaps, the most important advance in the evolution of living beings. The acquisition of the cellular type of structure was the starting-point for the evolution, not only of the higher groups of the Protista, but, through them, of the whole visible everyday world of animals and plants, in all of which the cell is the unit of structure, and which consists primarily of aggregates of cells. Further, with the cellular type of structure were initiated, in the speaker's opinion, two of the most universal and characteristic peculiarities of living beings—namely, the phenomena of sex and the tendency to form species.

Figure 1.

AN INTERESTING MICRO-OBJECT FROM A SINGULAR SOURCE.—The fungus known popularly as the truffle, and used as a flavouring, affords some interesting and instructive microscopical objects. At the same time it is not exactly easy to obtain, and it occurred to me to resort to the "truffle and liver sausage," so much in evidence at the foreign "*delikatessen*" shops, frequently found in some parts of London. The result was perfectly satisfactory; a thin slice of the delicacy yielding ample material for examination, and for mounting hundreds of slides had such been desired.

Several different species of the family *Tuberaceae* do duty as "truffles" in the popular sense, nor do they differ much from one another in character. As their name implies, they bear an outward resemblance to a tuber, such as a small potato or artichoke. Inside they are composed of *hyphae*—the much-branched and anastomosing tubular threads—which make up the greater part of all fungi. These are packed closely together, but numerous spaces and channels are found in which on the ends of the hyphae are developed the asci, or spore sacs. In most members of this family these are more or less spherical and contain typically four spores. In my specimen the bundles of hyphae are of a grayish tint, while the intervals with the numerous sacs containing brown, almost black, spores show as a darker mottling on the ground mass as represented in Figure 1a, which is a portion only slightly magnified (about × 5). There may be from one to four spores in an ascus and they are not formed simultaneously (Goebel), so that under the microscope, while one may be fully developed, others show earlier stages. The outer coat of the mature spore is thick and strongly cuticularized and is ornamented throughout the family with projections of various kinds. In the present species the large and handsome spores are covered with sharp spikes and points, Figure 1b. A second thinner coat within is easily made out with careful focussing. The young spores have less colour, and according to age the characteristic markings of the outer coat are not so fully developed. As in most of the very large class of ascomycetous fungi, the asci are elongated tubular sacs, while the typical number of spores in them is eight,—though exceptions are not few—the family brought under notice forms an interesting variety for comparison; while also many of its life processes, such as to some extent its method of growth from the spores and details of the formation of its fructifications, are still unknown. J. B.

ORNITHOLOGY.

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

THE BRITISH ORNITHOLOGISTS' UNION EXPEDITION TO CENTRAL NEW GUINEA.—The two members of this party invalided home.—Messrs. W. Goodfellow and G. C. Shortridge—have recently safely reached London, and the last-named has brought with him a large zoological collection, including about eleven hundred birds. One Paradise-bird is stated to be certainly new to science, and there are fine examples in the collection of the scarlet and yellow Paradise-bird (*Xanthomelas ardens*), new to the National collection at South Kensington: the female of the species was hitherto unknown. King-birds, rifle-birds, and manucodes are well represented: cat-birds, grackles and starlings of several species are numerous, and parrots of all sizes, from pygmy parrots to great black cockatoos; also kingfishers, rollers and pittas. The cuckoos include a rare and curious species (*Microdynamis parva*) resembling a honey-guide. There are, further, many different species of pigeons and fruit-pigeons, and numerous smaller birds, which are expected to yield the most interesting forms of all, when they have been studied by the authorities.—(*Country Life*, 4th March, 1911, page 291.)

In Ethnology the important discovery has been made by this expedition of a community of primitive people, wearing no clothes, having still in use the implements and weapons of the Stone Age, and unable to count beyond three. These people occur up the Mimika River, in the hitherto unknown interior of Dutch New Guinea. Lantern slides from these were shown at the March meeting of the British Ornithologists' Club.

WATERFOWL IN THE ZOÖLOGICAL GARDENS, LONDON.—Amongst recent improvements at the "Zoo" is a new lake for waterfowl, the stock of which is heavier now than it has been for a long period. It is hoped that one result may be a very full list of birds breeding this season.

The geese include examples of the Orinoco, upland, ruddy-headed, emperor, cereopsis, snow (blue and white), black-headed, bar-headed, Hutchins, and spur-winged. On the water may be found the common, ruddy and Argentine flamingoes, mandarin, summer and Bahama ducks, spoonbills, American and Chiloe widgeon, China pintail, cinnamon, blue-wing, green-wing, Japanese, chestnut-breasted, Andaman, Brazilian, Chilian, and versicolour teal, rosy-bills, red-crested pochards, white-eyes and maned geese. In the sea-lion's pond is a recently arrived king penguin, about three feet in height. (*The Field*, 25th February, 1911, page 384.)

CROSSBILLS IN THE BRITISH ISLES.—An account of the exceptionally wide-spread visitation occurring in 1909-10, and the phenomenal nesting which followed, is promised by Mr. H. F. Witherby, of *British Birds*, and the subject was illustrated by exhibits made at a recent meeting of the British Ornithologists' Club. Nests and eggs were shown, most of the eggs being those of the Continental crossbill, obtained last season in different parts of England and Ireland. Eggs were also exhibited from the Continent, as well as those of the resident Scottish race of this bird and of the parrot crossbill, for comparison. The nests showed much divergence in make and material. The Rev. F. C. R. Jourdain pointed out that the material for study had hitherto been scanty, and that there was no authentic record of a case of nesting in the same locality in England for two consecutive seasons.

THE WOOD-PIGEON PEST.—The number of resident birds of this species in Wilts, Hants, and other Southern Counties this winter has been enormously swollen by arrivals from other quarters. Many of these are smaller in size, and recognisable as immigrants from Scandinavia. The birds were abnormally prevalent and persistent, doing havoc to clovers and catch-crops, which are specially cultivated in the counties named for ewes and lambs in the spring months. A flock master at Cholderton, near Andover, with four thousand acres of ground, estimated that some six thousand to seven thousand pigeons frequented it. In Wiltshire alone the damage done by the middle of February was said to mount up to about £30,000. Ordinary methods of scaring and trapping having proved quite insufficient, a vigorous shooting campaign was organised. One, two, or three days in each week have been given to shooting the birds in each neighbourhood simultaneously, as far as possible, following them to their roosting-places. A Government Inquiry is being asked to investigate the extraordinary increase in the species, and how to deal with this plague to agriculturists.

A GOOD LOCAL LIST.—"The Birds of East Renfrewshire," by Mr. John Robertson (*Glasgow Naturalist*, February, 1911, pages 41–59; 207, Bath Street, Glasgow, 1/3), is one of those somewhat notable little works which show how rich a result follows continuous and careful observation, even in a not too favourable locality. The district covered is a limited inland one, encroached upon further and further each year, by the southern suburbs of Glasgow. Yet Mr. Robertson records one hundred and fifty-one species, eighty-three of which have bred. The number of kinds of ducks and waders which occur, season after season, is remarkable.

THE LATE PROFESSOR ALFRED NEWTON.—Those who only knew this great English ornithologist by his own writings and the eulogistic accounts which have been given of him in scientific and ornithological publications will turn, with great interest to an article in the March number of the *Cornhill* (pages 334–349), by Mr. Arthur C. Benson, who was a contemporary of the Professor at Magdalene, Cambridge, from 1904 to 1907. Mr. Benson's chapter is, of course, not ornithology, but is an intimate and personal narrative, revealing a character of a type probably not anticipated by those who had not personal acquaintance with the man. From this personal point of view, Mr. Benson's own feelings are thus expressed:—"I began by fearing him. I went on to admire him, and I ended by loving him."

"PHOTOGRAPHY FOR BIRD-LOVERS."—Messrs. Witherby & Co. have in the press n illustrated volume entitled "Photography for Bird-Lovers," by Mr. Bentley Beetham, a well-known and successful bird photographer. The book is an essentially practical guide to the pursuit of bird-photography in all its branches, and Mr. Beetham gives ungrudgingly from the store of knowledge gained by his own personal experience in the field.

PHOTOGRAPHY.

By C. E. Kenneth Mees, D.Sc., F.C.S., F.R.P.S.

THE RELATION BETWEEN THE COLOUR OF SILVER IMAGES, AND THE SIZE OF THE PARTICLES WHICH COMPOSE THEM.—In a former number of "Knowledge" (December, 1910), I referred to the investigation of this subject by Schaum and Schloemann, in which they came to the conclusion that the colours were due to optical resonance.

At the Royal Photographic Society, on March 7th, Mr. Chapman Jones gave an account of an investigation undertaken by him with a view to the examination of the accuracy of Zsigmondy's view that it was not possible to deduce the size of the particles from the colour of a colloidal solution, and that the colour was dependent to a considerable extent upon the separation between the particles.

As the subject of this investigation, bromide of silver, chloride of silver and phosphate of silver lantern plates were used, developed by means of developers containing ammonium carbonate and ammonium bromide, so as to produce carmine and yellow tones; while in one series of experiments the phosphate plates were printed out.

Mr. Chapman Jones adopted a most ingenious method of measuring the size of the particles. If a silver image be treated with mercuric chloride and, after washing, developed with ferrous oxalate, it adds mercury in the proportion of one atom of mercury to one atom of silver. A second intensification produces an image consisting of one atom of silver and three atoms of mercury; a third, one atom of silver and seven atoms of mercury; so that the particles grow rapidly in size, and from the known specific gravities of the various amalgams the increase in the diameter of the particles can be calculated. Eight such intensifications produce an enlargement of over seven diameters, and even particles which were at first completely ultra-microscopic may be thus rendered measureable.

The method appears to be capable of giving results of considerable accuracy, probably of the order of five per cent, and the results obtained were satisfactory concordant. They showed that in films, where the particles were too small to produce any visible colour, only a faint blue opalescence being visible, the diameter of the particles ranged from ·10 to ·12 microns. If the films were yellow the diameter was ·13 to ·14 microns; ·15 to ·17 gave orange or brown films, and in one case pink, while ·17 to ·18 gave purple tones, diameters above ·18 corresponding to brown-blacks and greys.

These diameters are somewhat less than those found by Schaum and Schloemann for their grains.

The refractive index of gelatine was measured by a number of methods, the most successful being the finding of a liquid mixture of known refractive index in which the edge of the film disappeared; the result obtained was 1·53. Now it will be seen that the diameters given for the various particles nearly correspond to the half wave-lengths in gelatine of the light whose absorption would produce the colour stated, thus the wave-length of the limit of the visible spectrum, ·4 microns in air, will become ·26 microns in gelatine, the half of which, ·13, corresponds well with the diameter of the particles which commenced to show a yellow colour.

Mr. Chapman Jones gave some remarkable instances of the accuracy of the relation found between the colour of the deposit and the size of the particles; he had examined images of mixed colours and had always found that such images contained particles of at least two different diameters, corresponding with the different colours.

He had also found that where the particles were of the same size, but were dispersed to different extents, the colours were the same, thus showing that Zsigmondy's suggestion that the colour depends on the dispersion of the particles cannot be substantiated for silver particles in gelatine films.

These results obtained by Mr. Chapman Jones are entirely different from those of Schaum and Schloemann, who experimented with a chloride emulsion developed with various developers, and also with gelatine films containing silver nitrate printed out, and who investigated the subject by means of the ultra-microscope.

The conclusions to which these workers came were:—

(1) In coloured images obtained under their conditions the ground was coloured and the particles of considerable size, and black, in opposition to the results of Kirchner and Zsigmondy, who found that in gold gelatine preparations the ground was colourless and the particles strongly coloured.

(2) The colour was unaltered by diluting a coloured film with gelatine and re-coating and drying. The colour was also little altered by intensification, bright red becoming dark red, bright green, dark green, yellow passing through orange to red, and blue becoming deep violet. The colour was also little altered by reduction, simply becoming less saturated.

(3) The colour is associated with the thickness of the layer of grains, as was found by Kirchner for Lippmann films, rather than with the size of the particles.

It is to be hoped that Mr. Chapman Jones' valuable paper will lead to further work upon the subject, which may result in a reconciliation of these apparently conflicting results.

THE EFFECT OF COLOUR FILTERS UPON THE DEFINITION OF A LENS.—If colour filters be used with a lens, it is clear that considerable attention should be paid to the optical accuracy of those filters, so that they do not introduce aberrations which may affect the definition of the image. Apart from the accuracy of the glass itself, distortion may be produced in colour filters in the course of their manufacture in several ways.

In the first place, if the filters are prepared by coating coloured gelatine upon the glass, then when this gelatine dries it will contract and bend the [illegible] when the filter is cemented with Canada Balsam [illegible]ving or drying at uneven temperatures will distort t[illegible]hile, finally, if pressure is exercised upon a thin filte[illegible] the filter may easily be permanently strained. I[illegible]ains were symmetrical they would be of small im[illegible]hey would simply produce a lens of slight positive [illegible]ver, and so, to a small extent, change the focal len[illegible]ns with which they are used. But generally they a[illegible] in one direction only, or are much greater in one d[illegible]an in the other, and so produce a cylindrical lens, which [illegible]oduces astigmatism. The effect of such aberration naturall[illegible] becomes much greater as lenses of longer focal length are used, the effect varying as the square of the focal length of the lens, so that a filter which would be perfectly satisfactory on a hand camera lens of six inches focus, would be with a telephoto combination quite useless. With medium and high power telephoto lenses only filters of the highest optical accuracy can be used.

This point must be carefully borne in mind, in view of the recent introduction of what may be termed semi-telephoto lenses, such as the Busch Bis-Telar, which naturally require that a filter should be far more accurate than would be assumed to be necessary for its diameter.

The aberrations of filters can be minimised by making them of as thick glass as possible, having regard to its optical accuracy, and for filters of the very highest quality it is usual for the two glasses to be about five millimetres in thickness.

PHYSICS.

By A. C. G. EGERTON, B.Sc.

GENERAL.—Among the events of the last month, mention should be made that the electromotive force of the Weston Normal Cell, made up according to specification, has been accurately found to be 1·0183 international volts at 20°C.; standard cells will in future be compared with such Weston Normal Cells at the National Physical Laboratory. The Weston cell consists of an H-shaped vessel, the one limb of which contains mercury and mercurous sulphate, the other containing cadmium and cadmium sulphate. Its electromotive force is very nearly independent of temperature over the usual range of working temperatures. The E.M.F. of the Clark Cell varies with temperature, while its E.M.F. is greater than the Weston cell, the former having a zinc negative pole instead of cadmium.

Professor Perrin gave a most lucid exposition of his investigations on Brownian Movement at the Royal Institution on February 24th. During his lecture he showed, by means of cinematograph photographs, the movement that colloid particles undergo when an emulsion of gum and water is prepared and examined under the microscope: their rotation, their collision, their random path, and their attraction and repulsion from electrified surfaces were beautifully illustrated. By an able investigation of the motion of these minute colloid particles and assuming the motion of molecules to be of the same character, Professor Perrin has succeeded in calculating in several ways the number of molecules per cubic centimetre and mass of the atom of hydrogen, the numbers agreeing well with those determined by other methods, such as the period of change of radium, the charge carried by the atom of hydrogen, the polarization of light and consequent blueness of the sky, and the values obtained by measuring the viscosity of gases for the average distance traversed by the molecules between collisions or their "Mean Free Path." The number of molecules per cubic centimetre is nearly twenty-eight trillions.

THE VISCOSITY OF GASES.—In the *Proceedings of the Royal Society* there have appeared lately several interesting communications by Dr. A. O. Rankine. There is much that is pleasing about a simple apparatus: the viscosity of gases has hitherto been a somewhat troublesome co-efficient to determine, but Dr. Rankine is able to find the viscosity of Xenon, which can only be obtained in small quantity, with comparative ease, by means of his apparatus. The apparatus consists of an elongated ring of glass tubing with a branch tube and tap sealed into the smaller sides of the ring; one of the two longer straight tubes is capillary. A mercury pellet in falling down the tube of larger bore pushes the gas in front of it through the tube of narrow bore. The time of fall is proportional to the viscosity of the gas: the more viscous the less easily can it pass along the capillary bore, and the longer the time of fall of the mercury pellet. The great advantage of the apparatus is that only small quantities of the gas under observation are needed. Dr. Rankine has observed the viscosity at different temperatures, and in this way has obtained measurements which enable him to calculate the relative attraction constants, radii and volumes of the molecules of the various gases. The gases of the argon group—helium, neon, krypton, xenon show interesting relationships respecting such constants.

THE DENSITY OF RADIUM EMANATION.—Just as in the series of compounds of carbon and hydrogen there is a group of hydro-carbons which are "saturated" and cannot combine with other atoms without replacement of those already combined in the molecule, so in the "Periodic Classification of the Elements" there is a group of elements whose atoms are unable to combine with other atoms, or which have zero valency. These elements are the rare gases above mentioned.

There is room for one or two elements more in the group according as to how the natural periodic classification of the elements is interpreted. The atomic weight of the one would be about one hundred and seventy-six, of the other about two hundred and twenty-two. Radium emanation or Niton, as Sir William Ramsay suggests should be its name, is the first break-down product of the radium atom, and is a gas behaving in every way as if it should belong to the argon group, and fit into one of these vacant places. From density determinations and observations of the boiling-point and critical point of this highly radio-active gas, it appeared that its density was such that its atomic weight should be one hundred and seventy-six. But since only one α particle or helium atom is expelled during the decay of radium into radium emanation, it was more probable that the density should be one hundred and eleven, or atomic weight, two hundred and twenty-two, unless the disintegration theory which explains the numerous transformations of radio-active substances was in fault. It was very important then to settle the point and determine the density of radium emanation.

The difficulty of such a determination would seem almost insuperable, for—to put it succinctly—it would require £15,000 worth of radium to get half a cubic millimetre of the emanation. Sir William Ramsay and Dr. R. W. Gray have, however, tackled the problem successfully. They have been able to construct a balance weighing to less than one-hundred-thousandth of a milligram, so as to be able to weigh with sufficient accuracy one-tenth of a cubic millimetre of the emanation.

It required several years of experimenting to design a balance of such sensitiveness. Dr. Brill, working under Sir William Ramsay, had improved the Nernst balance. This works by the torsion of a quartz fibre, one end of the beam acting as a counterpoise and pointer, but the deflection due to torsion of the fibre is not directly proportional to the weight. Dr. Brill's work suggested the employment of quartz knife edges and very light beams, which idea Dr. Gwyer improved and introduced a system of weighing which Dr. Steele, in Australia, independently arrived at. Sir William Ramsay and Dr. Gray were able to slightly improve Dr. Steele's balance and modify it for their purpose. A short description of the balance in a few lines is unworthy of such a beautiful instrument. It consists in the main of a fine silica rod beam resting on a specially-ground and very small quartz knife edge; from the ends of the beam is hung, by means of silica fibres, the substance to be weighed, silica counterpoises and a small silica bulb containing air. By altering the pressure inside the balance case, a small change in buoyancy of the air in the bulb is caused, so by finding the change in weight produced by a given change in pressure very fine adjustments of weight can be made; a mirror is attached to the beam of the balance, and the alteration in pressure necessary to bring back to zero the spot of light reflected from the mirror on to the scale, gives a measure of the alteration in weight.

The emanation was collected and sealed in a very fine tube which was counterpoised, then broken so as not to lose any particles of glass, the balance case evacuated so as to expel the emanation and replace it with air, then counterpoised again and the change in pressure noted.

Numerous corrections had to be made: the weight of the air entering the density bulb, after breaking it to let out the emanation; the change in the buoyancy due to the fact that the density bulb is glass and the counterpoise silica; the volume of the emanation that penetrates into the glass walls owing to its high activity, were among these corrections. The volume of the emanation was determined and the amount of its decrease before the actual determination by its change in activity.

The density came out to be two hundred and twenty-three as a mean of five experiments.

The results then confirm the disintegration theory of radioactive transformations which demands that since the atomic weight of radium is 226·5 that of the emanation should be 222·5. Further than this, they demonstrate the manipulative genius of Sir William Ramsay, and the success of these delicate experiments in the face of such huge difficulties reflects great credit on his collaborator.

MESOTHORIUM.—As an illustration of the disintegration theory, the products of change of thorium might be mentioned. Thorium first breaks down into mesothorium I., which in eight years has half broken down into mesothorium II., which again is half gone in nine hours, changing into radiothorium and throwing off β and γ rays; radiothorium then throws off an α particle (an electrically-charged helium atom) and becomes thorium X. Thorium X breaks down into thorium emanation, which is a gas having a half life period of only seventy-seven seconds, and breaks down with loss of an α particle into thorium A which is followed by other products B.C. and D., the final product being as yet unknown. Owing to the fact that considerable quantities of thoria are used in commerce for the manufacture of incandescent gas mantles, it has lately been possible to extract appreciable amounts of mesothorium and radiothorium.

The monazite sand is treated in some way devised by Dr. Hahn, so as to separate the mesothorium and so on from the thorium, and such preparations have lately been put on the market by the firm of Knöfler & Co., and will doubtless be used largely for medical purposes.

Professor Soddy has found that mesothorium and radium are identical in chemical properties—a very remarkable fact. He points out, too, that thorium, ionium, radiothorium form one group of radioactive elements, and mesothorium, radium, thorium X form a second group which are chemically identical and inseparable elements, although their atomic weights differ by two units in each case; while the last member of the first group and the first member of the last group (radiothorium and mesothorium) possess the same atomic weight and yet are chemically different.

THE NATIONAL PHYSICAL LABORATORY.—The annual meeting of the General Board at the Laboratory, Bushey House, Teddington, was held on Friday, March 17th, and in the afternoon a number of guests had the privilege of going over the Laboratory. They were received in the building containing the National Experimental Tank by Sir Archibald Geikie, who is the Chairman of the General Board. All the departments were thrown open and members of the staff were at hand to explain all the work which is carried out.

THE ROYAL AUTOMOBILE CLUB'S SUGGESTED LABORATORY.—We learn from the Secretary of the Royal Automobile Club that the Expert and Technical Committee has been asked to consider the expediency of establishing a central research laboratory for the scientific investigation of motor car problems and to report as to the equipment and maintenance to such a laboratory.

ZOOLOGY.

By PROFESSOR J. ARTHUR THOMSON.

THE BIOLOGICAL HOROSCOPE.—Professor D. H. Tennent, of Bryn Mawr, has been very successful in crossing sea-urchins of different genera, *Toxopneustes* and *Hipponoe*. The Toxopneustes influence dominates in sea-water of a higher OH ion concentration, and the Hipponoe influence dominates in sea-water of a lower OH concentration. It is suggested that this variation in the sea-water, brought about artificially in the laboratory, may correspond to normal seasonal changes. If so, it throws light on the difference previously observed between the winter embryos and the summer embryos of the cross between *Sphaerechinus* and *Strongylocentrotus*. Thus something depends on the *season of birth*, and thus we come back to the horoscope and astrology—in new guise, of course.

SPARROWS AND POULTRY.—The poultry-raising industry in many parts of the United States is seriously menaced by "blackhead" and similar diseases due to parasitic Protozoa known as Coccidia. Philip H. Hadley has found that these parasites are abundant in the intestinal tract of the English Sparrow, which he therefore blames for the diffusion of the disease. The parasite occurs also in some other wild birds, such as the American "robin" (*Merula migratoria*), and severe coccidiosis has been observed in the quail (*Colinus virginianus*) and the grouse (*Bonaso umbellatus*). Thus wild game birds as well as poultry (fowls, turkeys, ducks, geese, pigeons, pheasants, guinea-hens) are seriously threatened.

LEPTOMONAD IN EUPHORBIA.—Not long ago Lafont made the remarkable discovery that the latex of *Euphorbia pilulifera* in Mauritius contained [illegible] rasite, a species of *Leptomonas*, that is to say, a kin[illegible]site characteristic of animals, and next door to T[illegible]s which cause sleeping sickness and the like. Th[illegible]teresting discovery has been confirmed by G. Bo[illegible]. Roubaud in regard to other species of Euphorbia. [illegible] infection local, temporary, and without obvious [illegible] effects. They were led to regard a small Hemipterou[illegible] *Dieuches humilis*, as the infecting agent, but fresh [illegible]ments by Lafont, in the case of *Euphorbia pilulifera*, po[illegible] another bug, *Nysius euphorbiae*, as the culprit.

CILIARY AND MUSCULAR MOVEMENTS.—Looking down from the rocks into the water in the summer season one often sees a jellyfish and a Ctenophore moving together, both very beautifully, but in very different ways; for the jellyfish is moving mainly by muscular contraction and the Ctenophore by cilia. It has been shown by A. G. Mayer, in a series of interesting papers, that these two kinds of movement have a converse relation to one another. Thus sodium is the most potent check to ciliary activity and the most powerful neuro-muscular stimulant. Magnesium is most potent in maintaining ciliary movement and the most powerful inhibitor of neuro-muscular movements. Among reagents of this sort whatever stimulates cilia depresses muscular activity, and whatever inhibits muscular movement stimulates cilia. In nature the more highly specialised cilia, such as those of the Ctenophore's combs, which are under the control of the neuro-muscular system, stop whenever the muscles contract and beat only when the muscles are relaxed. "The discovery of this converse relation makes very apparent the incompleteness of all existing explanations of the cause of animal movements."

REVIEWS.

CHEMISTRY.

New Reduction Methods in Volumetric Analyses.—By E. KNECHT, Ph.D., F.I.C. and EVA HIBBERT. 108 + x. pages.

(Longmans. Price 3/- net.)

This little volume gives, in an accessible form, the numerous papers published by the authors in different journals upon the use of titanous chloride in volumetric analyses. Solutions of this salt can now be readily obtained in a fairly pure condition and its very powerful reducing properties render it particularly suitable for use in the volumetric estimation of all kinds of compound. Full descriptions of the methods of using it are given here, and in the case of some of these estimations there had previously been no reliable process of determining the substance in question. In particular, the application of this compound to the quantitative estimation of various dyestuffs will be found especially useful. The book will prove a valuable addition to the library of every laboratory.

BIOLOGY.

The Origin of Species by Means of Natural Selection (Popular impression of the copyright edition).—By CHARLES DARWIN. 432 pages. $7\frac{1}{2}$-in. × 5-in.

(John Murray. Price 1/- net.)

"The Origin of Species" has now passed out of copyright, but the edition which it is now open to anyone to print is the unrevised one which was superseded by the present one. Mr. Murray is to be congratulated on bringing out the popular impression at a price which is within the reach of everyone.

BOTANY.

Life Histories of Familiar Plants.—By JOHN J. WARD, F.E.S. 204 pages. 86 plates. 8-in. × 5-in.

(Cassell & Company. Price 3/6.)

This popular edition will give Mr. Ward's delightful essays on the familiar plants a wider circle of readers and will help on the great movement that is proceeding, whereby the public generally is being interested in the world of life around it.

Open Air Studies in Botany.—Second edition. By ROBERT LLOYD PRAEGER, B.A. 266 pages. 68 illustrations. 8-in. × $5\frac{1}{4}$-in.

(Charles Griffin & Company. Price 6/- net.)

We are pleased to see that a second edition of Mr. Praeger's book has been called for as it is not occupied with the dry-as-dust Botany, but with sketches of British wild flowers in their homes among the shingle, by the river, in the meadow, among the corn and along the fragrant hedgerow. Those who know Mr. R. Welch's photographs will know that the plates well illustrate the plant associations and habitats with which they deal.

Aids to Bacteriology.—Second edition. By C. G. MOOR, M.A., and WILLIAM PARTRIDGE. 240 pages. ($6\frac{1}{2}$-in. × 4-in.)

(Baillière, Tindall & Cox. Price 3/6 net.)

This book is a second edition of a little work dealing briefly with a great number of points coming under the heading of Bacteriology. In the Introduction general matters are considered and the various bacteria of disease, methods of examining them, forms producing fermentation, and the bacteriology of every-day life are briefly touched upon.

ELECTROGRAPHS.

By A. W. CLAYDEN, M.A.,

Principal of the Royal Albert Memorial University College, Exeter.

SEVERAL years ago, when experimenting with an early form of Tesla apparatus supplied to the College by Mr. Apps, I hit upon a phenomenon which deserves to be better known. At that time I believed the results were novel, but when I came to describe them I found that similar observations had been made by Mr. F. J. Smith at Trinity College, Oxford, and described by him on June 24th, 1892, to the Physical Society under the title "Inductoscript." His method was to place a coin or medal upon a photographic plate which rested on a conductor, and then connect the coin and conductor with the poles of an "Inductorium" or Transformer for a time varying from five seconds to fifty seconds. On development the details of the face of the coin in contact with the film were revealed. His paper appears in Volume XI of the *Proceedings of the Physical Society*, but unfortunately it is not illustrated by any reproductions of the photographs.

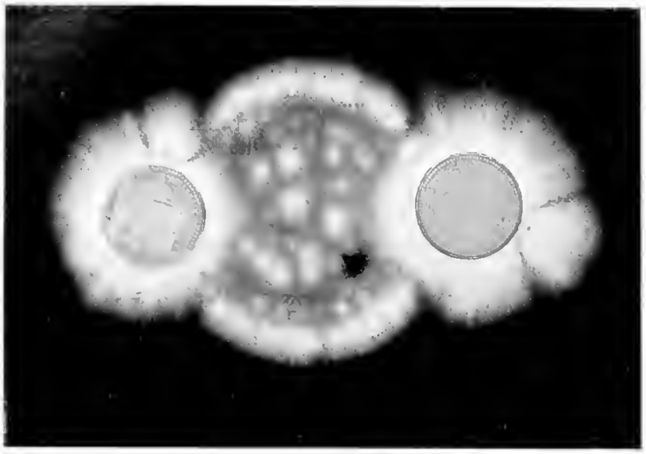

FIGURE 1.

Electrograph of a large coin (blurred image) resting upon two small medals.

Seven years later, struck by the beauty of the discharge from the Tesla transformer, it occurred to me that if a number of metal bodies were to be placed upon a sensitive plate it should be possible to get some sort of reproduction of the surrounding discharges.

If, for instance, a brass sheet is laid on the working bench, then a plate of glass, and a coin or group of coins upon the glass, on connecting one of the coins with one terminal of the transformer and the brass plate to the other terminal the coins are seen to be surrounded by beautiful radiating coronae caused by the discharge. I therefore substituted a photographic plate, film side uppermost, for the glass and let the discharge pass for a second or two. On developing, I was surprised to see that not only were the details of the radiating discharge far more perfectly rendered than I had expected, but the modelling of the whole face of the coin in contact with the film was sharply revealed.

In order to get the detail it was necessary to have the coin actually resting on the film. In some cases it was lifted up a short distance, and the mere thickness of a threepenny bit was found to be enough to spoil and blur the image. See Figure 1, in which the central large coin rests upon the little medals.

Mr. Smith attributed his photographs to the electric current, or at least the electrification of the film, but in the case of my observations it is not easy to say whether the action on the film was due to the discharge or to the light of the discharge. A coin under the conditions of the experiment, that is to say, in contact with one terminal of a Tesla transformer, is luminous all over, and the longest rays spring from the sharpest convexities, such as the the edges of the milled rim, in accordance with the general rule as to the distribution of a charge on conductor.

I am inclined to think that this distribution of the discharge is the real explanation of the phenomenon, though the effect on the silver salt may just as well be electric as strictly photographic.

FIGURE 2.

The effect of the sparks connecting coins and in the square hole of the Japanese example.

However this may be, the experiments are very easy to make, very beautiful to see, and yield results of considerable interest. Note, for instance, the sharp, slender sparks which connect the various coins, the corona of radiating sparks surrounding each coin, and the way in which these coronae decline to join. This last feature is especially well shown in the square hole in the Japanese coin shown in one picture (Figure 2), and in the discharge surrounding the coin common to the arms of the cross in another (see Figure 3).

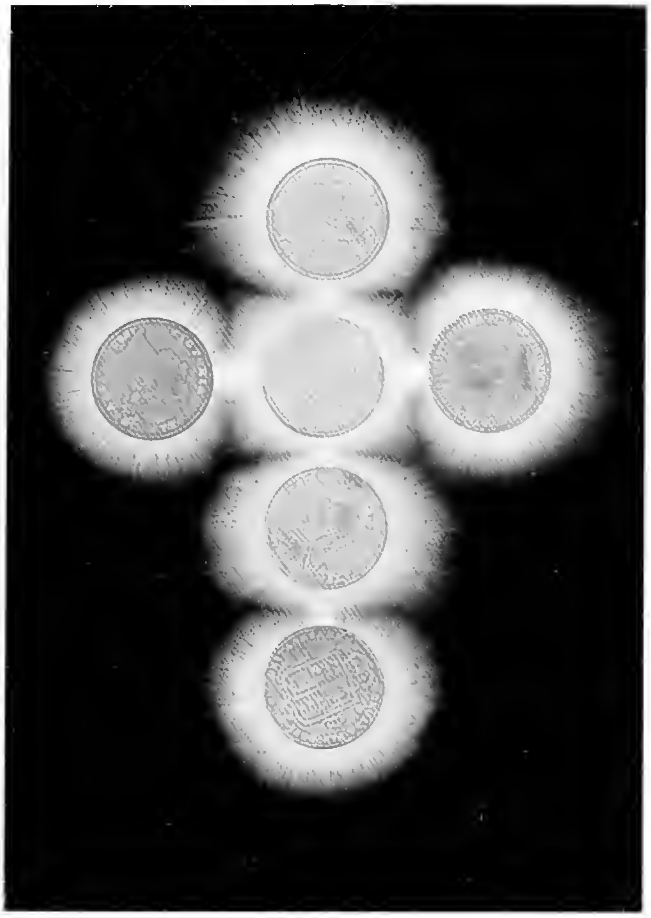

Figure 3.

Coins arranged in the form of a cross.

One specially interesting photograph (Figure 4) is perhaps that which shows a single coin and seven small dots. This was taken by connecting one terminal with the coin, then placing some small shot on the plate (the dots) at different distances, and finally connecting the other terminal with a ring of brass wire about six inches in diameter and concentric with the coin. The discharge was passed for one second and the plate then developed.

The corona round the coin at once calls to mind the solar corona, and the luminosities attached to the shot suggest comets' tails. Each shot has two fans of light, a broad one pointing away from the centre, which is larger as the shot is nearer, and a narrower sheaf connecting the shot with the coin, which dies out with increase of distance much more rapidly than what may be called the outer tail.

Without trying to found any argument as to the nature of comets' tails and the light sometimes seen pointing from a nucleus towards the sun, the pictures are certainly very suggestive, and the actual discharge as seen by the eye is much more strongly so.

However, space in these pages is valuable, and enough has been said. The photographs are in the main only what the known facts of the brush discharge would suggest, except that I feel sure no one would have supposed that it would be possible to reproduce such detail without the use of any lens or camera.

Inductoscripts, electrographs, or mere contact photographs, whichever they may be, I think they are interesting enough and curious enough to be made more common knowledge.

The apparatus I used was an induction coil giving a six-inch spark, by which two medium-sized Leyden jars were charged. The discharge from these was then sent through the primary of a small oil-insulated transformer, and the length of the spark gap adjusted until the wires from the terminals of the transformer were as luminous as it seemed possible to make them.

The coil, jars, and spark gap were covered by a large cardboard box so that the photographic plate was not fogged by stray light, but was exposed only to the action to be examined.

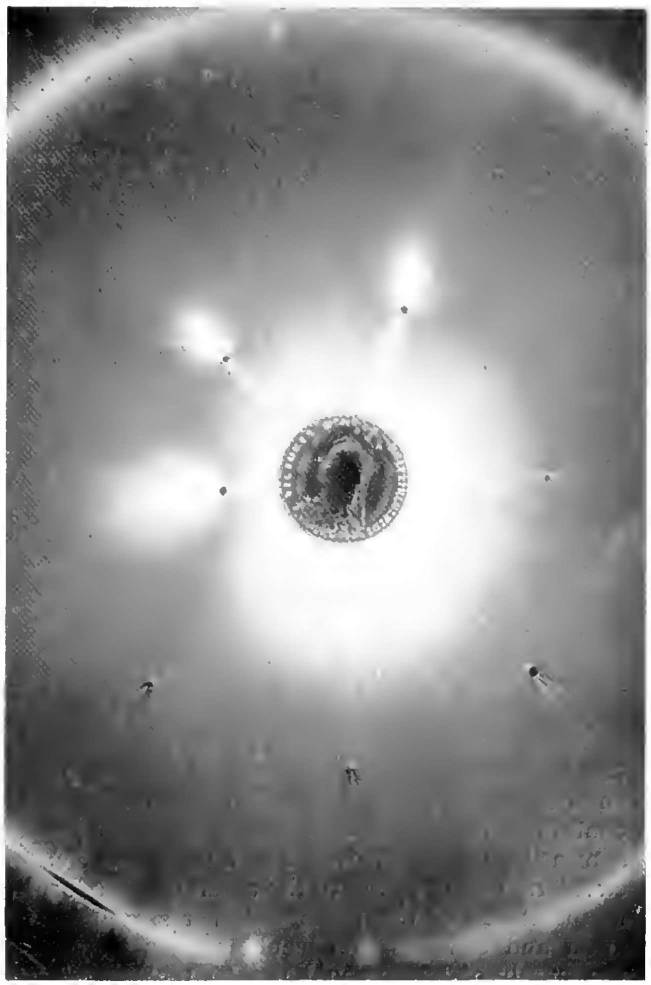

Figure 4.

Seven shot surrounding a coin.

THE PROBLEM OF THE ROTATION OF VENUS AND THE INFERENCE TO BE DRAWN FROM THE PROBABLE ATMOSPHERIC CONDITION OF THE PLANET.

By B. G. HARRISON, F.R.A.S.

In connection with the problems of tidal friction and planetary evolution the question of the rotation of Venus is of the utmost importance. Unfortunately its period is still a matter of considerable uncertainty, but is generally considered to occupy either about twenty-four hours, or else to be equal to the planet's orbital revolution of two hundred and twenty-five days. Although most astronomers favour the latter alternative, there are serious objections to either, and it is quite possible there may be another solution to the question. There now seems little doubt that Mercury always turns the same face to the Sun, but the case is not nearly so certain with regard to Venus, either from a dynamical or observatorial point of view.

Indeed, all the early astronomers assigned to the planet a period of about twenty-four hours, but their data seem to have been somewhat insufficient, owing perhaps, to the time of day at which their observations were carried out. The most favourable time is between sunrise and sunset, as the planet is then high in the heavens and its glare is not so pronounced, on account of the brightness of the sky, while it is also possible to observe any peculiar features that are presented for several consecutive hours. Until recently, however, all observations were carried out either shortly before sunrise or just after sunset, and consequently at much the same time each day, so that if any markings were noticed on the planet in the same position on successive days, it may have been attributed to a revolution having been completed in the interval.

Until the observations of Schiaparelli, in 1889, the idea of a period of two hundred and twenty-five days does not seem to have been seriously considered, but since then many eminent astronomers, including Professor Lowell, have come to the same conclusion.

If it could be established that Venus were cloud-covered, it would render this latter alternative very improbable. For if the planet always turned the same face to the Sun, unless its thermal conductivity is infinitely greater than that of the Earth, the temperature on the dark side would be certainly low enough to cause precipitation of the moisture contained in the hot winds blowing from the sunward side. There would be a rapid and constant circulation of air owing to the difference between the temperatures of the two hemispheres, and evaporation and condensation would be continuous. As the supply of water could not be replenished from the dark surface owing to its conversion into ice, all water would long ago have ceased to exist in liquid form, which would entail a consequent absence of cloud from the planet's atmosphere.

It is, of course, possible that the surface of Venus still has a certain amount of intrinsic warmth, and in that case the dark side may be in a similar condition to the Devonian and Carboniferous periods here, as the clouds would, to a great extent, prevent the access or escape of heat. Now, if we accept this as an argument in favour of a day equal in length to two hundred and twenty-five of ours, we must also bear in mind the considerable difference in the relative ages of the planets which the supposition would necessarily involve. As the density of Venus is only ·85 and its mass ·75 of that of the Earth, the former would not only have generated less heat by contraction, but would also radiate it more rapidly and must, therefore, have been evolved much more recently to be still in a more primitive condition than the Earth. The minimum period of terrestrial rotation is unknown, but was possibly five hours. If, however, we assume that the Earth and Venus each had an original rotational velocity proportional to their masses, and that that of the former has been diminished to its present speed by lunar and solar friction, it is obvious that the more recent the formation of Venus is considered to be, the less likely is it that it should have already reached its maximum rotational period owing to secular tidal action.

There is no doubt that a dense envelope of some sort surrounds the planet. The appearance of a luminous ring and the "black drop" observed at recent transits, are alone conclusive proof of this, while the irregular and graduated appearance of the terminator also furnishes us with further evidence of its presence. Then, again, the extraordinarily high albedo of Venus almost prohibits the assumption that it is the actual surface we see. Moreover, the dark markings which have been frequently observed scarcely exhibit the permanency one would expect in the case of furrows on the face of the planet, and it is quite possible they may be caused by convection currents effecting openings in the clouds. In any case, it is difficult to understand how it would be possible to see any detail on the surface itself when one considers this is probably surrounded by a mirror which reflects 92 per cent. of the light received. It is this very high reflective index which presents some difficulty to the theory of a cloudy atmosphere. Until recently cloud was considered to be the highest reflective surface of a planet. Now as its albedo is only 72 it seems scarcely enough to account for the brilliancy of Venus and this point has been brought forward as an objection to the cloud theory. Since it was necessary to give some alternative explanation, it has been suggested that the light is reflected from minute particles of dust suspended in the atmosphere, but this idea does not appear altogether satisfactory and it is possible to find another reason for the unusual brilliancy of the planet. The mean temperature of the air on Venus must be considerably higher than that of the terrestrial atmosphere, and should be taken into consideration. This would necessarily involve the attainment of a higher altitude and diminished pressure for the formation of clouds, which would, therefore, be probably thinner than ours, and would be covered by a film of cirrus extending almost to the limits of the atmosphere. It is well known that an attenuated substance is capable of reflecting more light than when condensed, and the rarefied condition of the clouds might thus account for the abnormal albedo of the planet. The peculiar appearance of the terminator, caused by the prolongation and occasional detachment of the cusps, can also be most easily explained by the theory of cloud reflection.

Another peculiarity has been noticed more than once when Venus has been examined under suitable conditions. The dark portion of the sphere has been found to emit a faint luminosity similar to that observed on the new moon. We know this latter spectacle to be caused by the reflection of light from the earth on the dark portion of the lunar surface. In the case of Venus, there is no one body capable of transmitting the necessary illumination, and its cause has always been rather a mystery to astronomers. Now this phenomenon, which for want of a better name may be termed "starshine," has been advanced as an argument in favour of a rotation of two hundred and twenty-five days. It has been pointed out earlier in this article that under these conditions if there were water on the planet it must all have been deposited on the dark side in the form of ice: and it is suggested by supporters of this rotational theory that the ghostly appearance sometimes observed is caused by the light from the Earth and stars *mirrored on the ice*. A moment's consideration will, however, show the impossibility of this idea. It is generally admitted that the whole sphere is surrounded by a dense atmosphere, and this would be quite sufficient to prevent the greater portion of starlight from reaching the surface, even in the absence of clouds. When one considers that the sunward side, where no ice can exist, is capable of transmitting over 90 per cent. of the light received, it is hardly necessary to invent an ice mirror to account for the "starshine" on the dark portion of the planet.

The evidence of the spectroscope shows that water vapour is probably present on Venus and thus this instrument adds its testimony to the likelihood of a cloud-laden atmosphere. At the same time the spectroscope gives no evidence of rapid axial rotation. It is well known that a rotat[illegible] which emits or reflects light, displaces the l[illegible] the spectrum. This gives the latter a twisted [illegible], owing to one limb of the sphere approa[illegible] observer, whilst the other recedes, and thus [illegible] relative wave-lengths of the light. The amo[illegible] alteration for a given speed of rotation is [illegible], and as it is possible to obtain by these means [illegible] angular velocities of the Sun, or any body whose diameter is known, and compare them with the results obtained by visual observation, the accuracy of this method has been indisputably proved. Naturally, the lower the velocity happens to be, the greater is the difficulty experienced in its measurement by these means, but in the case of a body having a diameter of seven thousand seven hundred miles, any motion involving a rotational period of less than two months might be detected.

As the spectroscope has failed to show any shift in the spectral lines, this presents an almost insuperable obstacle to a period anything like so short as twenty-four hours. We have also seen that a rotation, which would cause the planet to turn the same face always to the Sun, is incompatible with the presence of water. We are thus led to conclude that the planet's day is between two months and two hundred and twenty-five of our days in length.

This is rendered more probable since the slow axial rotation which this hypothesis necessarily involves would be almost impossible to detect from observation. Schiaparelli himself admitted that the planet's day might be any period between six and nine months in length, and it was, therefore, concluded somewhat prematurely that if Venus had no visible rotation it had already reached the stage when the same face was always turned to the Sun. If this has happened there must have been an intermediate stage when the planet's day was shorter than its year, but still not short enough to enable us to detect any motion, *and there is no evidence to show that this stage has yet been passed*. With the exception of Mercury all the other principal planets appear to have rotations of twenty-four hours or under, and if their periods are eventually lengthened until they are synchronous with their respective orbital revolutions, the time required for this process will be extended as their velocities decrease, owing to the consequent reduction of tidal friction. This friction will also be further diminished since time will cause an increasing rigidity of each planet on account of its gradual loss of heat, and in the case of the inner planets through the escape of water vapour by molecular activity. Consequently, the final stage of rotational independence will be prolonged for a considerable period before it is completely controlled by the sun, and this renders it likely that Venus still has a somewhat shorter day than its year. Moreover, the only friction capable of acting on Venus is that generated by the solar tides, and although, as their capacity for retardation varies inversely as the sixth power of the distance, these are seven-and-a-half times more effective than those on the Earth, the rotation of the former planet has never been checked by lunar action, which in our own case may have been an exceedingly powerful factor in the earlier stages of evolution. It therefore does not seem improbable even from a physical standpoint that the length of the Cytherean day is shorter than its year, and this supposition would meet most of the difficulties we should otherwise have to contend with. There is also, of course, the possibility of the planet having a slow retrograde motion, although this is very unlikely on purely dynamical grounds.

Altogether the importance of this rotational question can scarcely be over-estimated, and the necessity of obtaining further information on a subject about which so much uncertainty exists, opens up an admirable field of research for amateurs.

REVIEWS.

PHYSICO-CHEMISTRY.

Théorie Physico-Chimique de la Vie et Générations Spontanées.—By Stéphane Leduc (Professeur à l'école de Médecine de Nantes). Paris. 204 pages. 57 illustrations.

(A. Poinat. Price 5 francs.)

This little book gives an excellent summary of some of the most important physico-chemical processes that take place in living organisms, and in particular of osmosis. The author shows by a series of extremely interesting photographs (of which one is reproduced in Figure 1), that it is possible by introducing mixtures of certain salts into solutions of other salts to produce, by osmotic pressure, forms analogous to those of plants and the shells of aquatic animals. These forms may be used as illustrations of the mechanism by which the forms of living organisms were possibly produced, but, in our judgement, it is straining analogy of form too far to regard them as evidence of spontaneous generation. The author does not succeed in bridging the gulf between the force that causes a crystal to form in a certain way and the force that we know as "life." He refers also to the analogy between Bredig's so called "inorganic ferments" and enzymes such as pepsin and diastase. In both cases the action is inhibited by the presence of certain poisons, but whereas colloidal platinum may be rendered active over and over again, an enzyme such as diastase is destroyed by a moderate degree of heat, and its activity can never be restored. In fact, it might almost be possible to form an enzymic definition of life. When once an enzyme has been produced without the aid of a living organism the possibility of proving spontaneous generation will be nearer than it is at present.

By the courtesy of Mr. Deane Butcher. *From "The Arcana of the Roentgen Ray."*

Figure 1. Osmotic Growths.

PHYSICS.

Radium: Its Physics and Therapeutics.—By Dawson Turner, M.D., F.R.C.P. 86 + x. pages.

(Baillière, London, 1911. Price 5/- net.)

In this book, Dr. Turner has summarised in a concise yet readable form the various researches published in scattered scientific journals upon the physical phenomena of radium. He has also given a description of the uses to which radium has been put as a curative agent, illustrated by outlines of the cases and photographs, which are obviously more intended for the medical than for the general reader. It is in fact with the therapeutic part of the subject that the book mainly deals, and it appears to us to be admirably suited as a guide to medical men who desire a handy manual upon radium.

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, 1911.

PLANT HAIRS.

By K. E. STYAN.

Introduction.

JUST as there is a reason for "all things under the sun," so there is a reason why plants should possess hairs on some of their many organs. They are placed where we find them for a definite purpose, and tiny as they are, these delicate hairs—these purposes are wonderfully carried out! Do not the hairs on nettles, which are long, sharp-pointed, and full of a burning, acrid secretion that "stings" when pierced into one's flesh, help to keep at bay browsing animals, insects, and anyone who tries to do damage to the plants? Does not the dense, webby growth of hairs found on the mulleins and numerous other plants cause an unpleasant sense of choking to anything that tries to eat them, and so acts as a deterrent as would a piece of flannel? Again, the presence of hairs is a guard against the attacks of aphis and other blights of a similar nature, and is also a protection against any excess of drought, or the too fiercely burning rays of the sun. Plants found in very hot, burning situations are often clad in a thick felt-like dress, so that they may check too rapid evaporation of the moisture drunk in by their roots, and so live and thrive in safety. Against any excess of damp and cold a hairy dress is equally protective, and thus we find hairy plants are common in *very* cold localities as well as in *very* hot ones, at very high as well as in low altitudes. So, too, do hairs help a plant to climb and cling; to suck up food (as root-hairs), to disseminate its fruits and seeds, to protect its delicate and essential organs (viz., stamens and pistils), to guard the pores in leaves, and in many other ways to act as most necessary organs essential to the life of the plant. In forming the delicate silky fringes on leaves and stems; the beautiful silvery or coloured hairy appendages on flowers; and the "felt," "web" and woolly coverings of many a plant's surface, Nature made structures of infinite loveliness and strangeness of outline. We may see them, *en masse*, any day, and admire the softness and richness of their make, but it needs the

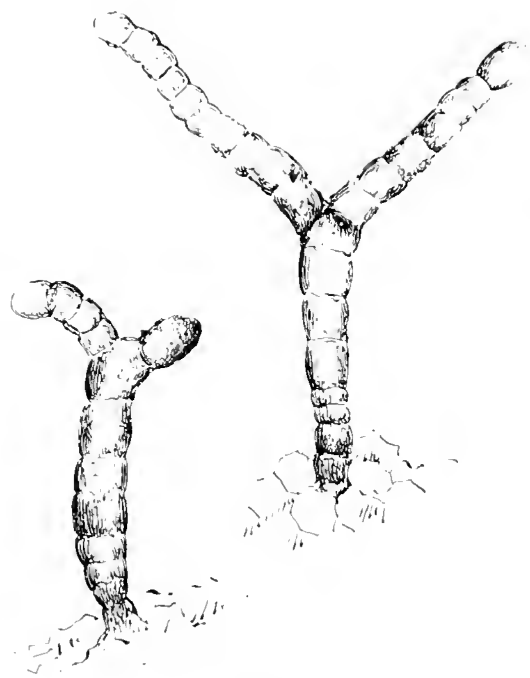

FIGURE 1.
Forked Hairs from the Corolla of the Vegetable Marrow.

microscope to show us the true loveliness of each individual kind of hair. For there are very many different kinds, and each, in its way, holds some charm: some, too, show choice colours, others emit pleasant or disagreeable odours; some produce oily or viscid exudations, whilst others form secretions with peculiar properties, such as bitter, (*Primula sinensis*), lemony, saltish, sugary and burning (stinging nettle). Some we find are very smooth-coated, others very rough, whilst—internally—one hair may be built up of a number of separate cells, and another may consist of merely one, long and narrow or broad and rounded as the case may be.

If we look at any two hairs, either is different from the other: no two are ever quite alike, and herein lies the absence of all monotony. Each is an object of interest in itself; something truly marvellous, worthy of the closest scrutiny we can bestow upon it.

Figure 2.
Forked Hairs from the Stem of the Garden *Aubretia*.

Amongst the many different kinds met with, the following are the principal:—(1) Forked, (2) Hooked, (3) Glandular, (4) Branched, (5) Stinging, (6) Stellate, (7) Peltate, (8) Jointed, though, perhaps, those known as *Root-hairs* should be considered chief of all, since they are, truly, the means by which a plant derives its food from the soil in which it grows, and is able to perform its life's functions. They are the most *useful*, though their lives are very brief, and, at the same time, some of the most simple in form that can be met with anywhere.

I.—Forked and Hooked Hairs.

Forked, or, as they are also called, *barbed* hairs are often extremely curious as well as beautiful in form and are very frequently met with on plant surfaces. Their distinctive feature is, that the hair pedicel, or stem, terminates in two or more prongs which are sometimes thick and rounded at the tips, but most often very sharp-pointed: sometimes, too, they are quite erect in position, whilst at others they become curved.

Figure 3.
Forked Hairs from the Leaf of Rough Hawk-bit.

Some quaint examples may be seen in the accompanying illustrations. Figure 1 shows forked hairs found on the blossom of vegetable-marrow. It may be noticed that the hair consists of a number of thick cells placed one on top of the other till quite a long pedicel is formed, and then that the pedicel divides off into two thick branches, or prongs. In the smaller hair illustrated, it will be seen that the prongs are being formed.

Figure 3 represents barbed hairs that abound on the leaves of our Wild Rough Hawk-bit. Each prong will be seen to be *very* sharp-pointed. Figure 2 is a specially pretty example of a three-pronged hair from the stem of *Aubretia*, a plant so favoured in our rock-gardens and rock edges of borders. The way in which the sharp prongs spread out from the tip of a somewhat short, thick stem, is very suggestive of a fork.

Hooked hairs are also known as curved or saw-like, and are found largely on climbing plants and those that, whilst not being in the true sense climbers, straggle up hedgeways, and in and out of the undergrowth of copses. They are very useful to such plants, for they act as small grappling irons and readily catch on to any foreign supports.

Figure 4 shows curved hairs found on the leaf of the garden scarlet-runner bean. They are beautiful little structures and most useful as climbing supports, tiny though they are. Figure 6 represents the saw-like hairs found on every surface, stem, leaf and flower of wild Cleavers; a plant that grows in rank luxuriance in most of our hedges and copses; a "weed" that often causes great annoyance by the persistent way in which it clings to one's own clothing when wandering along the countryside. Strange, indeed, are the hooked hairs met with on wild Hop (see Figure 5), another climbing plant of English hedgerows. On stem and leaf these curious hairs abound, and one needs only to see their formidable appearance to understand why it is that in wet weather (when the hairs are specially stiff), if hop-picking, or wandering carelessly between the hanging sprays in a hop-garden, one's skin becomes so terribly torn: the hooked hairs are really able to tear and cause great soreness to hands and face. Each hair is bulbous, or swollen at the base, and gives off one or two curved arms at its apex: when two are present the whole structure has the appearance of a bull's head. Many hooked hairs are very rough to the touch, their upper cells showing excrescences of various kinds; these are also useful adjuncts to the plant for climbing purposes.

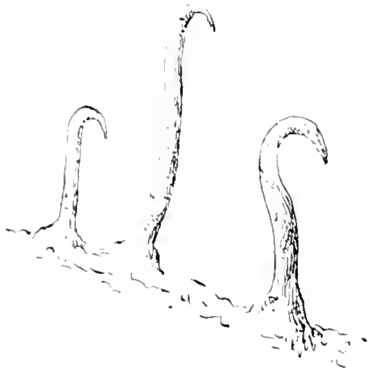

FIGURE 4.
Hooked Hairs from the Stem of the Scarlet Runner Bean.

II.—GLANDULAR PLANT HAIRS.

Amongst this class of hairs—one of the most numerous of all—are found structures of the most varying types.

A typical glandular hair consists of a more or less swollen base, a pedicel that is either long or short, and, at the tip of this, a head—or cap—that assumes in different plant species a great variety of shapes. In some plants it is oval (White Campion), in others triangular (Speedwell), and very frequently indeed it is circular. In this cap, or head, are secreted oils, irritant juices (*Primula obconica*), resins, gums, and peptonising digestive fluids, as the case may be, to whose presence are due the varying colours, odours and flavours met with amongst plant-hairs. These properties are useful in attracting or warding off welcome or unwelcome insect visitors, in catching and digesting insects (as do the tentacular hairs on Wild Sundew and other insectivorous plants that *live* on the food trapped and digested by their hairs), also in protecting young buds whilst developing.

FIGURE 5.
Hooked Hairs from the Stem of the Wild Hop.

The hairs that play such an important part in doing this latter work are peculiar glandular ones called *colleters* that are present on leaf-buds, and, after rapidly maturing, usually die away as soon as the bud really begins to open. They secrete a watery gum mucilage, together with drops of resin or balsam, which become laid over the surface of the bud, thus forming a protection for the delicate structure they guard. In Ribes, Salvia and Honeysuckle, gum is largely present in the colleters. Many plants show more than one kind of hair on the same structure, each kind having its own special function to perform. Thus the Marsh Avens produces a tiny fruit (achene) that is provided with a feathery awn. This awn shows tw[illegible] forms of hairs:—(1) beautiful slender, long si[illegible]at easily catch the wind, that wafts the frui[illegible]2) glandular ones that are extremely sticky [illegible]p the wee fruit to *adhere* to anything [illegible] it may come into contact.

Beautiful beyond all description a[illegible]ndular hairs on the Sundew, nor can anyone [illegible]s ever seen a mass of these plants, growing on [illegible] area of bog-land, ever forget the sight of th[illegible]lish-hued hairs glistening and sparkling in the sunlight like vast myriads of diamonds. Each hair tip (when in a state of quiescence) shows a bead of silvery, shining secretion, and the effect of this, as a sunbeam streams across it, is one of infinite charm. In the accompanying illustrations are some glandular hairs often met with. Figure 10 shows triangular-headed hairs from the leaf of *Atriplex patula*—a common "weed." Figure 11 is a very much magnified hair from the calyx of Purple Dead Nettle, showing the many cells and circular tip with which the hair is built up. Figure 9 are quaint hairs from the sepals of Sweet Pea. These hairs are extremely bulbous at the base, but very long and slender above, and they bear no "cap" at the tip of the pedicel. In the swollen base, full of glands, the secretions are formed. Figure 8, showing hairs from the stem of London Pride, is well worth studying, for the microscope can hardly show any hair groups more lovely than those found on this plant. One may liken them to rows of long, slender, silvery-hued, stemmed goblets, springing from a slightly spreading stand, and ending in a circular bowl filled with a rich ruby-coloured wine. The whole plant is covered with these exquisite little forms. In Figure 7 are seen the curious hairs from the leaf of White Bryony: note the curious glandular tips composed of many cells. Figure 12, too, is very remarkable. The leaves of *Arctotis* are covered with a thick "felt," and under a microscope we find that this is made up of a mass of slender intertwining thread-like hairs, whose bases

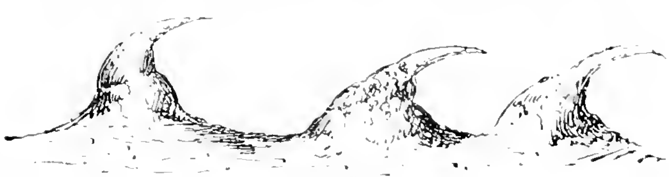

FIGURE 6.
Hooked Hairs from the Stem of Cleavers.

differ. One kind of hair is circular and glandular below, and the other, long and brick-like. The tips of each give off a very long thread that turns in and out, interweaves, and forms the "felt" we see and admire so much even with the naked eye.

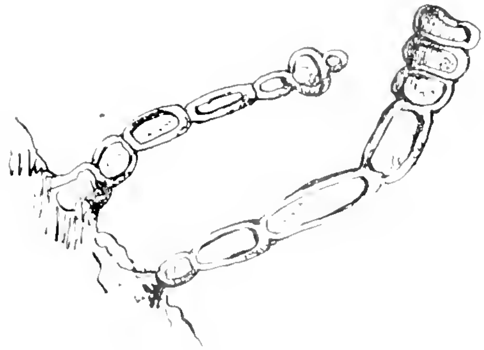

FIGURE 7.
From the Leaf of White Bryony.

FIGURE 8.
From the Stem of London Pride.

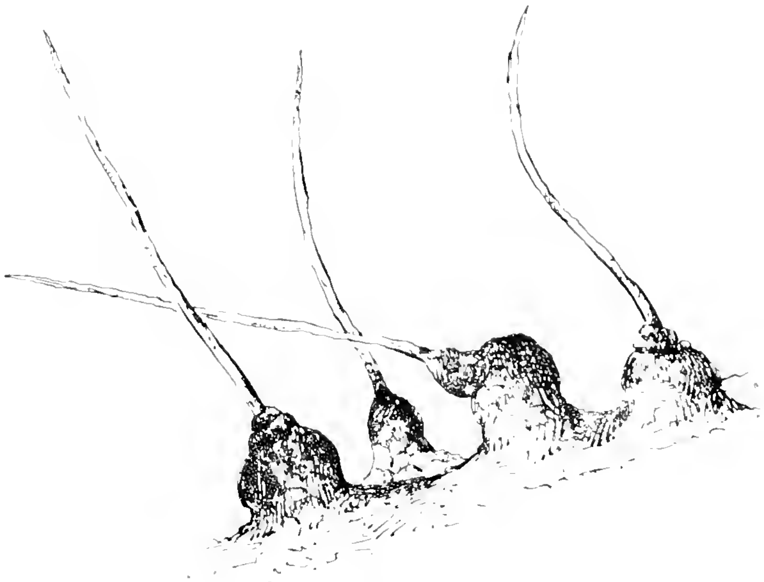

FIGURE 9.
From the Sepals of the Sweet Pea.

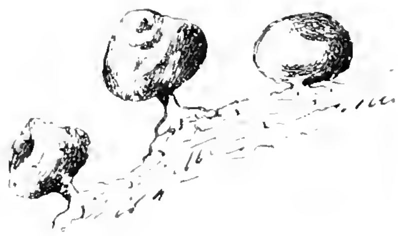

FIGURE 10.
From the Leaf of *Atriplex patula.*

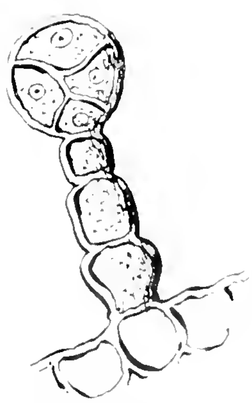

FIGURE 11.
From the calyx of the Purple Dead Nettle.

FIGURE 12.
From the "felt" of the Leaf of *Arctotis breviscarba.*

(To be continued.)

EUTECTICS.

By J. E. W. RHODES, Assoc. Inst. M.E.

It has long been known that most alloys melt at lower temperatures than their constituent metals.

Thus solder containing 32 per cent. of lead and 68 per cent. of tin melts at a lower temperature than either tin or lead; and fusible alloys consisting of lead, tin, bismuth, and sometimes cadmium, melt readily in hot water.

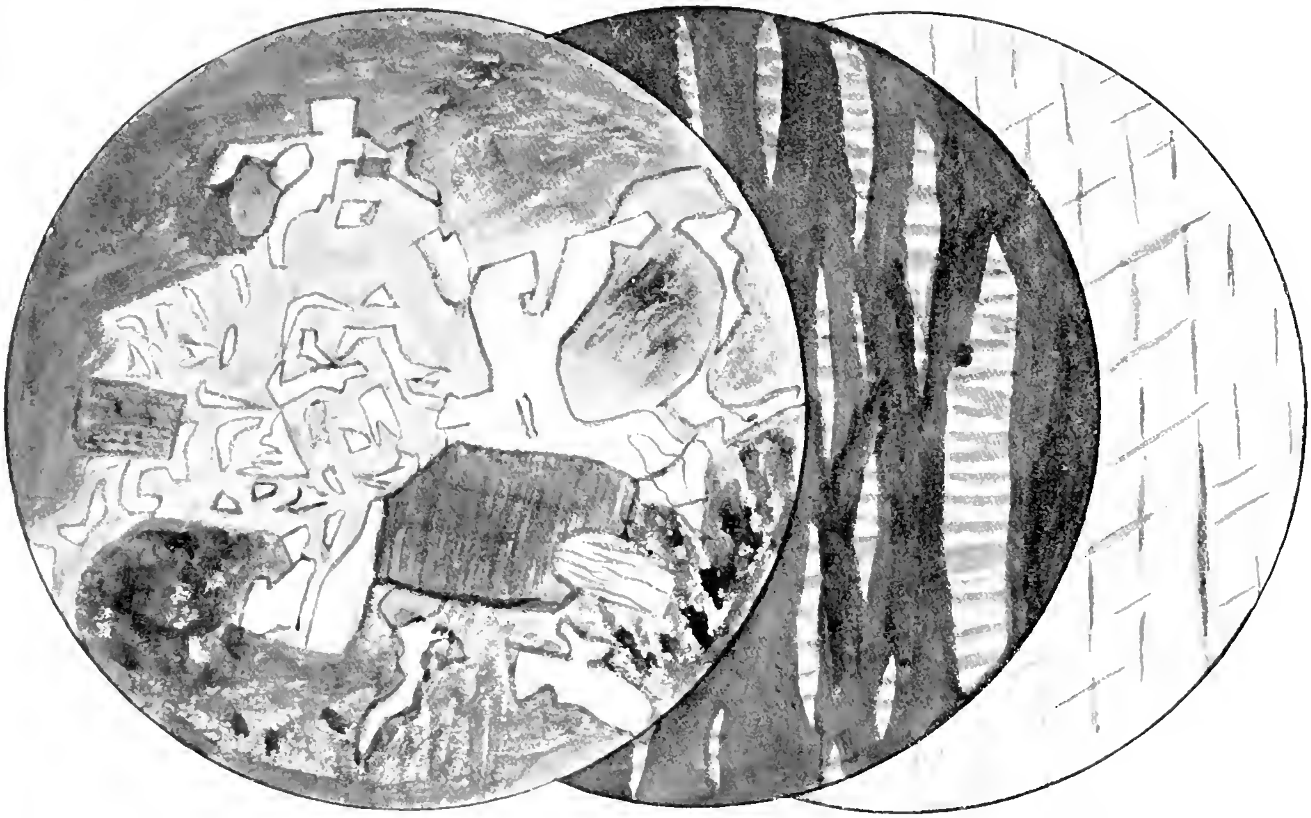

Figure 1. Micropegmatite in dioritic granophyre.

Figure 2. Perthite parallel to basal plane.

Figure 3. Perthite parallel to clinopinacoid.

The same principle has been found to apply to salts: thus fusion mixture consisting of sodium and potassium carbonates in molecular proportions melts much more readily than either of them. The use of fluxes in metallurgy frequently furnishes another instance, so that we may regard the fusion of alumina in presence of cryolite as due to a similar lowering of melting-point.

Let us now take up the study of the tin-lead alloys and plot out the melting points against the percentage of tin. We find our curve consists of two branches with a cusp shown at A in Figure 4. The increase in the percentage of tin continuously lowers the melting-point until A is reached at 180° C and 68 per cent. of tin after which the melting-point rises continuously. This point is called the *eutectic* point and the alloy the [illegible] alloy.

The question now arises as to why the alloy should possess such peculiar properties. Is it a chemical compound, since it possesses definite composition and melting-point? To this we can say no at once, for every chemical and electrical test shews that the eutectic contains free lead, free tin, and nothing else. To solve the difficulty the microscope is brought into use. It is at once seen that of all the alloys the eutectic is the only one that is homogeneous: all the others consist of more or less perfect crystals imbedded in a fine grained matrix identical with the eutectic.

It is now easier to understand the phenomenon.

Taking an alloy fairly rich in lead, X in Figure 4, we see that as the temperature falls no crystallisation occurs till we reach a point Y on the curve when pure lead separates out and the temperature falls along the line YA. When A is reached all the lead over and above eutectic proportions has crystallised out and the tin and lead remaining crystallise simultaneously. A eutectic point is therefore the point at which two substances crystallise simultaneously. Now if this occurs, obviously each substance will interfere with each other's crystallisation, so that we shall get a mass in which the component crystals are very intimately intergrown.

Let us now turn from alloys to the applications of this theory to the crystallisation of rocks.

Few rocks have been synthesised, but many rock-forming minerals have been crystallised from slags, and Vogt has successfully tackled the determination of some of their eutectics. Thus he has found that 68 parts of augite to 32 of olivine form a eutectic, and so do 70 parts of plagioclase felspar to 30 of olivine. And this has been proved to hold in the igneous rocks, for Harker has shewn that in allivalite (a rock composed of olivine and the lime-bearing plagioclase, anorthite) the anorthite always crystallised first when constituting more than 70 per cent. of the rock, otherwise the olivine crystallised first.

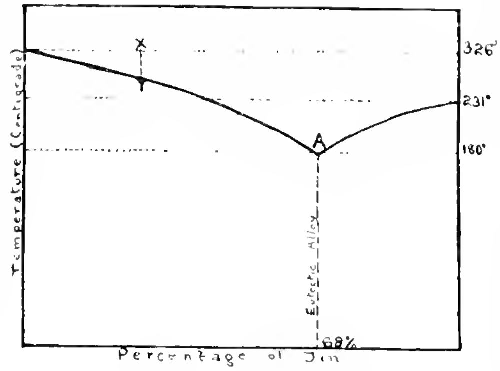

FIGURE 4. Tin-lead Alloys.

In 1888, Teall suggested that the curious intergrowth of quartz and felspar known as micropegmatite was a eutectic, and Vogt shewed from a chemical analysis that the ratios of quartz to felspar in micropegmatite was 26 to 74.

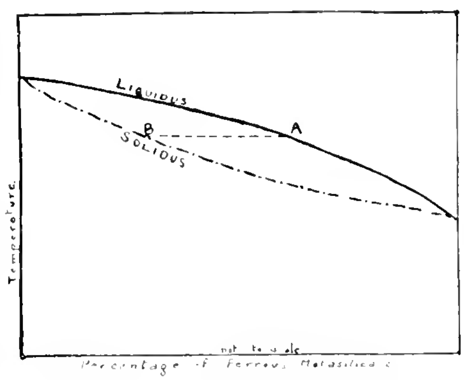

FIGURE 5. Roozeboom's Type I.

Hitherto we have been restricting ourselves to substances which do not shew any crystallographic relationship. We must now examine the melting-point curves of isomorphous mixtures and touch upon the investigations of Bakhuis Roozeboom. He found that the curves fell into five groups, of which only two need at present be examined. Taking the enstatite-hypersthene series of isomorphous metasilicates, where crystals of every possible composition can be obtained, he found that instead of one he obtained two curves, the freezing-point curve or *liquidus*, and the melting-point curve or *solidus*. Thus a liquid of the composition A gives rise to crystals of the composition B, since crystals of the composition A would have melted at this temperature. This curve (shewn in Figure 5) constitutes his Type I. Instances, however, are frequent of imperfect isomorphism in which one constituent, X, will only hold a certain amount of the other, Y, just as ether and water will only mix in certain proportions. This imperfect isomorphism gives rise to Type IV, shewn in Figure 6, where the upper curve, the *liquidus*, is seen to have a eutectic point

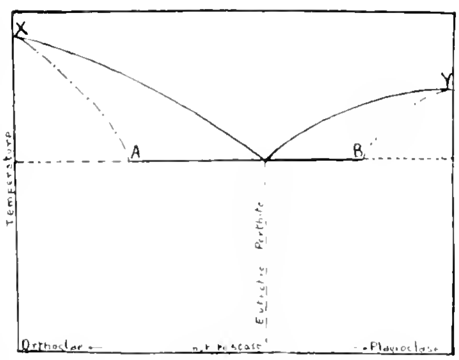

FIGURE 6. Roozeboom's Type IV.

formed not of the substances but of the mixed crystals A and B, each of which contains both constituents. This has a very interesting application in the case of perthite, a peculiar intergrowth of orthoclase and plagioclase. Orthoclase may contain up to a certain percentage of albite, being then known as soda orthoclase, whilst albite may likewise contain a limited amount of orthoclase. This is because orthoclase being monoclinic and plagioclase triclinic, perfect isomorphism is impossible; nevertheless the relationship is both chemically and crystallographically so close that small amounts of one can form mixed crystals with the other.

The importance of eutectics in rock formation is very great and the conditions are often very complicated, there being frequently several successive eutectics between different pairs of minerals. A condensed account of the crystallisation of a granophyre may give some idea of the rôle of the eutectic. The rock to be described consists of ferromagnesian metasilicates which crystallise out as augite, alumino-alkali anhydrosilicates which form felspar, and quartz. The augite first separates out in well-formed crystals; then the felspar builds large more or less perfect crystals termed phenocrysts, until the eutectic composition is reached, when the felspar and quartz remaining solidify as micropegmatite, whose felspar is in optical continuity with the phenocrysts.

Besides these micropegmatitic or granophyric rocks, there are many whose ground-mass is too fine to be resolved by the microscope, but has been shewn chemically to be nearly eutectic in composition. Spherulites of minute radiating fibres are found in them, and these have been shewn in some cases to consist of micropegmatite. Hence this ground-mass has been supposed to represent the eutectic on a cryptocrystalline scale, and is termed amphi-eutectic, that is, almost eutectic.

It only remains to add that a classification of rocks has been seriously proposed on the nature of their eutectics. Its advocates regard the eutectic as the dominant feature of the rock. It is being vigorously opposed by the school of petrologists who place chemical composition first; but time alone can decide between them.

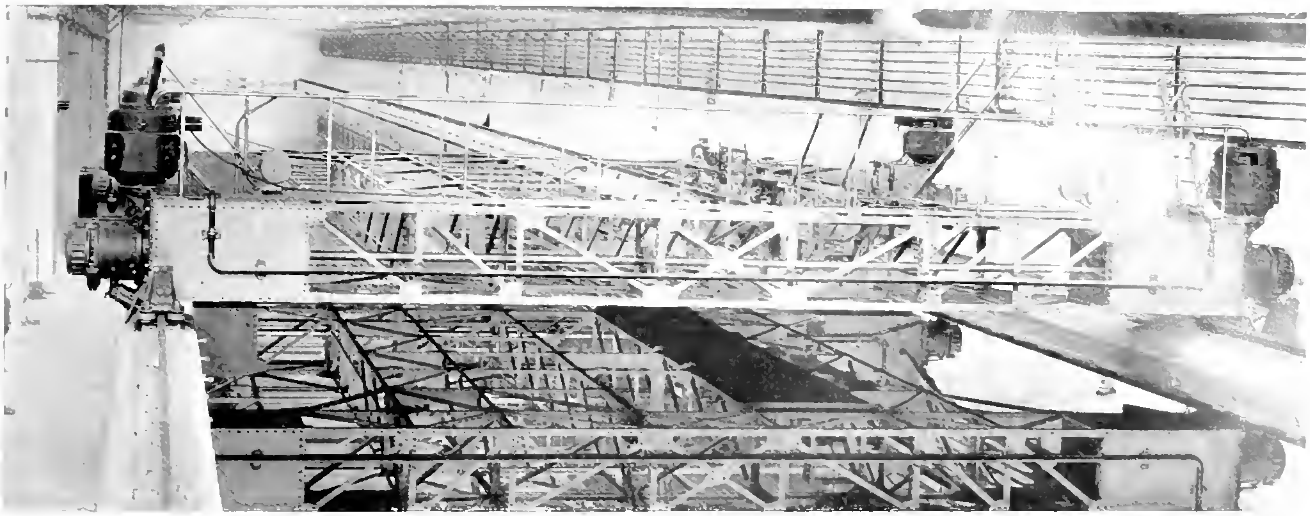

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FIGURE 1. The Experimental Basin and Carriage for towing Models.

THE NATIONAL EXPERIMENTAL TANK.

WORK AT THE NATIONAL PHYSICAL LABORATORY.

By E. S. GREW.

AT last the National Experimental Tank, which public subscription and private benefaction have set up within the precincts of the National Physical Laboratory, Bushy Park, is completed; its equipment is undergoing test; and within a very short time the ship-building industry of Great Britain will be served by an instrument of precision unsurpassed in any other country. Speaking roughly, one may say that an experimental tank is designed to test the resistance which is offered by the hulls of ships to passage through the water. The desired knowledge is obtained by towing wax models of hulls of given shape and dimensions through the water of the tank, and (after their resistance to towing has been ascertained by the most refined methods of measurement) by converting the results thus arrived at into terms of the larger hulls of iron, wood or steel which the models represent. The National Experimental Tank is intended for much more recondite experiments than are indicated in the foregoing sentence; but the uses of such experiments—which are constantly being made in the experimental tanks of the German shipbuilders, as well as in the tank belonging to Messrs. Denny, of Dumbarton, and in the naval yards of the great Powers—may be readily made clear.

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FIGURE 2.

Small Tank to be used for experiments with the water flowing past the Model, the latter being held in a fixed position.

Let us consider, for example, some of the problems which confront the designer of a torpedo-boat destroyer. He has first of all to derive a high speed from his craft. But he cannot put in as much engine power as he pleases, because that plan may result in an undue weakening of the hull, or in sinking the hull too low in the water, or in depriving the vessel of the necessary room for armament or accommodation.

Therefore his designs are limited in various directions, and it is only by slight alterations in the shape or in the flotation lines of the hull that he can expect to lessen its resistance to the water through which it is to be driven. The effect of these alterations can be tried, of course, by building a large number of vessels: but evidently the cheaper way, if it is equally trustworthy, will be to experiment with various types of models, which being made (for example) of wax, can actually be altered to different shapes.

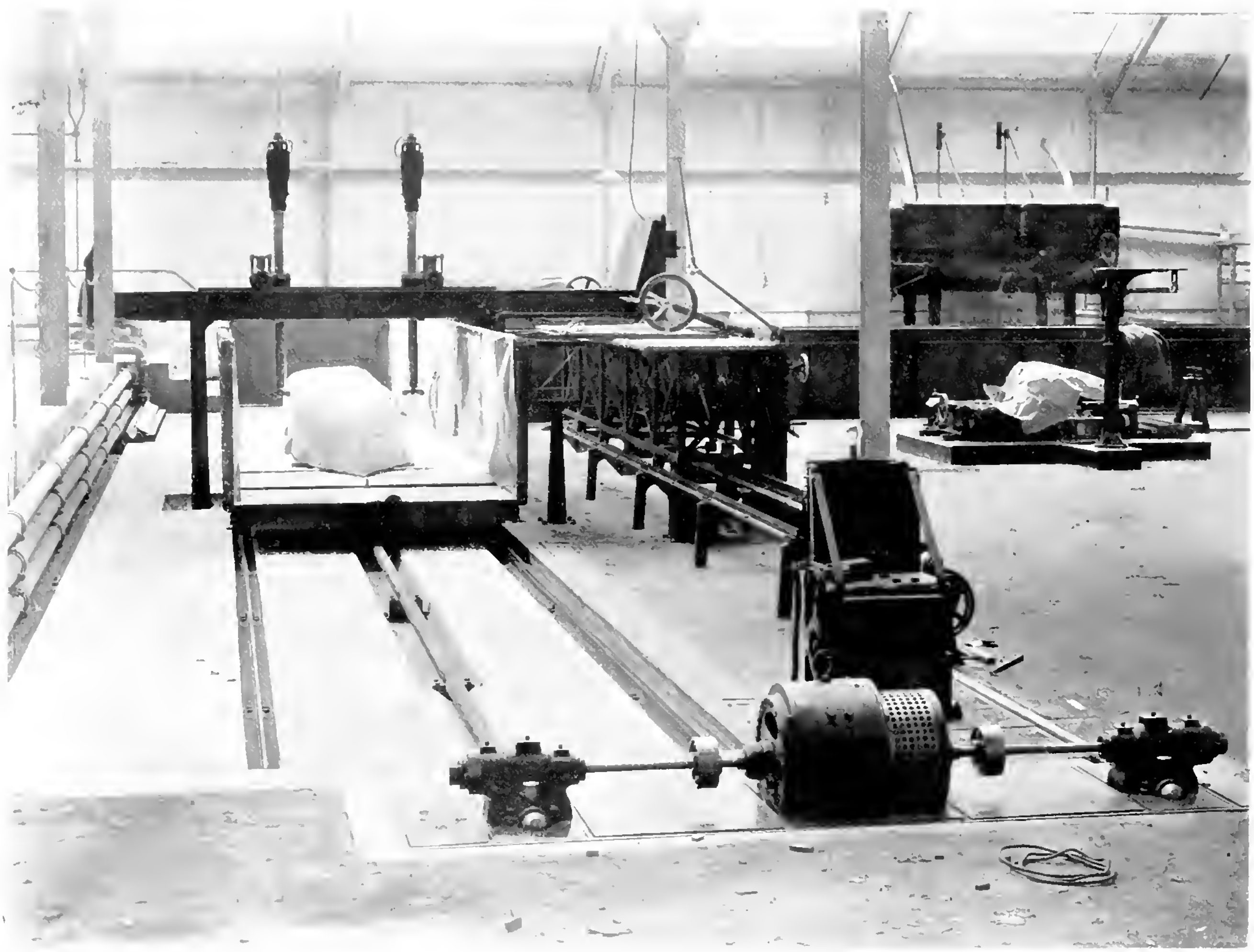

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FIGURE 3. Model-making Apparatus.

The larger the vessel of which the most desirable shape has to be ascertained, the more numerous the difficulties. All sorts of new factors of resistance to passage through the water are introduced. The hull of an ocean liner, or an ocean tramp, or a cruiser, is not smooth. It is studded with bilge-keels, pitted with shaft-escapes, and has other openings and projections in its sunken sides. The rudder, as it moves, causes resistance; and the rudder has to be protected. The propellers also exercise, by their shape and resistance, a considerable effect on the vessel's speed. One may think of the resistance offered by a ship's hull against its forward movement through the water as being composed of a frictional resistance and a wave- and eddy-making resistance. The first kind of resistance is brought about by the friction of the immersed surface of the ship's hull with the water; the second by the formation of waves at the bows and of waves and eddies around the stern.

These coëfficients can be found empirically by the aid of the wax models. The frictional resistance depends on the size and nature of the immersed surface, on the density of the water, and on the speed at which the ship or its model is driven or towed. As the frictional coëfficients for the different kinds of surfaces of ship and model are known — they vary not only with the nature but the lengths of the immersed surfaces—the frictional resistance may be ascertained mathematically without difficulty. If the

FIGURE 4. General View of the Experimental Tank.

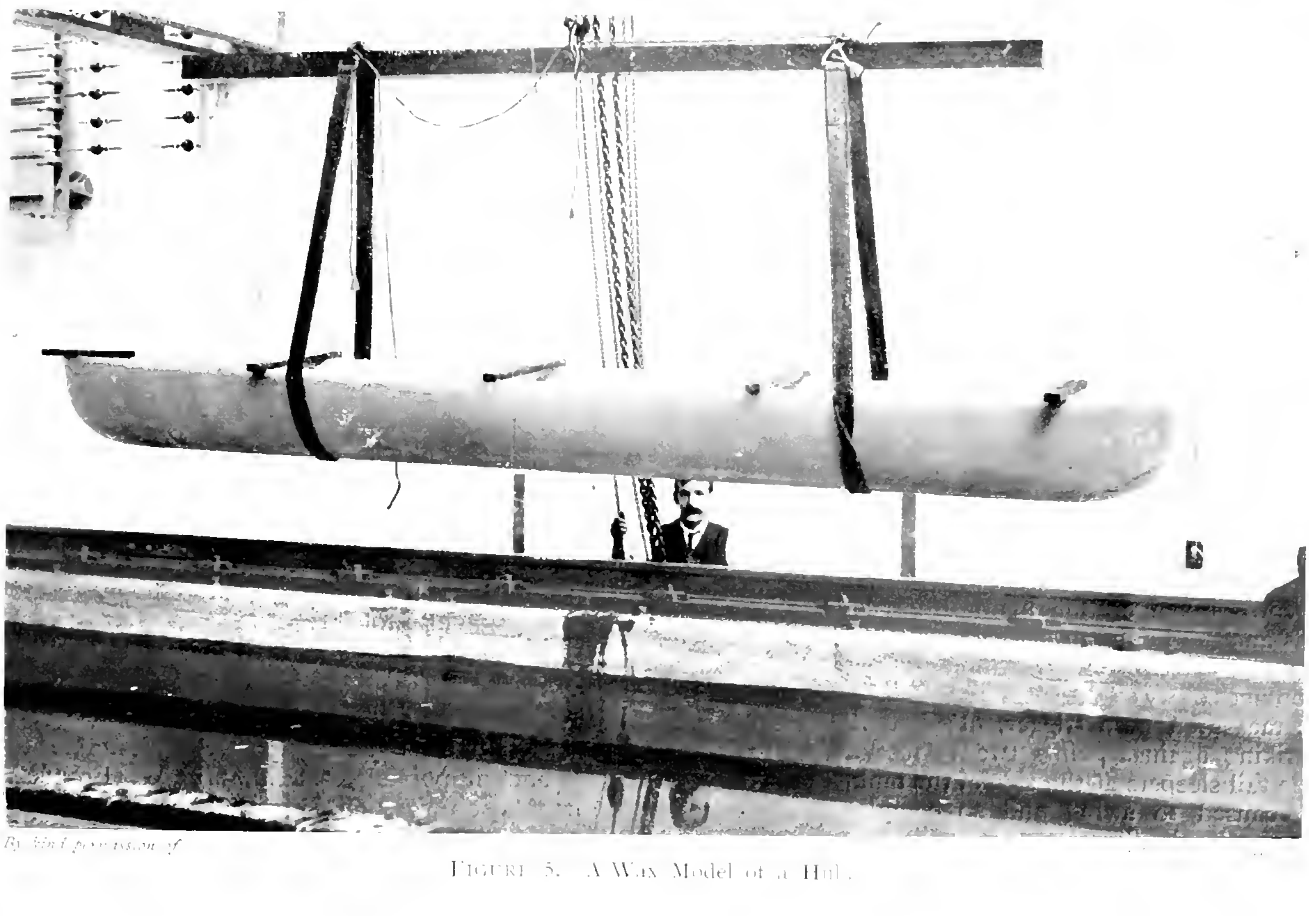

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FIGURE 5. A Wax Model of a Hull.

total resistance of the model has been found by towing experiments the wave- and eddy-making resistance, which is not mathematically ascertainable, can be found by subtracting the frictional resistance from the total resistance.

Newton's law of mechanical similarities, first applied by Froude in the calculation of the resistance of ships, and therefore called "Froude's Law," enunciates the theorem that if two geometrically similar ship bodies are moving at corresponding speeds through the water, the wave- and eddy-making resistances of these bodies are proportional to the third powers of their linear measurements or displacements.

As soon as the wave- and eddy-making resistance of the model has been found by experiments it need only be multiplied by a^3—the third power of the proportional displacement of ship and model—in order to obtain the corresponding resistance of the ship. If the frictional resistance of the ship is added to this resistance the total resistance of the the ship can be found by a simple mathematical formula.

It will be readily understood that in experiments of the nature indicated the most important instrument of precision is the towing carriage, the mechanism which registers the resistance to towing set up by the wax models. The carriage at Teddington spans the whole width of the tank and is borne on four wheels, thirty-six inches in diameter, which travel on rails built on the sides of the tank. It is made entirely of steel and the illustration (see Figure 1) gives a better idea of it than any description. Its dimensions are thirty-two feet six inches by thirty-four feet six inches and its weight including all motors and electrical equipment, but excluding the model dynamometer and other apparatus, amounts to fourteen-and-a-half tons. The carriage is driven by four motors and can be run at more than four hundred registered speeds, towing the models at rates varying from one foot to fifteen feet a second. The dynamometer and towing apparatus are made to follow the methods evolved by Froude, at Haslar, and allow the model some small amount of movement while being towed. It is not possible in the space at our disposal to describe the electrical measuring apparatus. It must suffice to say that this apparatus, (so sensitive that if the length or breadth of the wax model were altered by a thousandth part, the resultant alteration of its resistance would be registered by the dials on the towing carriage) is fitted with several drums. The records taken on the main drum consist of time, distance and resistance. The first of these is given by an electric clock, which makes and breaks contact every half second. The distance towed is measured by a trigger, fitted to the fore girder, striking against points twenty feet apart, fixed to the rail sleepers at the side of the tank. This trigger is caused to swing and so complete an electro-magnetic circuit. Records of the trim of the model can be taken, when required, on separate drums.

There are two tanks at Teddington. The Great Tank (see Figure 4) is of dimensions as follows:—

Length.............	549-ft. over all.
Breadth............	30-ft. on water line.
Depth of water....	12-ft. 3-in. along the middle line.

In the tank walls an observation window has been fitted on either side, about mid-length of the tank. An arc lamp is to be fitted on one side of the tank to illuminate the water through the window, so as to enable a passing model to be observed *under* water, and any phenomena to be photographed.

A smaller tank (see Figure 2), sixty-four-and-a-half feet in length, and of five feet width, has been made for the purpose of investigations with running water. Experiments can be made in this tank under two sets of conditions—either in the still water and the model being towed; or with the model held on a dynamometer arm and the water made to flow past at any velocity. For the second of these purposes a rotary pump has been fitted at one end of the tank, and provision has been made for reducing eddies. This pump will give a velocity of about three miles an hour to the water, and the velocity can be regulated as desired. Special apparatus has been designed for casting the wax models—in lengths varying up to twenty-five feet—and for making them exactly to scale. The initial programme of experiments is as follows:—

A standard model will be made to the same lines as that used at the Haslar Experiment Works, and the results of the experiments with this model will be compared with those at Haslar.

Further experiments will be made with (say three) models of widely different types already tried at Haslar, to ensure the general accuracy of the apparatus and methods adopted.

On the satisfactory completion of this work, and with a view to a series of experiments on mercantile forms, a preliminary set of experiments will be made on some typical forms of passenger-cargo and cargo vessels having as wide a variation of block coëfficient and form as possible.

In conjunction with the foregoing, some experiments will be made to test the effect produced on the diverging system of waves by varying the bow form. These experiments will start on the lines suggested by Lord Rayleigh (*Phil. Mag.*, September, 1909).

As further work to be undertaken at an early date, the Committee have approved the suggestion to explore thoroughly the wake in the afterpart of several typical models. Experiments would be made to give the direction of flow, the pressure, and the velocity head in the streams.

It has also been agreed that it is desirable to repeat, and, if possible, extend, Mr. W. Froude's experiments on friction; it is hoped to make observations on planks up to at least one hundred feet in length.

ON THE PROPER MOTIONS OF THE FIXED STARS.

By W. DOBERCK, Ph.D., F.R.A.S., M.R.I.A.

Halley found that some of the brightest fixed stars had changed their places since they had been observed by the ancient Greeks, and such changes are so obvious as to be recognised on ancient coins. Sir William Herschel, in 1783, arrived at the conclusion that a relative motion of the Sun among the fixed stars in the direction of a point situated near λ Herculis would account for the greater part of these proper motions: the motion of the sun towards the "apex" must cause the fixed stars in half the sky to apparently move away from that point, and in the other half of the sky to move towards the diametrically opposite point, the "anti-apex." Since then a great many astronomers have determined the situation of the "apex," but the results do not agree very well, especially as regards the declination. Bessel investigated the matter and declared himself dissatisfied with the evidence. When the direction of the proper motion of a fixed star has been ascertained, a great circle laid through the positions of the star observed at two epochs is thereby determined, and if the great circles belonging to different stars intersect in a point (the apex), it is easy to see that the poles of these great circles must lie on another great circle, of which the apex is the pole. Bessel found that the poles do not lie on or near a great circle but are scattered over the sky. Kobold, the editor of the *Astronomische Nachrichten*, who some years ago took up Bessel's investigations, proceeds as follows. He imagines the celestial sphere inscribed in a cube which touches the sphere at the two poles and at four points on the equator. He supposes the eye of the observer situated in the centre of the sphere, and any great circle on the sphere is then projected as a straight line on one or more of the faces of the cube. Kobold had already used maps made on this principle in determining radiants of shooting stars, and the writer had subsequently, in Hongkong, used similar maps for the same purpose. Kobold projected the poles of a great number of proper motions on such maps. Those that correspond to proper motions intersecting in the apex should lie on a straight line corresponding to the great circle of which the apex is the pole, but that is not clearly shown on the maps.

Kapteyn, who has the merit of having originated many hypotheses that appear destined to aid greatly in the astronomy of fixed stars, solves the difficulty by accounting for a great number of proper motions on the supposition that there are two distinct apices both close to the galaxy. It had, indeed, in course of years, become the general impression that the galaxy is made up not of isolated heavenly bodies but of a conglomerate of clusters of stars and nebulae. There was, therefore, nothing extraordinary in the circumstance that the stars belonging to two clusters did not move in the same direction. Kapteyn's hypothesis has been examined at the Greenwich Observatory and confirmed there by the independent evidence of proper motions, other than those used by Kapteyn. It has been confirmed also at the Cape of Good Hope. It has been to some extent confirmed by spectroscopic evidence at the Cape Observatory and at the Lick Observatory.

The speed in miles with which a star is moving towards or away from the earth can be measured in the spectrum, the wave-length of the lines being respectively shortened or lengthened, and it is found that the stars on opposite sides of the sky indicate a general drift or even two drifts, but the objects used should be evenly distributed over the whole sky, and the spectra of only few faint stars are known with sufficient accuracy for this purpose.

Meantime other radiants have been found. Boss, editor of the *Astronomical Journal*, has shown that the Hyades form a great cluster moving in parallel lines towards a certain radiant point. Another apparently (but perhaps only apparently) much larger cluster, which has been investigated at the Potsdam Observatory, contains the stars in the Great Bear, Sirius and other bright stars.

As mentioned above, the spectroscope enables astronomers to measure the motion of a heavenly body in the line of sight in miles per hour. The proper motion, expressed in seconds of arc, shows how much it is moving in the line perpendicular to the line of sight. When the direction of motion in space is known, then the parallax is at once obtained from these two quantities, and that direction is given by the radiant. Parallaxes of fixed stars are more accurately determined in this way than by any other method. Numerous results have been obtained. They show that the magnitude of a star forms no guide to its distance from us. Stars of different intrinsic brightness are mixed in space. Therefore, it would be no wonder if some of the small telescopic stars should turn out to be comparatively near the solar system. Proper motions have hitherto been determined by comparing positions recently determined by the meridian circle with older results. Burnham, at the Yerkes Observatory, has of late years determined a number of proper motions by aid of micrometric measures compared with previous measures made by Struve, Sir Robert Ball and others. In those cases where his results differ from the result of meridian work, the difference is probably caused by hitherto unsuspected proper motions of faint stars, which it will be possible to determine by future micrometric measures compared with Burnham's observations. At Heidelberg proper motions of faint stars are discovered by simply looking in a stereoscope at photographic plates of the same part of the sky taken several years apart. Turner has discovered large proper motions of stars as faint as the eleventh magnitude marked on photographic plates, and states that stars with proper motions greater than 15″ per century are scattered with no sensible reference to the galaxy.

It may be asked what becomes of Herschel's explanation of the apex caused by the Sun's proper motion when there are not one but many apices. It should be kept in mind that all motion is relative, and it is quite legitimate to attribute the apex of the cluster that contains the largest number of stars to the proper motion of the Sun. Boss has lately discussed about six thousand proper motions, and he determines the apex without taking into account the existence of different systems, and also without excluding any objects.

It appears that all the radiants so far found lie near the galaxy, and it is much easier to determine additional radiants on the supposition that they all lie near the galaxy, than if they were scattered over the sky. If the pole of the galaxy is projected on Kobold's maps, and also the straight line (or rather lines) corresponding to the great circle of the galaxy, any straight line from the projected pole to any point on the projected galaxy represents a great circle perpendicular upon the galaxy, and the projected poles of proper motions that lie near this line indicate stars the radiant of whose proper motions is the pole of the galactic meridian in question. By investigating the proper motions all round the sky in this manner it should be easy to discover all the radiants that lie near the galaxy.

Kapteyn, on the supposition that there are only two radiants, explains these as being caused by stars moving in two diametrically opposite directions, and the fact that they do not appear to be diametrically opposite he explains by combining the proper motion of the Sun with each of them. In this way the direction of the Sun's proper motion is determined, but it is seen that the Sun belongs to neither of the clusters. However, there are probably more than two star streams, and there is so far no reason to suppose that they move in exactly opposite directions.

It is conceivable that two globular clusters might attract each other, approach, and pass through to the opposite side. When they had reached the same distance apart on the other side, they would stop and their motion would be reversed. The period of the swing of such a pendulum would exceed millions of years. But when the enormous distances between the stars are taken into account and their relatively insignificant sizes, the forces are found too insignificant to account for existing proper motions. The energy of runaway stars cannot be derived from attractions between fixed stars or clusters: it may be due to explosions.

As all observations of heavenly bodies are made by comparison with positions of fixed stars, the accurate determination of the proper motions of the latter may be said to be in some sense the most important object of astronomical observation. Several astronomers, especially Porter in Cincinnati, have devoted their energies to the discovery and determination of proper motions. An international coöperation between observatories in all parts of the world is being arranged to make a determination with the utmost accuracy of the positions of a very great number of fixed stars evenly distributed over the sky to serve as standards for determining the positions of faint stars recorded on photographic plates. But however perfectly the catalogue embodying the results of such coöperation may reflect the actual situation in the sky of the stars it contains, it must in a few years become quite inaccurate as the stars change their places, and for the determination of these changes the catalogue must rely on observations made in the past, so that the old observations, far from being superseded, gain in importance; and the older they are, the more important it becomes to take them into consideration.

CORRESPONDENCE.

THE FLIGHT OF BIRDS.

To the Editors of "KNOWLEDGE."

SIRS,—The representation by Gatke and others of the prodigious rapidity of the flight of migrating birds does not appear to rest on observations bringing conviction. I suggest that some knowledge on the subject might be obtained. An amazing number of birds are killed by dashing against the lighted lanterns of lighthouses. Therefore, I should suppose that, if on a "fly-line" near the shore there were placed a dark screen, twenty feet square, and in the middle thereof there were an aperture of, say, six feet diameter, covered with such material as that which equestrians jump through at a circus, and that it were very strongly lighted from the land side, immigrant birds travelling in the dark would make for it, and dash right through the flimsy material. They should then come in sight of another similar screen three hundred yards away, in the middle of which should be a disc of strong glass very brightly lighted from behind. At this the birds would dash as they do at the lantern of the lighthouse, and would fall dead—to be identified and registered by an attendant naturalist. The time of the first screen being broken by a bird and its death at the second should be taken by stop-watches. Between the screens a man should have a camera with which to cinematograph the approaching bird. There should be a contrivance for immediately replacing the broken flimsy in the first screen.

The birds on reaching the coast might, perhaps, have slowed down through fatigue, but the bright lights might stimulate them to renewed exertion.

Years ago, crossing the Channel from France, I observed a small bird accompanying the steamer for a mile or so. I could not say *pari passu*, for it frequently spurted, going with apparent ease ahead of us and then dropping behind. The speed of that bird during that flight, till it disappeared, could hardly have exceeded ten miles an hour.

Some migrants fly high: but the light of a bright screen might bring some of them down to its level.

FRANCIS RAM.

HINTS ON THE PREPARATION OF SKELETONS OF VERTEBRATES.

By J. A. BULLBROOK.

FOR the serious study of Comparative Anatomy there is nothing better than the preparation of typical skeletons of the classes and orders of Vertebrates. It is axiomatic that Morphology cannot be learned from text-books alone.

Moreover, though museum preparations are useful complements to practical study, they cannot supersede it. Much can, and must, be learned from the museum, because the material cannot be observed elsewhere; but such study is only superstructure, the foundation must be laid in the laboratory or home.

The fascination of preparing and mounting skeletons of various animals, for study or exhibition, does not seem to be appreciated by either the student or the amateur naturalist.

Yet, of all practical methods of obtaining correct and precise information concerning animal structures, this is certainly the best and probably the most interesting—that is if it is carried out intelligently.

It *is* possible to prepare a skeleton and yet have learned very little, or nothing at all, about the real nature of the animal or its anatomy.

The work should be done systematically and in definite order, and never without the aid of good diagrams, or, failing these, a lucid and exact description. To be of any value, the skeleton must be prepared for use and constant examination, not merely as a specimen of neat and clever handicraft.

Although this article is intended primarily for students, I hope to make it appeal also to the amateur naturalist, who has, perhaps, but little time and limited means to bestow upon his hobbies.

Now, just in these two particulars, this work is valuable. It is true that the preparation of a skeleton takes a great deal of time; but on the other hand, the work may be done at odd moments. In point of fact one is almost sure to spoil a specimen by working at it too long at a time; the work requires patience and plenty of it, and will not be hurried. A long sitting, therefore, is not only unnecessary but really disadvantageous. As to expense, all the necessary instruments and reagents may be purchased for a few shillings, and the material, with few exceptions, may be collected by the enterprising worker at the cost of a little energy and toil. Indeed, this is one of the charms of the work, that it entails a study of natural history in almost every aspect. It is far better to go into the country and gather the material first hand, so learning something of the habits and the haunts of animals, than to rely on the live-stock dealer. For the convenience of the reader, I have appended to this article a list of the necessary apparatus and reagents, with their approximate cost, and a list of animals which are easily obtained and are of most value for dissection.

Before, however, one can hope to make a satisfactory preparation, one must spoil some material and make several practice attempts, both at preparing and mounting. For these practice attempts, many advocate using frogs. I, myself, prefer the toad. It is almost as easy to obtain and it has the advantage that the bones are larger. I have illustrated this article with the photographs of some skeletons, including that of the toad (*Bufo vulgaris*). I will describe first the preparation and mounting of the latter skeleton, and this will apply to all vertebrate animals (except fishes) up to the size of a mole or rat. Larger animals should be mounted articulate or, better still, put into boxes partitioned for the different skeletal regions. They can be mounted on black boards by using wire, but there is no advantage, and the specimen then takes up a great deal of space. As to the preparation of fishes' skeletons, they are unsuitable to any but the advanced student, and will not be described in this paper.

Now, there are two things, one or both of which the beginner is always tempted to do: either to bury or to boil the animal, hoping to pick out the bones clean and just ready to dry and mount. I never knew of a really good specimen being procured by either of these methods. Moreover, by doing either, nothing whatever is learned of the soft parts, and all the meaning of the marks on the bones and their varying shapes is lost.

The animal should always be dissected first and then macerated.

A good description and diagrams are essential. There are in most places libraries which contain some books on Comparative Anatomy. It is not absolutely necessary to have a picture or description of the animal or its skeleton as a whole, though it saves trouble, and few text books have such descriptions of many animals. It is best, therefore, to fall back on such books as "Mivart's Lessons in Elementary Anatomy," which contain good diagrams and lucid descriptions of the various regions—if not actually of every animal, at least of so many types that almost any skeleton may be prepared from them. I have appended a list of books which will be of use and easily obtained.

To start with the dissection. This is an art which cannot be taught: it can only be learned by patient and plodding labour. The toad should be dissected carefully and thoroughly, with the aid of a book. All the structures and organs should be noted, and drawings made at the different stages of the dissection, especially of the muscles and ligaments. When satisfied that the soft parts have been properly studied, as much of the flesh as possible is cut from the bones, and the ligaments are carefully examined.

The body must now be macerated. This process consists of soaking the body in water for an indefinite period. For this purpose zinc tanks are useful (never iron or tin), of the following dimensions:—4-in. long, 3-in. wide, 1½-in. deep, for small animals; and 6-in. long, 4-in. wide, and 2½-in. deep for larger animals; these should always have tight-fitting lids. A useful substitute, however, is a pie dish or other shallow earthenware vessel, covered with a sheet of glass. It is often advisable to macerate the body in sections, taking care always to keep together the bones of similar regions. Especially is this method useful with larger animals, as in this case the quantity of flesh one is obliged to leave on the bones after dissection is often considerable, and by putting them into separate tanks one obtains a larger mass of water to each bone, and so expedites the process of rotting. The hands and feet should *always* be cut off at the joints, and each macerated separately in a small earthenware or glass jar. While it is macerating, the specimen needs frequent attention. The vessel should always be kept covered when one is not actually working on it, and the specimen must never be allowed to dry up.

As soon as the bone is loose and all flesh on it is soft, it is taken out and put aside in fresh water or preservative (weak spirit or formaldehyde solution) after it has been carefully cleaned. I do not advocate retaining the ligaments. These should be studied in the fresh condition, unless the object of the preparation be essentially to display them. Should one wish to keep them, the macerating specimen will need careful watching, and it must be taken out of the tank immediately when any ligaments show signs of coming away from the bones. Should any flesh still be adherent, it should be scraped off gently with a scalpel. But for the preparation in question, viz.: the toad, the ligaments are not required. When macerating do not remove too much of the débris at first, as by so doing the bacterial action is liable to be retarded. After decomposition has thoroughly commenced it is advisable to take out some of the rubbish from time to time. For this purpose an old table fork is very useful. As one takes out the bones they must be cleaned. This is a very tiresome and delicate process. Except for large bones the knife should not be used. A camel-hair brush, an oil-painter's flat bristle brush with the bristles cut down to about a quarter of an inch; a couple of needles mounted in handles; a pair of fine forceps; and a pair of fine-pointed scissors, curved on the flat, are the necessary instruments. Any stubborn fibres of ligament should be cut off close with the point of the scissors; the flesh and débris are brushed off with the hard brush, and the bone is finished by brushing with the soft brush. The brush should always be used in one direction only, not to and fro. The bones should always be held in the forceps—never in the fingers, and the whole cleaning should be done as far as possible under water. A piece of ground glass, made to fit the bottom of the cleaning vessel and with its smooth surface blackened with paint, so that the colour shows dull through the ground surface, is very useful as the bones show up clearly upon it when one is cleaning them. If after cleaning, some pieces of flesh still adhere tightly to the bones, they must be macerated further.

It sometimes happens that the ligaments will not yield to maceration; especially is this the case with the hands and feet of all vertebrates and the vertebrae of Ophidia. In this case boiling becomes necessary. The bones should be boiled in a small enamelled saucepan, the smaller the better. Before putting them into the saucepan, a few drops of strong solution of caustic potash may be added to the water; very little should be used and the potash should never be added in solid form, because it takes some time for it to diffuse and the specimen is liable to injury through coming in contact with a very strong solution. The liquid potash should be added to the water, drop by drop, and the whole well stirred before putting in the bones.

The ligaments will often soften by just bringing them to the boil, and the specimen must never be boiled for more than a quarter of an hour. It is not advisable to boil the bones clean; they should be cleaned, in the manner mentioned above, after boiling.

The next process after cleaning is bleaching. When all the bones are clean they should be washed free from any preservative—if such has been used—with distilled water. They are then placed in a glass vessel in a 1 in 20 solution of hydrogen peroxide. The strength is made by mixing the strong solution ordinarily sold, with 19 parts water. This does not of course represent 1 part H_2O_2 in 20 of water. The vessel containing the bleaching bones should always be kept covered with a sheet of glass so that no oxygen is lost. Never use chloride of lime for bleaching as it injures the bones and destroys the markings.

The vessel should be broad and shallow so as to obtain the greater surface area, and it should be placed on a white surface so that the light is reflected fairly equally on to all parts of the bones. The bones are whitened more quickly by adding a few drops

FIGURE 1. A Skeleton of a T[illegible]d (*Bufo vulgaris*).

of caustic potash to the peroxide solution, but this should only be done with the larger bones, as the small ones absorb a good deal of the caustic and rapidly turn yellow after mounting. In any case very little potash must be used or else tubercles and other markings will be obliterated. Hydrogen peroxide is harmless, but caustic potash is not. The bones should all be placed in the same strength of bleaching solution and remain in it for the same length of time, *i.e.*, until all are whitened. But it is advisable still, and indeed throughout, to keep the hands and feet separate from the rest, each being prepared in a separate dish.

After bleaching, the bones should be washed carefully again in distilled water; any débris still adherent may be taken off with a soft brush and the bones thoroughly dried. For this purpose a few racks are required. For larger bones these are best made of what is known as [illegible], *i.e.*, iron sheet stamped through with s[illegible] drawn out into diamond-shaped net-work. [illegible] of this material are nailed on at the sides [illegible] blocks, this form of rack allowing the [illegible] freely all round the bone. The iron s[illegible] with some hard enamel to prev[illegible] being injured by rust. For small bones [illegible] earthenware plate such as is used by [illegible] ing crystals, is best, although blott[illegible] will serve the purpose. The bones sh[illegible] one by one, not shot out promiscuously [illegible] dry for at least twenty-four hours. S[illegible] débris resembling bones remain in the [illegible] slight pinch with the forceps will always [illegible] their true character.

There now only remains the mounting. [illegible]

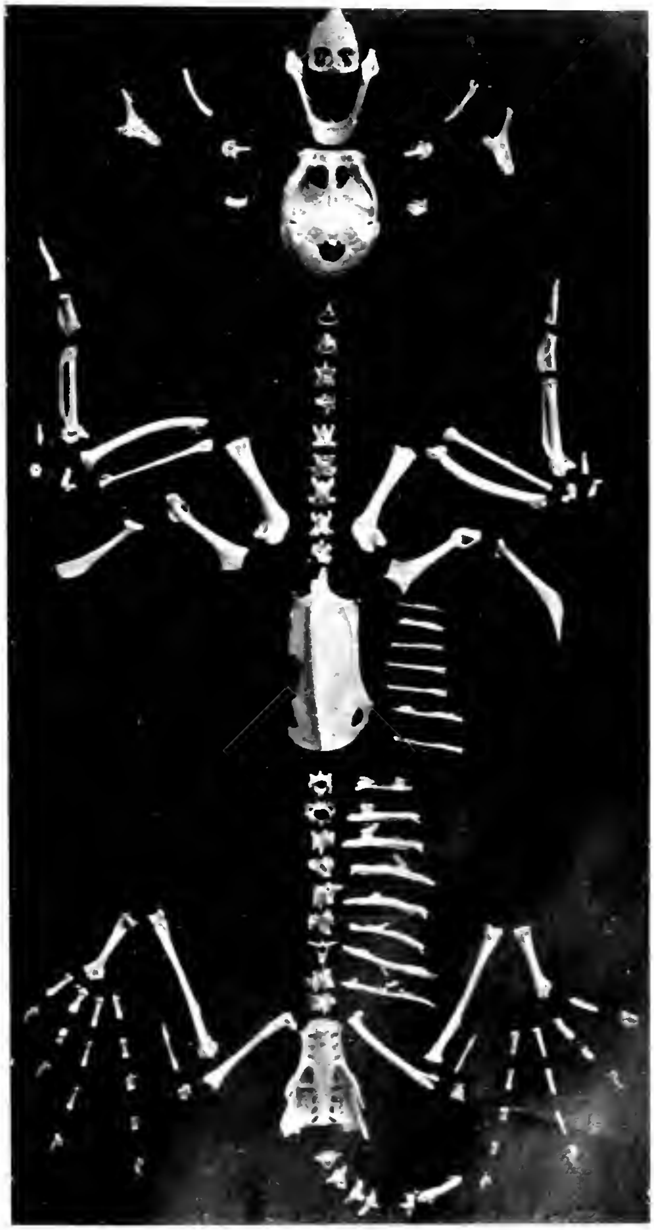


FIGURE 2.

A Skeleton of [illegible] Lo[illegible] Bird (*Androgl[illegible] agap*[illegible]).

should be done as far as possible at one sitting. The bones should be taken and arranged on a card, or, better still, on the blackened glass sheet, in their respective natural positions, the different regions being spaced distinctly. The skeleton should be mounted in a similar fashion on stiff card which has first been carefully blackened with a dull pigment (such as ivory black) as seen in the illustrations, and thoroughly dried. A good method is to paint red lines around or between the different regions. I would advocate mounting all one's skeletons on the same plan, and I think that the best is that shown in the accompanying figures (1 and 2). It is mapped out thus:—

Lower Jaw
and
Hyoideal
Face
and
Cranium.

Hand. Fore limb. Pectoral Girdle. Fore limb. Hand.

Cervical to Sacral Vertebrae

Foot. Hind limb. Hip Caudal Girdle. Hind limb. Foot.

Vertebrae

The bones on either side are to be placed showing inferior and superior surfaces respectively, so as to display the various markings, and so on. The mounting is done with a fine camel-hair brush dipped in benzol solution of Canada balsam. This should not be too stiff or a skin will form before the bone can set; nor must it be too thin, or it will soak into the bone and discolour it. In mounting the bone, it is held in position above the card by the forceps, and the brush is drawn over the card so that it leaves a film of balsam as near the shape and dimensions of the bone as possible, on which the latter is then dropped. Only sufficient balsam should be used to ensure the bone remaining on the card, and care should be taken not to soil the forceps with the mucilage, or the marks of the bones may be masked. The specimen is now placed in a box into which the card fits exactly, and is kept in a horizontal position. The preparation is now complete save for the drying of the balsam, which takes a week or two.

Regarding the preparation of skeletons of larger animals, little need be added to what has already been said. The bodies may, however, be boiled with less risk, and both in cleaning and bleaching, caustic potash may be used at discretion. A tooth brush and nail brush are necessary for cleaning, and the knife may be used more freely.

The mounting, however, of larger preparations differs considerably from that already described.

The bones, except the vertebrae, hands and feet, should be left loose. Those of the hands and feet should be mounted on black cards, unless they are large, when they should be bored and strung on catgut in their proper positions. The best instrument for boring is a "fiddle drill" such as is used by jewellers. The skeleton should be kept in a box and divided up into regions as before, each region being placed in a separate partition for easy reference.

For larger animals, it is useful to keep two skulls, one articulate and one disarticulated. To disarticulate the skull, it is first cleaned, and all the brain matter removed with a scoop. The cranium is then filled through the Foramen Magnum with raw rice or dried peas, according to the size of the foramina in the skull, and the Foramen Magnum plugged tightly with a cork. The whole is then placed in cold water in a saucepan and boiled until the grain, by swelling, has forced the bones apart at the sutures. The bones are then taken out, washed and bleached.

It is sometimes useful to keep cartilaginous structures. To retain these in their original shape is difficult, in fact, almost impossible. The most satisfactory method of preparing them is to dissect them; clean; place in good methylated spirit for twelve hours; soak in moderately thick solution of Canada balsam for at least three days; and then allow them to dry hard.

I have purposely refrained from any description of the methods of articulating skeletons. This work would require an article to itself, and is unsuitable to the beginner.

List of Animals suitable for Skeletons.

Rana temporaria (frog)	...	Batrachian.
Bufo vulgaris (toad)	...	do.
Triton cristatus (crested newt)	...	Tailed Batrachian.
Lacerta vivipara (grass lizard)	...	Lacertilia.
Tropidonotus natrix (common snake)	...	Ophidia.
Sturnus vulgaris (starling)	...	Aves.
Mus decumanus (rat)	...	Rodentia.
Talpa europea (mole)	...	Insectivora.
Erinaceus europeus (hedgehog)	...	do.
Canis familiaris (dog)	...	Carnivora.
Felis domesticus (cat)	...	do.
Sciurus vulgaris (squirrel)	...	Frugivora.
Cercopithecus callitrichus (green monkey)	...	Anthropoid monkeys.

List of Books.

Lessons in Elementary Anatomy	...	St. George Mivart, M.D.
Osteology of Mammalia	...	W. H. Flower, F.R.S.
Comparative Anatomy	...	Weidersheim.
Practical Zoölogy	...	T. J. and W. N. Parker.
Manual of Zoölogy	...	H. A. Nicholson.
Text-book of Zoölogy	...	T. J. Parker & W. Haswell
The Cambridge Natural History	...	

List of necessary App[illegible] Instruments and Reag[illegible]

Fiddle drill and drills	...	[illegible]
Dissecting forceps	...	[illegible]
Fine forceps	...	[illegible]
Double-spooned brain scoop	...	[illegible]
Two needles in handles	...	[illegible]
Dissecting scissors	...	[illegible]
Fine-pointed scissors curved on the flat	...	[illegible]
Two scalpels	...	[illegible]
Glass jars	...	1d. [illegible]
Porcelain developing dish (¼-plate)	...	1s.
Glass covers	...	1d. and [illegible]
Glass dishes with covers	...	6d. to 2s. each
Drying racks	...	2d. each.
do. plate	...	1s.
Watch glasses	...	1d. each.
Blackened glass	...	4d.
Zinc tanks	...	9d. to 2s. each.
Hydrogen peroxide (20 Vols.)	...	2d. per oz.
Potassium hydroxide (sticks)	...	1s. per lb.
Methylated spirit	...	4d. per pint.
Carbolic acid (crystals)	...	2d. per oz.
Formaldehyde solution (40 %)	...	4d. per oz.
Canada balsam (in benzol)	...	4d. per oz.

SOLAR DISTURBANCES DURING MARCH, 1911.

By FRANK C. DENNETT.

There was a slight increase of activity upon the Sun's surface during March, and the repetition of outbreaks upon, or close to, the site of previous disturbances was very marked. The disc appeared free from disturbance on March 6th, 15th, and 17th, and only faculae were observed on 13th, 14th, 18th, 19th, 20th, 21st, 22nd, 26th, and 27th. The longitude of the central meridian at noon on March 1st, was 237° 34′.

No. 5 remaining visible until March 5th is shown on the chart.

No. 6.—A group of pores, a leader with some tiny companions in front, with a larger pore bringing up the rear. The group was 39,000 miles in length, and remained visible from the 2nd until the 5th, and on the 7th two black pores were seen close to the same place.

No. 7.—A pore amid faculic surroundings only seen on March 5th.

No. 8.—A small spot came round the eastern limb, and continued visible from the 8th until the 12th.

No. 9.—A pair of pores about 37,000 miles apart, in a very bright faculic disturbance, marking the site of No. 6, seen on the 10th and 11th of March.

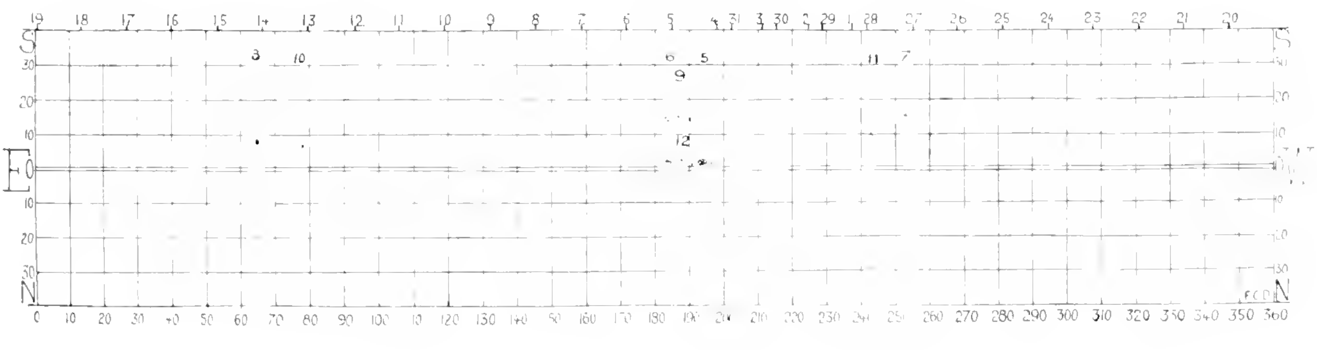
No. 10.—A solitary pore seen only on the 16th.

No. 11.—Another single pore with faculae around it, seen only on March 24th and 25th.

No. 12.—After the disappearance of No. 5. The site was marked by a fine faculic disturbance as it approached the limb on the 9th and 10th. It was found on the 26th to have come round the eastern limb, and on the 28th a group of four black pores had made their appearance in the group. On the 31st there was a considerable spot as leader, and another as trailer, with some pores between them. On April 1st, the leader was preceded by a tiny pore, and the whole of the group following the leader was made up of pores, the rear ones partially outlining an ellipse. On the 4th there was seen to be a black hydrogen flocculus close to a pore, east of the leader, and the pore seemed to increase in size. When just within the limb on the 6th, the leader, which alone remained visible, appeared to be increasing in size. The leading spot attained a diameter of 15,000 miles, and the group a length of 83,000 miles.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock and the writer.

DAY OF MARCH.



THE FACE OF THE SKY FOR MAY.

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

THE SUN.—On the 1st, the Sun rises at 4.35 and sets at 7.19; on the 31st he rises at 3.51 and sets at 8.3. Sun-spots and faculae may usually be seen on the solar disc, but spots are small and not numerous. The positions of the Sun's axis, equator, and heliographic longitude of the centre of the disc are shown in the following table:—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
May 1	24° 22′ W	4° 6′	152° 46′
" 6	23 24′ W	3 35′	86 41′
" 11	22 10′ W	3 2′	20 34′
" 16	20 58′ W	2° 20′	314° 26′
" 21	19 20′ W	1 54′	248 18′
" 26	17 52′ W	1 10′	182 9′
" 31	16 5′ W	0 43′	115 59′
June 5	14 11′ W	0 6′	49 49′

THE MOON:—

Date.	Phases.	H. M.
May 5	First Quarter	1 14 p.m.
" 13	Full Moon	6 10 a.m.
" 21	Last Quarter	9 23 a.m.
" 28	● New Moon	6 24 a.m.
June 3	First Quarter	10 4 p.m.
May 15	Apogee	6 48 p.m.
" 28	Perigee	5 24 p.m.
June 11	Apogee	10 42 p.m.

There is a Penumbral Eclipse of the Moon on the morning of the 13th, but since the Moon sets before the middle of the eclipse and only passes through the penumbra very little can be seen. The following are the particulars:—

	May 13th.
First contact with the Penumbra	3^h 40^m a.m.
Middle of the eclipse	5^h 57^m a.m.
Last contact with the Penumbra	8^h 7^m a.m.

The first contact occurs at 65° from the North point of the Moon's limb towards the East. The Moon sets at Greenwich at $4^h \cdot 7^m$ a.m.

OCCULTATIONS.—No naked eye stars are occulted and visible from this country during the month.

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
May 1	2 55	N 18 11′
" 11	2 35	13 48′
" 21 ...	2 31	11° 26′
June 1	2 57	13 0′
" 11 ...	3 44	N 17 11′

On May 5th, Mercury is in inferior conjunction with the Sun and therefore unobservable. Towards the end of the month the planet is a morning star in Aries rising at 3.11 a.m. on the 31st. On June 1st the planet is at greatest westerly elongation from the Sun of 24° 30′. The planet is in conjunction with Saturn on the 29th May, at 3 a.m.

VENUS:

Date	Right Ascension.	Declination.
	h. m.	
May 1	5 0	N 24 25′
" 11	5 51	25° 20′
" 21	6 42	25° 21′
June 1	7 30	24° 0′
" 11	8 23	N 21° 42′

Venus is a brilliant object in the evening sky, looking N.W. by W. immediately after sunset.

The planet is well placed for observation, appearing high above the horizon at sunset, and not setting till 11.15 p.m. on May 14th, and 11.22 on May 31st.

As the distance from the Earth diminishes, the apparent diameter of the planet increases, and is now about 16″; later in the year, when the planet appears still brighter, the diameter increases to over 40″.

The planet can readily be seen with the naked eye long before it is dark, and a telescope of only 1-inch aperture is sufficient optical aid to find it in broad daylight when directed to the correct position in the sky.

As seen in the telescope, the planet appears gibbous, 0·7 of the disc being illuminated; broad daylight is the best time for observing, and with magnifying powers of 150 to 250 on 4-inch or 5-inch telescopes shadings may be seen on the planet's disc on the terminator side, the limb appearing intensely brilliant. The Moon appears near the planet on May 1st, and on the 30th, conjunction takes place with Neptune.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
May 1	22 34	S 10 45′
" 11 ...	23 2	8° 3′
" 21	23 29	5° 16′
June 1	23 59	S 2° 10′
" 11	0 26	N 0° 38′

Mars is a morning star, rising E. by S., about 2.20 a.m., near the middle of the month. The apparent diameter of the planet is only 6″·5. This is too small for useful observations to be made; towards the end of the year, however, the planet is in opposition, and the apparent diameter will then be three times the above amount.

JUPITER:—

Date	Right Ascension.	Declination.
	h. m.	
May 1	14 31	S 13° 23′
" 11 ...	14 26	13° 0′
" 21	14 21	12° 39′
June 1	14 17	12° 19′
" 11	14 14	S 12° 7′

Jupiter is in opposition to the Sun on May 1st, and hence at this time he appears on the meridian at midnight, and, moreover, he then appears at his brightest.

The planet is a very conspicuous object in the evening, looking S.E., rather low down; on May 1st he rises at 7.2 p.m., and throughout the month he has risen in the E.S.E. before the Sun has set.

The planet is describing a retrograde path near the star λ Virginis.

On account of the belt markings on the disc, and his bright satellites, this is the easiest and most interesting planet to observe in small telescopes. The polar flattening is also a noticeable feature, since the equatorial diameter is 44″ and the polar diameter 2″·8 smaller.

The Great Red Spot has been difficult to observe during the past few years, but the period deduced from observations of the spot give the planet's rotation as $9^h\ 55^m\ 38^s$.

The rapidly moving satellites present a diversity of configurations in the same evening: the following table gives their principal phenomena observable before midnight.

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
May				May				May			
1	I.	Oc. D.	[illegible] 55	16	I.	Tr. I.	9 5	24	III.	Sh. I.	10 7
1	II.	Ec. R.	9 14	16	I	Sh. I	9 [illegible]	24	II.	Tr. E.	[illegible]
1	I.	Oc. R.	11 5	16	I.	Tr. E.	11 4[illegible]	24	I.	Ec. R.	11 15
2	I.	Sh. E.	8 2[illegible]	17	II.	Sh. E.	9 1	24	II.	Sh. E.	11 44
8	II.	Oc. D.	8 55	17	I.	Ec. R.	9 21	24	III.	Sh. E.	11 4[illegible]
8	I.	Oc. D.	10 38	23	I.	Tr. I.	11 2	31	I	Oc. D.	10 12
8	II.	Ec. R.	11 51	23	I	Sh. I.	11 51	31	II.	Tr. I.	10 20
9	I.	Tr. E.	[illegible] 1	24	II.	Sh. I.	9 [illegible]	31	III.	Tr. I.	11 20
9	I.	Sh. E.	10 14	24	III.	Tr. E.	9 21	31	II.	Sh. I.	11 4[illegible]
15	II.	Oc. D.	11 11								

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn:—

Date.	Right Ascension.	Declination.
	h. m.	
May 1 ..	2 32	N. 12° 43′
" 17 ..	2 40	13° 21′
June 2 ..	2 48	N. 13° 55′

Saturn is in conjunction with the Sun on May 1st, and therefore unobservable during the early part of the month. Towards the end of the month the planet is a morning star, rising in the E.N.E. at 3.34 a.m., on May 21st.

Uranus:—

Date.	Right Ascension.	Declination.
	h. m. s.	
May 1 ..	20 6 20	[illegible] 7′
June 1	20 5 14	[illegible] 40′

Uranus rises about midnight on th[illegible] and about 11.18 p.m. on June 1st. The plane[illegible]ourably placed for observation as he is low down [illegible]: he is describing a retrograde path in Capricornus a[illegible] S.E. of σ Capricorni.

Neptune:—

Date.	Right Ascension.	Declination.
	h. m. s.	
May 1 ..	7 22 5	N. 21° 30′ 10″
June 1 ...	7 25 15	N. 21° 24′ 49″

Neptune is observable in the N.W. portion of the evening sky, not far from Venus, and is in conjunction with that planet on the 30th. The planet sets at 11.50 p.m. on the 15th.

The planet is difficult to identify among the numerous small stars appearing in the same field of view, as it requires a high power (about 300) and good definition to distinguish his disc; he can, however, be detected by his relative motion if observation be made on successive nights.

Meteor Showers:—

The principal shower during May is the *Aquarids*. This may be looked for between May 1 to 6; the radiant being in R.A. $22^h\ 32^m$ Dec. S. 2°, near the star η Aquarii.

Telescopic Objects:—

Double Stars.—α Librae, XIV.^{h} 46^m, S. 15° 40′, mags. 3, 6; separation 230″; very wide pair.

σ Coronae, XVI.^{h} 11^m, N. 34° 8′, mags. 6, 6½; separation 5″·0; binary.

α Herculis, XVII.^{h} 10^m, N. 14° 30′, mags. 2½, 6; separation 4″·8. Very pretty double, with good contrast of colours, the brighter component being orange, the other blue.

δ Herculis, XVII.^{h} 11^m, N. 24° 57′, mags. 3, 8; separation 14″.

Clusters.—M13 (cluster in Hercules) is situated about one-third the distance from η to ζ Herculis, and is just visible to the naked eye. It is a globular cluster, and with a three or four inch telescope the outlying parts of the cluster can be resolved into a conglomeration of stars.

QUERIES AND ANSWERS.

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

QUESTIONS.

35. MOVEMENT OF A TAUT WIRE.—When a taut wire, say a mile long, has a weight at one end and one pulls it a foot towards one at the other, does the distal end of the wire move at the same time as the proximal in one's hand, or is its movement later?

Francis Ram.

36. METEORS.—It is stated in most books on Astronomy that meteors are ignited by friction with our atmosphere at a height of seventy miles sometimes. As the density at this height does not amount to nearly the millionth of that at sea level, can any of your readers explain how falling bodies could be ignited by such a rarefied atmosphere, even assuming that they move at the rate of forty-five miles a second, the maximum speed for meteors?

"Puzzled."

37. ROTATION OF STUFFED BIRDS ATTACHED TO WIRES.—The little birds, which are suspended by wires in a case in the hall of the Natural History Museum, may be observed very slowly to rotate, the tips of their wings describing a quadrant of a circle, or more: and so they have done, I can aver, for the last twenty years. What is the cause of the movement?

Francis Ram.

38. THE EFFECT OF GREAT ALTITUDES ON THE EARS. Is it true that persons ascending mountains experience, on reaching great altitudes, bleeding of the ears?

If so, would not this bleeding be beneficial to persons suffering from any congestion of the ears?

Thirdly, could an atmospheric condition similar to that which obtains at great altitudes be produced on the sea-level by any scientific process?

E.B.

39. ANTI-CYCLONE. I should be much obliged by your favouring me with an explanation of the term "Anti-Cyclone." I have always understood it meant the opposite of Cyclone, viz., a perfect calm. This I have had disputed, and that the storms we have lately had from the Easterly have been caused by an "Anti-Cyclone." Now, if Anti-Cyclone and Cyclone both mean storms, why the prefix "Anti"? Some of the books I have, merely give "Cyclone," but do not mention "Anti-Cyclone," or if the term is referred to, it is only in a very vague way, and the language is by no means plain or explanatory.

WM. S. JEFFERY.

40. WATER-FINDING.—The other day, Mr. Pogson, a well-known water-diviner of Madras, located as many as six subterranean springs in a garden in Cuddalore, India. Wells were sunk at all the six spots, and, strangely enough, water was found in all of them at very nearly the same depth, and in approximately the quantity calculated by the diviner.

Like all other water-finders, Mr. Pogson locates water by means of an ordinary rod—either of wood or of metal—which, without any volitional effort on his part, spontaneously rotates in his hand when he stands above a bed of water underground, or points vertically downward if he happens to be over a spring of small dimensions. I should be very much obliged if a scientific explanation can be given of this wonderful phenomenon.

It may be well here to point out that Mr. Pogson is also endowed with magnetic susceptibility, by which he can tell which pole of a bar magnet is turned to him. Halley's comet, he says, affected him before and after its perihelion passage, exactly like the North and South poles of a magnet.

T. K. JOSEPH.

REPLIES.

10. WATER AND ITS OWN LEVEL.—The real meaning of the common expression that water finds its own level is identical with that of Mr. Yerward James ("KNOWLEDGE," March, 1911, page 103) that it seeks its "Appropriate Spherical Curvature." What he says about the variation in the surface of a cup of tea when lifted may be true, but there are so many influences in operation that it might take a little time for the fluid to adjust itself, the motion of lifting having some action besides the effects due to inertia, capillarity and friction. So the centre of gravity of the earth is affected by any displacement of particles on the surface of the earth, such, for instance, as when a boy throws a stone, or when a crane lifts a mass of rock, or when a ship takes a cargo of coal from one place to another.

As regards experimental proof of the convexity of the surface of water, reference should be made to the experiment tried on the Bedford Level Canal, a straight piece of water six miles long. This experiment was fully reported in *The Field* newspaper, March and April, 1870, and might be considered proof conclusive of the convexity of the surface of water.

LUMEN MARTIANUM.

30. FINDING THE TIME BY DAY.—(1) Local apparent time can be roughly found when the ratio of the length of an upright stick to the length of its shadow is known, by using the following method:—

Taking the data given by "Interested," and the angles to the nearest degree of arc, we have latitude 52° and Sun's declination on the given day 15 North. Call the length of the stick unity: then in the right-angled triangle whose perpendicular and base is the length of the stick and shadow respectively, we must find the angle ABC. In the given case (shadow twice the length of the stick) tan $^{-1}\frac{1}{2}$ 27 angle CAB which is the altitude of the Sun above the horizon at the time the measurements are taken. It will now be necessary to find the northmost angle of a spherical triangle on the celestial sphere, three sides of it being given, viz. (90° — Sun's altitude) or Sun's zenith distance, the Sun's angular distance from the north pole of the heavens, and the colatitude of the place. Using the formula

$$\sin\frac{P}{2} \sqrt{\frac{\cos s.\ \sin(s-a)}{\cos l.\ \sin p.}}$$

where P is the angle required (being the Sun's angular distance from the meridian and therefore equal to the time), a the altitude of the Sun, l the latitude of the place, p the Sun's polar distance, and s half the sum of the three last mentioned quantities, the times deduced are either $7^h\ 44^m$ a.m. or $4^h\ 16^m$ p.m., the shadow in this particular case having the same length twice during the day. This process, by the way, is

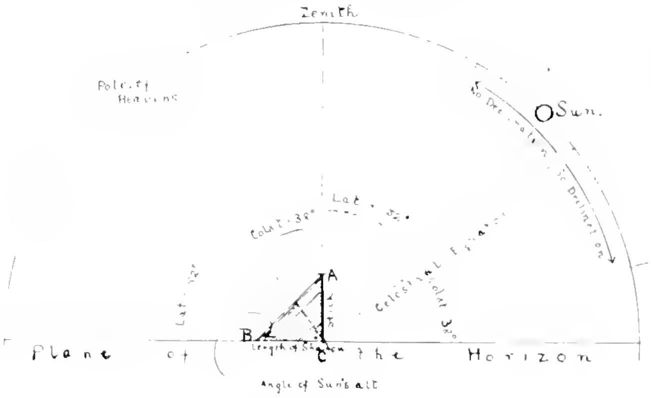


FIGURE 1.

similar to that used to find time at sea except that a sextant is used to measure the altitude of the Sun instead of the ratio of the length of a stick to its shadow.

(2) In the latitude of London the length of a perpendicular stick is equal to the length of its shadow at noon at about 9th April and 5th September of each year. The reason is apparent from a study of the figure. With the sun on the meridian and with the stick and its shadow of equal lengths we have, by elementary geometry, the angle ABC 45, which must be the altitude of the Sun at noon. Now the colatitude of London is about 38 (see Figure 1) so that the Sun will require to have a northerly declination of 7 to make its meridian altitude 45 and the Sun's declination has such a value on the dates mentioned.

(3) The latitude of any place can be found, if the ratio of the length of the stick to its shadow at noon is known (the Sun's declination being also known approximately), for by the first answer the altitude of the Sun can be found from the given data, and by the figure it is seen that the latitude when the Sun is north of the celestial equator is equal to its zenith distance (*i.e.*, its altitude subtracted from 90) added to the northerly declination, and when south, the latitude is equal to the Sun's zenith distance minus the southerly declination.

Note. In the figure the length of the stick is drawn out of all proportion to the other lines. The stick, if drawn to scale, would require to be represented by an infinitesimal line on an infinitely small earth situated at the centre of the celestial sphere, half of which is shown.

THOS. R. ADLAM.

30. To find the time of the day by comparing the ratio between the length of a stick and that of its shadow involves the solution of a spherical triangle.

The formula for determining the hour angle is as follows:—

$$\sin\frac{h}{2} \sqrt{\left\{\frac{\cos\frac{1}{2}(\phi+\Delta+a)\sin\frac{1}{2}(\phi+\Delta-a)}{\cos\phi\sin\Delta}\right\}}$$

where ϕ is the latitude, Δ the polar distance of the Sun, or 90 - declination, a the altitude, and h the hour angle.

If the ratio of the length of a stick to that of its shadow is $\frac{1}{2}$, the tangent of the angle of elevation is $\cdot 5$, and $a = 26° 34'$. Now, on May 1st the Sun's declination is 14° 49′ N., or $\Delta = 90 - 14° 49' = 75° 11'$.

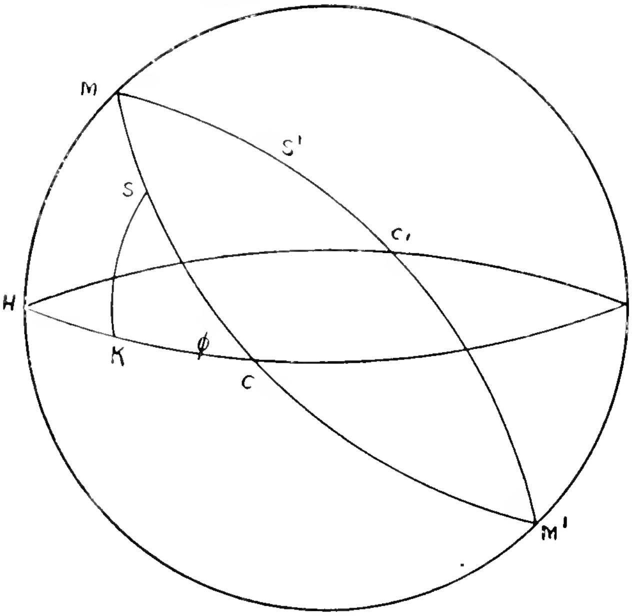


FIGURE 1.

ϕ, the Latitude of London is 51° 31′ nearly.

Making these substitutions we find that

$$\sin \frac{h}{2} = \cdot 5436$$

$$\frac{h}{2} = 32° 56' \text{ nearly.}$$

$$h = 65° 52'$$

$$= 65 \cdot 866$$

Hence, the number of hours before or after the Sun has crossed the Meridian is

$$\frac{65 \cdot 866}{15} = 4 \cdot 39$$

$$\text{or } 4^h. 23^m.$$

Hence the time is about 7.37 a.m. or 4.23 p.m.

The Sun will attain nearly the same declination on August 13th, so that the same ratio between the length of a stick and that of its shadow would hold at the above times on this date.

To solve the second part of the question, finding the dates when the length of a stick and that of its shadow are equal at noon in Latitude London, we have the well known equation

Colat. ± Dec. = Meridian Altitude.

Where Colat. = 90 − Lat. = 90 − 51° 31′
= 38° 29′

In this case M.A. = 45°, since the tangent of the angle of elevation is 1.

Hence Dec. = 45° − 38° 29′ North.
= 6° 31′ N.

The Sun attains this Declination about April 7th and September 7th. On these two dates, therefore, the length of the shadow will be equal to that of the stick at noon, in Latitude of London.

To find the Latitude, assuming we know the ratio between the length of a stick and that of its shadow at noon on April 20th.

Suppose a stick 7-ft. 1-in. high cast a shadow 6-ft. long at noon.

If a be the angle of elevation, $\tan a = \frac{85}{72}$

$= 1 \cdot 1805, \quad \therefore a = 49° 44'$

Now, on April 20th, the Decl[illegible] the Sun is 11° 13′ N.

Colat. + Dec[illegible] Altitude.

∴ Colat. = 49° [illegible] 13′
38 [illegible]

Hence Latitude is 90° − 38° 31′
51 [illegible]

or, about the Latitude of London.

On August 24th, the Sun attains ne[illegible] declination, so that this ratio would hold on that dat[illegible] should be noted that the time found in the first part [illegible] will be apparent time. The mean time, or clo[illegible] found from it by the equation. Mean Time = App[illegible] Time ± Equation of Time. As, however, the equation [illegible] is ne[illegible]er more than sixteen minutes, there is no considerab[illegible] in taking the two as coinciding. On none of the dates [illegible]ven above does the equation of time amount to five minut[illegible].

(REV.) M. DAVIDSON.

30. In answer to Question 30, of "Interested" (March issue of "KNOWLEDGE"), may I suggest the following as possible solutions to the queries therein mentioned?

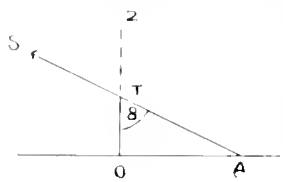


FIGURE 1.

(1) How can the time of day be ascertained by measuring the ratio of the length of a stick to that of its shadow on a given date?

In Figure 1, O T represents the stick, O A the length of the shadow of the stick cast by the Sun, O Z the zenith.

Then

$$\tan^{-1} \frac{OA}{OT} = \text{Sun's zenith distance at instant of observation.}$$

In Figure 2, E H W is the horizon, E Q W is the equator, P the celestial pole, Z the zenith, S the Sun.

S Z = Sun's zenith distance (found by means of the stick).

Z P = Colatitude = (90° − 51° 30′) = 38° 30′. (If London is the place of observation).

S P = Sun's North Polar distance = 90° − Sun's Decl. (found from almanac on given date).

< S Z M = Sun's Azimuth, *i.e.*, Sun's angular distance from Meridian measured from the north point, through E S H W.

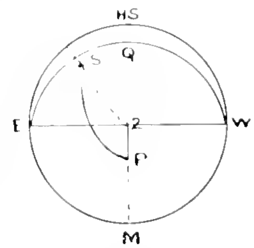


FIGURE 2.

Then from Spherical triangle S Z P.

$$\frac{\text{Sin } S P Z}{\text{Sin } S Z} = \frac{\text{Sin } S Z P}{\text{Sin } S P} \quad \therefore \text{ Sin } S P Z = \frac{\text{Sin } S Z}{\text{Sin } S P} \text{ Sin } S Z P$$

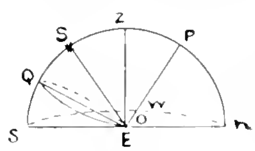


FIGURE 3.

and this gives the Sun's Eastern or Western hour angle according as the observation is before or after noon. If the observation is before noon, 12 − Sun's hour angle gives the approximate time. If after noon the time is given by Sun's hour angle alone.

(2) At what times in the year will the length of stick be the same as that of its shadow at noon? (Latitude of London.)

When the length of shadow equals length of stick the Sun's zenith distance is then 45° and 51° 30′ − 45°, gives the Sun's declination at the required times ∴ Sun's Declination = 6° 30′.

From the almanac we find that the Sun's declination has this value on the 7th April, and the 7th September.

(3) Can the latitude of a place be determined by comparing the ratio between the length of a stick and that of its shadow at noon?

Sun's zenith distance at noon

$$= \tan^{-1} \frac{\text{length of shadow}}{\text{length of stick}} = < Z O S$$

Sun's Declination = < Q O S, (E Q W represents the equator) (P the pole) and < Q O Z = Latitude required.

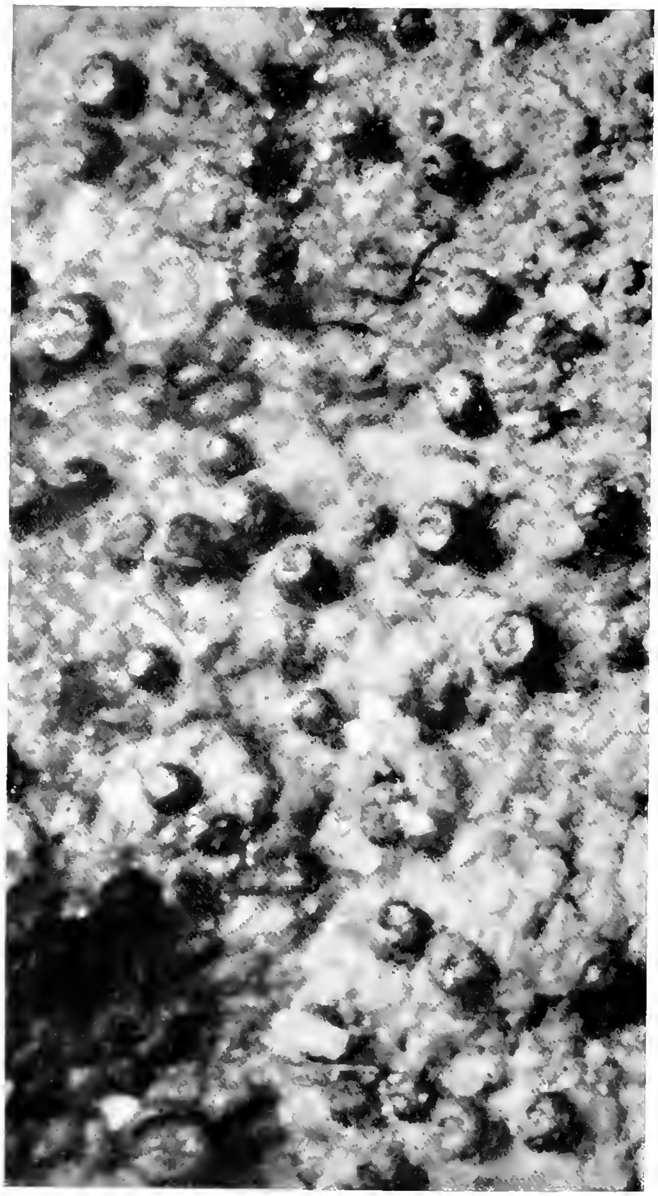
Latitude = < S O Q + < S O Z. L. O. G. P.

A NEW LICHEN, *GONGYLIA VIRIDIS* A.L.Sm., IN SURREY AND ESSEX.

By ROBERT PAULSON, F.R.M.S.

A NEW lichen growing on the sandy bank of a footpath in the neighbourhood of Horsley, Surrey, and named by Miss A. Lorrain Smith, *Gongylia viridis*, was first collected by Mr. B. W. J. Starling, in February, 1910. Since that date it has been recorded by Mr. Percy Thompson from three separate localities of Epping Forest, all in the vicinity of Loughton and Theydon Bois. It has again, quite recently, been gathered from another spot in Surrey, by Mr. Starling. The finding of this lichen in Epping Forest was not a result of the discovery in Surrey, as it was sent for identification with other material that had been collected, both at the Essex Field Club Lichen and Moss Foray held in November last and at periods previous to that date. It was, most probably, first collected in the Forest in April, 1910.

There is little matter for surprise that this plant has hitherto been overlooked, for its thin, green, crustaceous thallus grows upon the ground and takes, as it spreads over the surface, all the irregularities of the soil. To anyone standing erect it appears as a green discoloration of the ground similar to that given by algae in damp places. It might easily be passed over, when not fertile, as the immature thallus of *Bocomyces roseus*. The sandy bank at Horsley has a southern aspect, so that the plant is fully exposed to the sun, there being little or no shade there. In Epping Forest this lichen occurs on sandy soil around gravel pits, and in one case it is on the perpendicular face of the digging, but all the Forest localities are more or less shady, thus showing that an exposed sunny situation is not essential, as might have been inferred if the Surrey plant alone had been found.



From a photograph *by A. W. Dennis.*

FIGURE 1. *Gongylia viridis* A.L.Sm.

Magnified twenty-five times.

The genus *Gongylia* belongs to the Verrucariaceae and has representatives in North and Central Europe; it is now, for the first time, included in the flora of Great Britain. The accompanying photograph by Mr. A. W. Dennis shows the chief characters of this plant, viz.: the thin thallus, exhibiting all the roughness of the ground, and the numerous globose, shining, black fruits, *perithecia*, with a depression at the top of each. Microscopic examination is necessary to make out other important characters of this species. The size and shape of the spores must be known for the purposes of exact determination. The fertile period is apparently at its best during the early months of the year.

Interesting questions arise respecting the present distribution of this plant, such as: How wide a range has it in the southern counties? Does it extend farther north than Essex? It should be looked for on sandy banks and mounds, both in sunny and more or less shady spots. Epping Forest would appear to most lichenists as a very unlikely locality for a new plant.

The diagnosis of *Gongylia viridis* appeared for the first time in the *Journal of Botany*, Volume 49, February, 1911, and it was discovered just in time to be included in the second volume of the Monograph of British Lichens which has been prepared by Miss A. Lorrain Smith, F.L.S., and printed, 1911, by order of the Trustees of the British Museum.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, D.Sc.

THE GYRO-COMPASS.—This instrument was described at the recent meetings of both the Royal Astronomical Society and the British Astronomical Association. It may claim a distinct astronomical interest from the close relationship that has always existed between Astronomy and Navigation, and also because it points to the astronomical instead of the magnetic north, its driving force being entirely non-magnetic, and arising from the earth's rotation. The benefit from the navigational point of view is fairly obvious, for not only is the magnetic deviation different for every point, but even at the same point it undergoes a slow secular change, so that the values marked on the charts need to be continually revised; there is the further obviation of all magnetic difficulties arising from the iron in the ship. This trouble had been partially corrected by Airy by the use of compensation magnets, but there was still a residual effect due to the change in the ship's magnetism when she changed her course, and so on. The driving force in the new compass is sufficiently powerful to enable a gearing-up arrangement to be used, an inner card giving angular deviations thirty-six times those of the outer one, or an entire revolution for 10°, so that a change of course of a small fraction of a degree is rendered manifest; further, the readings of a single compass (which in the case of warships can be placed in a secure position below the water-line) can be electrically reproduced on dials in various parts of the ship. There is a very ingenious arrangement for damping the oscillations from true north by the changing effect of an air jet escaping from the box containing the gyroscope. A diagram was shown in which the compass was pointing some 50° from north when the gyroscope was started. It only took a few minutes to find the meridian within a few degrees; swings continually diminishing in amplitude took place till after four hours they became insensible. The gyroscope should be started a few hours before the commencement of a voyage. It is turned by an electromotor; hence a current of electricity is required, but this is now available on all large ships.

It is of interest to compare this instrument with that devised by Foucault to demonstrate the earth's rotation. This was in addition to his well-known pendulum experiment, which was repeated at the Pantheon a few years ago. His gyroscope had freedom in all three axes, and thus, as Proctor pointed out in "Old and New Astronomy" page 236, it behaved "like an independent planetary body with its own proper polar axis directed constantly to the same point of the celestial sphere." The gyro-compass has not so much freedom, being suspended pendulum-wise by means of a float in a mercury trough. The idea of giving it complete freedom was considered, but abandoned, as it was found to be almost impossible to obtain such perfect balance about each axis that it could be depended upon to keep its direction in space for any length of time. Foucault's principle was practically used by Professor Piazzi Smyth on his voyage to Teneriffe, described in "Teneriffe, an Astronomer's Experiment." A telescope was mounted on board ship attached to a Foucault gyroscope, and it was found that celestial objects were kept for some time in the field, in spite of the rotation of the earth and the rolling of the ship. Unfortunately the flywheel was unequal to the strain, and gave way before long, but sufficient was done to illustrate the principle.

THE APPLICATION OF PHOTOGRAPHY TO FUNDAMENTAL ASTRONOMY.—Since the introduction of astronomical photography, many minds have been at work in the endeavour to apply the new method to astronomy of position. Of course the difficulty is that either the plates cover only a very small region of the sky, or they are of too small a scale to give accurate positions. Hitherto most of the methods suggested to give results over more extended regions have made use of the existin[illegible]rcle, simply substituting photography for visual [illegible] of the stages. Professor Turner proposed [illegible]thods in a paper read before the Royal Astronomic[illegible] March, which gave rise to an interesting discussion. [illegible]als do not aim at the independent formation of [illegible] new catalogue of stars, but (1) to obtain differential p[illegible] other faint stars with the aid of the existing places of [illegible] brighter stars in the same zone, and (2) to detect systematic [illegible] in the existing catalogues, such as the large error of a pe[illegible] kind that formerly affected the Greenwich clock stars, and which apparently has not even now been wholly removed. For the first problem he suggests the use of a coelostat reflecting a region of the sky into a fixed horizontal telescope. At the same time a small beam of light from a fixed source is made to fall on the coelostat and thence on the plate. This beam can be occulted by the clock pendulum at each swing, and thus serves as a time record. An exposure is given sufficient to record stars down to the tenth magnitude or so. After ten minutes (say) the coelostat is moved back to the first position and the process repeated. This can be done as often as desired till there are pictures of (say) twenty regions on the plate, all of the same declination, and differing in Right Ascension by known amounts. There will in the end be enough known stars on the plate to obtain good differential positions of all the stars on it. And it is claimed that the labour and expense would be far smaller than if all were observed with the transit-circle.

For the second problem he suggests the use of two horizontal telescopes at right angles, both facing a fixed mirror. Two fiducial marks in the two telescopes, exactly 90° apart, are found by simultaneous observations of the marks and their reflections in the successive faces of a silvered cube, in the place subsequently occupied by the mirror. Simultaneous photographs of two regions in the sky 90° apart are then taken, the following being done by moving the plates, not the mirror. The correction for refraction is discussed, and shown to be nearly constant if the altitude of the two regions is the same. It is pointed out that for observatories in high latitudes the most suitable study would be the observation of regions of the same declination, 90° apart in Right Ascension, while for equatorial ones, stars near the equator and poles might usefully be compared, thus checking our system of fundamental declinations.

Professor Turner has obtained a Government grant for prosecuting experiments of the kind here briefly indicated, and the results will be awaited with interest.

MARS.—Professor Lowell writes to me pointing out that he had previously used the method of shift due to motion in the line of sight, in the endeavour to separate the lines of Martian and terrestrial water-vapour in the spectrum of Mars (*vide* "Knowledge" for February). Like Professor Campbell, he did not succeed in getting definite results from the method, and found the comparison of the Martian spectrum with that of the moon more suitable.

A series of glass positives of this planet, taken by Professor Barnard with the great Yerkes Refractor, were exhibited at the R.A.S., and are reproduced (necessarily with some loss of detail) in the *Monthly Notices* for March. These photographs are on a larger scale than those taken at Flagstaff, and are, I think, superior to these in the delineation of the dusky regions (the so-called Seas) of which the outlines are very sharply shown, also the various depths of shading in different parts. They do not, however, show as many canaliform markings as the Flagstaff ones, though a few are indubitably shown. The extreme narrowness of these markings makes them very liable to be affected by bad definition, and that at Yerkes is said to be inferior to that at Flagstaff, which was carefully selected for this very purpose, and is at an altitude of seven thousand feet, surrounded by a desert.

BOTANY.

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

"SOIL WAX" AND SOIL FERTILITY.—In the first of a series of papers entitled "Contributions to our Knowledge of Soil Fertility" (*Proc. Linn. Soc. N. S. Wales*, 1910), Greig-Smith gives an interesting account of observations on the action of wax-solvents and the presence of thermolabile bacteriotoxins in soil. Water extracts from soil a substance which is toxic to bacteria, the toxicity of the extract being made evident by the retardation of growth, or even the destruction of the bacteria. The toxin is destroyed by heat, by sunlight, and by storage; it slowly disappears from air-dried soil, and rapidly decays in aqueous solution; it is not destroyed by salts such as sodium chloride or potassium sulphate. Soils vary in the amount of toxin they contain, good soils containing less, poor soils more. The particles of soil are covered or "waterproofed" by soil-wax, or "agricere," and various wax solvents such as volatile disinfectants increase the fertility of the soil by removing this "waterproofing," when the nutrient substances in the soil are more easily dissolved by soil-water and attacked by bacteria.

From the results of Greig-Smith's work, it is clear that the problems of soil fertility are very far from being solved yet. Doubtless further research will throw light upon such questions as the origin of the toxins and of the soil-wax, whether or not the protozoa occurring in soils have any real importance in soil fertility, and so on.

GRAFT HYBRIDS AND CHIMAERAS.—Some remarkable discoveries have been made during the last few years as the result of research on "graft hybrids" and allied forms.

Until 1907, only three so-called graft hybrids were known. The most familiar is Adam's Laburnum (*Laburnum Adami*), obtained in 1825 by M. Adam, a French horticulturist. Adam grafted *Cytisus purpureus*, a small tufted species, on the common Laburnum, and obtained a shoot with intermediate characters, which was readily propagated by grafting and by cuttings, and has long been in cultivation. A second remarkable form is "Crataegomespilus," supposed to be a graft hybrid between the hawthorn *Crataegus monogyna* and the medlar *Mespilus germanica*; the original tree is said to exist still in Lorraine. The third case is that of the Bizzaria orange, believed to have arisen through the inter-grafting of *Citrus Aurantium* and *Citrus medica*.

In 1907, Winkler (*Ber. deutsch. bot. Ges.*, Band 25) grafted a scion of *Solanum nigrum* (the common weed, black nightshade) on *S. Lycopersicum* (tomato), and after growth was resumed, a transverse cut was made across both stock and scion, in the hope that adventitious shoots would grow from the cut surface along the line of contact of stock and scion. Such shoots did actually appear, and in one case the new shoot involved tissues of both stock and scion, but this was clearly not a graft hybrid—one side of the shoot was *Solanum nigrum* and the other was *Solanum Lycopersicum!* To this peculiar structure, Winkler gave the name "Chimaera"; so sharply marked was the line between nightshade and tomato that some leaves were partly of one species and partly of the other.

In 1908 (*Ibid.*, Band 26) Winkler obtained an apparently true graft hybrid, which he named *Solanum tubingense*. Out of about two hundred and seventy grafts between tomato and nightshade, there arose over three thousand shoots, among which there were five chimaeras and the supposed graft hybrid *Solanum tubingense*; the latter, while intermediate in character, is rather closer to the nightshade than to the tomato.

In 1909 Winkler (*Zeitschr. für Bot.*), obtained several further "graft hybrids" by using the same methods. To the four varieties of these forms he gave the names *Solanum Darwinianum*, *S. Gaertnerianum*, *S. proteus*, and *S. Koelreuterianum*; the first two resemble the nightshade more than the tomato, the last two are closer to the tomato. Some of the new forms appeared as branches from chimaeras; some of them arose several times in the cultures. In a more recent paper (*Zeitschr. für Bot.* 1910), Winkler has reported the results of a study of the progeny of these new forms, with some interesting details. The vegetable shoots seem able to fuse and merge readily in various ways, yet the tomato and nightshade cannot be hybridised sexually. The "graft hybrids" without exception revert to the nearer parent, the seedlings of *S. tubingense*, *S. Darwinianum*, and *S. Gaertnerianum* being always *S. nigrum*, while the seedlings of *S. proteus* and *S. Koelreuterianum* always are *S. Lycopersicum*. The new forms may be hybridised sexually with the nearest parent form, the progeny being pure nightshade or tomato as the case may be. Moreover, reversion in the vegetative shoots is always to the nearer parent form. It is to be noted that the behaviour of the new *Solanum* forms is exactly like that of *Laburnum Adami*, which often shows vegetative reversion to one of the parent forms, and whose seeds give rise not to *L. Adami* but to *L. vulgare*.

Before proceeding to consider the interpretations of these very remarkable results, we may briefly summarise some still more extraordinary discoveries made by Erwin Baur. In Baur's first paper (*Zeit. Abstr. Vererbungslehre*, Band 1, 1909) he described the minute structure of geraniums with white-edged leaves (gardeners' "albo-marginate varieties"), and found that the green cells and the colourless cells are each descended from others of their kind, the external portions (comprising two or three rows of cells) being colourless and the internal portions green, and the limits between them very sharp. Since the sexual cells are derived from the external white layers, the seedlings give pure white forms. White branches give only white forms vegetatively, and green branches green forms only. If a pure white and a pure green be hybridised sexually, there arise green-white mosaic forms in addition to pure white and pure green forms. If in the mosaic forms the growing-point is situated on the line between the white and green portions, there results a chimaera, such as Winkler obtained so often in *Solanum*. In a cross section of the stem the two components appear as sectors, hence Baur calls such forms *sectorial chimaeras*. For the condition found in an ordinary *Pelargonium* with white-edged leaves, Baur proposed the term *periclinal chimaera*, one of the components investing the other; the growing-point is periclinally divided into white and green cells, the white being outermost, so that the entire plant consists of a body of green geranium invested by a mantle, two or three cells deep, of white geranium!

In a recent paper, Baur (*Biol. Centralbl.*, Band 30, 1910) notes his discovery that "Crataegomespilus" is a periclinal chimaera, consisting of a *Crataegus* body with a *Mespilus* investing layer either one cell in thickness (epidermis) or two cells deep. Baur solves the riddle of *Laburnum Adami*, finding that it also is a periclinal chimaera, with an epidermis of *Cytisus purpureus* covering a body of *Laburnum vulgare*; seedlings are always the latter, simply because the hypodermal layer, which produces the sexual cells, is of that species! When the outer layer consists of two or more layers of cells, the seedlings are of the peripheral species, as in *Pelargonium*.

Baur's astonishing discovery was almost anticipated in 1895, by Macfarlane (*Trans. Royal Soc. Edinburgh*, Vol. 37), who made a careful anatomical study of *Laburnum Adami* and in his figures showed clearly that this form agrees with *Cytisus purpureus* as to its epidermis and with *Laburnum vulgare* as to its internal tissues. Macfarlane, however, did not appreciate the meaning and importance of his own observations. In one of his latest papers, Winkler has re-investigated his *Solanum* forms in the light of Baur's epoch-making work, and finds that for the greater part they are, as Baur had suggested, periclinal chimaeras. Winkler supposes that what have been taken to be graft hybrids may be actual graft hybrids, resulting from fusion of the cells of different species; or they may have a hybrid nature owing to the migration between stock and scion of various substances as atropin or nicotin in Solanaceae; or again they may be chimaeras—sectorial, periclinal, or some other kind. Careful study shows that *Solanum tubingense*, *S. proteus*, *S. Koelreuterianum*, and *S. Gaertnerianum* are periclinal chimaeras. Of these forms, *S. tubingense* has a nightshade body and a tomato epidermis; *S. Koelreuterianum* has the reverse relation of the two components; *S. proteus* has a tomato periphery of two layers of cells, while *S. Gaertnerianum* apparently has the reverse relation. Winkler thinks, however, that in *S. Darwinianum* he has a true graft hybrid produced by fusion of the vegetative cells of the nightshade and tomato. If this proves to be correct, it will be the first experimentally produced graft hybrid, and the only instance of such a form so far obtained.

The wonderful discoveries of Winkler and Baur, which do not appear as yet to have attracted attention in this country, break new ground and open up a new field of experimental biology. To both writers belongs equally the credit due to the pioneer in a new branch of investigation. The bearing of these discoveries upon theories of inheritance, and in particular upon the function of the nucleus in heredity, brings us to the cytological aspect of graft hybrids and chimaeras. In 1905 and 1907, Strasburger (*Jahrb. für wiss. Bot.*, Band 42, Band 44) investigated *Laburnum Adami* from this point of view. If this form is really a hybrid—owing its origin to fusion of the nuclei of *Laburnum vulgare* and *Cytisus purpureus*—then its nuclei should contain a number of chromosomes equalling the sum of the numbers characteristic of the two parent species. This is not the case, however, and Strasburger regarded this fact as evidence against the hybrid character of the graft. He also investigated forms obtained by grafting tomato and nightshade, and found that there was no migration of nuclei and no fusion of the nuclei of stock and scion; hence he concluded that Winkler's graft hybrids are merely chimaeras, calling them "hyperchimaeras"—forms in which the elements of the two parent forms are more or less intermingled but without any real nuclear fusion. Strasburger therefore denies emphatically the reality of graft hybrids, but as we have seen, Baur's results are of vastly greater importance than these cytological observations, and they enable us to place upon Winkler's work an interpretation different entirely from those made by either Winkler himself or Strasburger.

Strasburger goes on to consider the case of parasitism between Angiosperms; for instance, between mistletoe and its host plants, where there is an intimate relation between the two plants, but no mingling of nuclei. In grafting, a bud from the point of union might possibly give rise to a shoot bearing a flower in which an anther might be from the scion and an ovary might be from the stock; close fertilisation might then give rise to a true hybrid, but, Strasburger argues, hyperchimaeras would be more likely to produce flowers the seeds of which would give rise to pure plants of either the scion or the stock. The fact that pollen from his graft hybrids would cause fertilisation in tomato or nightshade, while neither of these plants can be crossed with the other, is regarded by Winkler as proof of true hybrid character; but Strasburger thinks that the pollen was probably pure, consequently fertilisation was to have been expected, but that only nightshade or tomato would result.

Winkler himself, in his account of the generation obtained from the seed of his hybrids, gives some results as to the chromosome numbers. In tomato the X (sexual) and $2X$ (somatic) numbers are 12 and 24, while in nightshade they are 36 and 72. He suggests that the difference in chromosome numbers may prevent the crossing of the two species, though noting the fact that Rosenberg crossed two species of *Drosera* with 10 and 20 chromosomes in the sexual nuclei and obtained a hybrid with 30 chromosomes as the $2X$ number. If the *Solanum* hybrids are due to fusion of somatic nuclei, they should have 72+24, or 96 chromosomes, unless the fusion should be followed by reduction, in which case the number would be 48. Winkler found the X number to be 36 in *S. tubingense*, *S. Darwinianum*, and *S. Gaertnerianum*, and found 12 in *S. proteus* and *S. Koelreuterianum*, the first three of these reverting [illegible]n formation to nightshade and the other two revertin[illegible]. Winkler suggests that the graft hybrids more cl[illegible] nightshade are from nightshade cells, and that t[illegible]ling tomato are from cells of that parent, the nucl[illegible] those of one parent or the other, but the protop[illegible]mingled with that of neighbouring cells. This th[illegible] that the protoplasm has great influence, obviou[illegible] with the now generally accepted view that the [illegible] the sole bearer of hereditary characters—but, as al[illegible]. Baur's results probably make both Winkler's and [illegible]burger's explanations unnecessary.

Much further work is required both on the experimental production of graft hybrids and chimaeras, and the histological and cytological characters of these forms. In his most recent account of the cytology of the *Solanum* forms, Winkler (*Ber. deutsch. bot. Ges.*, 1910) states that *S. tubingense*, *S. proteus*, *S. Koelreuterianum*, and *S. Gaertnerianum* are periclinal hybrids; but that *S. Darwinianum*, at least in the subepidermal layer of the stem apex, is a fusion hybrid. The germ cells of *S. Darwinianum* have 48 chromosomes, and since the parents (tomato and nightshade) have 12 and 36 chromosomes as the X numbers, Winkler infers that the subepidermal layer from which the pollen is derived must have 48 chromosomes; he supposes that a nightshade cell with 24 chromosomes has fused with a tomato cell with 72, giving a nucleus with 96, and that in the progeny of this nucleus the number is reduced by halving.

CHEMISTRY.

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

Spontaneous Combustion of Coal.—The various factors that tend to bring about the spontaneous combustion of coal have been made the subject of an experimental investigation by Messrs. Parr and Kressman, who have published their results in the *Journ. Ind. Eng. Chem.*, 1911, III, 151. They show that oxidation processes begin as soon as the coal is taken from the mine, and that when the temperature produced by external factors reaches a certain point, autoxidation sets in and results in the ultimate destruction of the coal. The average temperature for autoxidation lies between 200° and 275° C., according to the state of division of the coal, while ignition takes place at about 350° C.

The factors contributing to raise the temperature of the coal to the stage of autoxidation include:—(*a*) External sources of heat, such as sunlight, or impact due to the method of unloading; (*b*) Fineness of division; (*c*) Readily oxidisable compounds of a bituminous nature; (*d*) Iron pyrites, the presence of as little of which as five per cent. may raise the temperature by about 70° C.; (*e*) Moisture, which promotes the oxidation of the pyrites; (*f*) Oxidation of carbon and hydrogen, which takes place at temperatures above 120° to 140° C.; (*g*) The fourth or autogenous stage of oxidation.

Any measures to prevent spontaneous combustion must be based upon a consideration of these facts. All external sources of heat must be eliminated as far as possible, and all dust or finely divided material separated. Complete dryness in storage will prevent oxidation of iron pyrites, which is a fruitful source of danger in coal from the mid-American fields. No system of sorting at the mine can eliminate all risk from this source. Drenching the coal with water may increase the chances of oxidation where the sulphur is distributed throughout the whole mass, while complete submersion of the coal will probably not prove practicable. Preliminary heating might be used to bring about the initial stages of oxidation, and thus eliminate some of the factors which would subsequently supply the necessary heat for destructive oxidation processes. Treatment with chemical agents does not hold out much chance of success, but a system of circulating a cooling liquid through pipes distributed throughout the mass appears more promising. On the other hand, the formation of air passages, which is frequently advocated as a remedy, seems likely to do as much harm as good, since the heat of the oxidation promoted by the access of fresh oxygen may more than counter-balance the heat carried away by the air currents.

THE BLACK GLAZING ON GRECIAN POTTERY.—Many of the specimens of early Greek and Italian pottery have been coated with a fine black glazing upon a terra cotta ground, but the means employed to obtain this has long been a lost secret. According to M. A. Verneuil, who has recently published the results of his experiments upon the subject (*Comptes Rendus*, 1911, CLII, 380), the pottery has apparently been fired in an oxidising furnace; but the only way in which he was able to produce a similar black enamel, was by heating a flux containing magnetic oxide of iron in a reducing furnace. A mixture of iron filings, sodium carbonate and the powdered calcareous clay of the pottery itself yielded a flux, which when heated in an oxidising furnace produced a black glaze, which resembled the ancient black lustre in showing a greenish sheen in reflected light, but was not equal to it in depth of tone.

INFLUENCE OF CHROMIUM COMPOUNDS ON PLANTS.—An account of the experiments of Dr. P. Koenig, upon the influence of certain chromium salts upon plant life is given in the *Chem. Zentralblatt* (1911, I, 498). From these it appears that when applied in very small quantities chromium compounds, and especially chromous acetate, have a stimulating influence upon the germination and growth of plants, but that in large quantities their action is very toxic, and has a particularly injurious effect upon the roots. Solutions of chromates are the most poisonous, but their action may be minimised by adding an equivalent amount of lime to the liquid, or by the addition of salts of metals, such as silver or lead, which form insoluble chromates. In the case of plants, such as lupins, however, to which lime is injurious, the presence of the chromium intensifies the effect of the lime.

The degree of toxic action also varies with the composition of the plant, and the nature of the soil. Thus plants which contain much silica offer the greatest resistance to the action of chromates, while vegetation in a sandy soil is much more affected than that growing in loam, probably on account of the greater proportion in the latter of substances capable of combining with the chromate.

The amount of chromium taken up by the plant differs in the case of different compounds, and it is remarkable that alkali bichromates, which are the most toxic of the chromates, give up least chromium to plants. There is also a greater accumulation of chromium in the roots than in the other parts of the plant.

As the results of these experiments would indicate, a solution of potassium bichromate has proved very effective as a weed killer.

GEOLOGY.

By RUSSELL F. GWINNELL, B.Sc., A.R.C.S., F.G.S.

CLIMATE AND PHYSICAL CONDITIONS IN PRE-CAMBRIAN TIMES.—In the January—February number of the *Journal of Geology*, the oldest known rocks in Canada are dealt with by A. P. Coleman. Constituting the Keewatin Series in the west and the Grenville and Hastings Series in the east these pre-Huronian rocks stretch for one thousand miles across the country. The Huronian or Algonkian rocks, both sedimentary and eruptive, are already admitted to have been formed like rocks of later times. We find evidence in these early times of climates not unlike those of later ages, when wind and weather, flowing rivers, and beating waves and even great ice sheets did their regular work. In northern Ontario glaciers formed boulder-clay in latitude 46° showing no hint of the action of primeval heat such as the usually accepted version of the Nebular Hypothesis demands.

But there is much less certainty regarding pre-Huronian times. The world was already very old before the Huronian ice-sheets began their work. Many geologists have been inclined to see in the underlying "basal complex" portions of the earth's original crust, of plutonic rocks and crystalline schists consolidated from the cooling globe, which was still too hot to permit the condensation of water, so that no rivers or oceans were possible. The conviction, however, is growing in the minds of many geologists that, although the Huronian basal conglomerate means a break in *time*, it does not mean a break in the *continuity* of marine and terrestrial processes, but that the affairs of the world were conducted in the same way before this great interval as after it.

The author then shows that these pre-Huronian rocks include large amounts of sedimentary materials—limestones, dolomites, slates, gneisses having the composition of clayey sandstones, and so on. In the east the seas were clearer and deeper and limestones predominated, while in the west volcanic activity was very pronounced producing thousands of feet of ashes, and so on. There must have been great land-surfaces from which rivers flowed bringing down sand and clay. The sea contained plants to furnish the carbon (often reaching several per cent. in slates, gneisses and limestones) while the limestones hint at calcareous algae or animals having hard parts.

Similar sediments penetrated by granites and gneisses occur in the Lewisian of Scotland and in the Ladogian of Finland, and so on.

It is thus evident that the Keewatin and Grenville Series of America, like the oldest rocks of Europe, do not take us back to the commencement of geological time, since they include clastic sediments which imply the weathering and erosion of previous rocks before they were spread out on the sea bottom. "We have extended our outlook much farther into the past, but there is still an impenetrable background beyond. We shall perhaps never be able to say 'in the beginning'; but we may safely say that there is no hint of a molten earth in process of cooling down. If the earth was ever hot it had so far cooled down before the oldest known rocks were formed as to allow air and water and life to do their work in the world very much as they do now. If the earth ever passed through a period of great heat it was at a time too remote in the past to leave a geological record or to have any special interest for the geologist."

THE GEOLOGISTS' ASSOCIATION.—The Geologists' Association celebrated the fiftieth anniversary of its foundation by the publication of a useful work entitled "Geology in the Field: the Jubilee Volume of the Geologists' Association." This book, edited by Messrs. Monckton and Herries, has within the last few months been completed by the issue of Part V.

The places visited during the fifty years' existence of the Association were arranged in groups or districts, and a number of geologists, selected for their special knowledge of the localities, were asked to contribute descriptive articles on the respective districts, using the previously issued reports of the excursions as a basis. The scope of the work is confined, however, to England and Wales.

Hardly is this book completed before the work of the Geologists' Association comes once more before the general public. For, on behalf of the Association, Dr. J. W. Evans is arranging a series of exhibits in the Science Section of the Coronation Exhibition at Shepherd's Bush. These exhibits, intended to illustrate the work of the Geologists' Association, consist of maps and relief-models of districts visited and geological specimens collected by members from these districts. By the time these notes are published, the exhibition will probably be open.

A NEW INDUSTRY IN THE HEBRIDES.—The finding of iron ore in Raasay, one of the islands of the Inner Hebrides lying in The Minch, between Skye and the Torridon district of the Ross-shire mainland, was announced late in the past year. The discovery was really made eighteen years ago by Mr. H. B. Woodward, F.R.S., in the course of his work on the Geological Survey, but the deposit has been recently investigated from a commercial point of view, and as a result the great firm of ironmasters and colliery owners, Messrs. Wm. Baird & Co., Ltd., of the Glasgow Coalfield, have bought the island. The deposit is situated at the junction of the Upper and Middle Lias, thus corresponding approximately with the position of the Cleveland ironstone. It is a ferruginous limestone forming a good basic ore. The deposit is from six to seventeen feet in thickness and probably many millions of tons will be available. Though it is not likely that blast furnaces will be erected on the island, for the ore will merely be calcined and then shipped to the South, still the opening up of mining operations in this quiet and remote spot will greatly alter the character of this district of grouse moor and deer forest.

This will not, however, be the only mineral industry carried on in that part of the Western Isles, for at two places on the adjacent coast of Skye, quarrying has been in operation on a comparatively small scale. The deposits of diatomite, a lake deposit consisting of the siliceous tests of minute plants, have been worked for many years in a wild, desert region north of Portree, and the calcined product shipped away for use in a multitude of industries—the manufacture of fireproof partitions, of tooth powder, of dynamite, of disinfectants, and so on. A beautiful white marble, somewhat like the Carrara stone, and produced by the metamorphic action of granite on Cambrian limestone, has been quarried intermittently near Broadford, and within the last four or five years systematic operations have been carried on, a mineral railway is now being constructed, and an export trade is being opened up.

THE PASSAGE OF LIGHT THROUGH CRYSTALS.—The issue of Dr. Tutton's popular account of the fascinating phenomena of crystallography ("Crystals." International Scientific Series, 1911), recalls his evening discourses before the British Association in Winnipeg, and the Royal Institution in London.

I had the good fortune to be present at the Royal Institution lecture, and shall never forget the wonderful experiments then performed. The most "showy" demonstration was an illustration of the fact that the light reaching the eye from a crystal is of two kinds, namely, white light reflected from the exterior faces and coloured light which has penetrated the crystal substance and emerges refracted and dispersed as spectra. Two powerful beams of light from a pair of widely separated electric lanterns were concentrated on a cluster of magnificent large diamonds arranged in the shape of a crown. The effect was not only to produce a blaze of colour about the diamonds themselves, but also to project upon the ceiling of the lecture theatre numerous images in white light of the poles of the electric arc, derived by reflection, interspersed with coloured spectra derived from the rays which had penetrated the diamonds and had suffered refraction and internal reflection.

The "Mitscherlich experiment," with gypsum, was also performed by Dr. Tutton. In this, a suitably-cut section of the mineral is shown with convergent polarised light, the resulting interference figure being projected on to a screen. At the ordinary temperature, the mineral is biaxial with a wide optic axial angle. As the crystal is heated gently this angle decreases, then closes up altogether (so that the mineral becomes uniaxial) and finally opens out again in a plane at right angles to the original optic axial plane. On allowing the crystal section to cool again the phenomena are repeated in the reverse order. No other mineral exhibits this phenomenon of crossed-axial-plane dispersion, by change of temperature alone, quite so well as gypsum. When one appreciated the significance of the interference figure as projected on the lecture-screen, admiration was called forth as there appeared first the usual lemniscates and rings around the two optic axes at the right and left margins [illegible] field; then the axes approached one another and unit[illegible] centre of the field, the dark hyperbolic brushes [illegible] to produce a rectangular cross, and the rings a[illegible]cates becoming circles; then the dark cross opened [illegible] into brushes, but in the vertical direction, and the [illegible]ated out into ellipses and lemniscates again. Dr. Tut[illegible] deals with many other interesting crystallographic [illegible]h as the significance of isomorphism and dimorphi[illegible]enomena of "right- and left-handedness" in crystal[illegible] peculiar optically-active liquids described as "liquid-[illegible] and so on.

METEOROLOGY.

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

THE weather of the week ended March 18th, as epitomised in the Weekly Weather Report issued by the Meteorological Office, was generally cold, wet and dull, with snow at many stations. Temperature was below the average in all districts.

Readings above 50° were reported only at Tottenham, Armagh, Killarney, and in the English Channel, the highest being 54° at Killarney and at Guernsey. The lowest minimum was 22° at Llangammarch Wells on the 17th, but readings below freezing-point were observed in all districts. The minimum on the grass was as low as 11° at Llangammarch Wells, and 18° at Plymouth. Rainfall was in excess, except in the North and West of Scotland, England N.W., and in Ireland; in some places the amounts collected were from three to four times as great as usual. The highest total reported was 1·93 inches at Hillington, Norfolk. Sunshine was in excess in Scotland and Ireland, but was generally in defect elsewhere. The sunniest station was Castlebay, Barra Island, with 51·9 hours (65%), while Deerness, still further to the North, but to the East, had only 2·3 hours (3%). Glasgow reported 28·7 hours (36%), while Eastbourne had only 17·9 hours (22%). The total duration of sunshine at Westminster was 9·1 hours (11%). The temperature of the sea-water varied from 48° at Seafield, to 37° at Cromarty. A thunderstorm was reported at Rothamsted and Raunds on the 13th; at the latter station it was accompanied by a violent snowstorm and great darkness.

The week ended March 25th was cool and unsettled, with snow in many places, and with thunderstorms in the S.E. and S. Temperature was above the average in England S.E. and in the English Channel, but was below the average elsewhere. The highest readings recorded were 63° at Tottenham on the 22nd, and 62° at Margate and at Guernsey. The lowest of the minima were 22° at Fort Augustus and at Balmoral. On the grass the minimum fell to 18° at Balmoral and to 19° at Llangammarch Wells. Rainfall was light as a rule, and in Scotland W. and Ireland N. the week was rainless. In Scotland N. the total district value was only 0·03 inch, or 1·00 inch below the average for the week; in England N.W. the amount was 0·04 inch, or 0·49 inch less than usual. Bright sunshine varied much in different localities, but was generally below the normal. Castlebay was again the sunniest station, with 54·7 hours (65%), Worthing coming next with 50·9 hours (61%). Sheffield had only 9·0 hours (11%); Westminster reported 19·9 hours (24%). The mean temperature of the sea ranged from 37°·5 at Cromarty to 47°·0 at Newquay.

The week ended April 1st, was dry, though cool and cloudy, but heavy rain commenced in the S.E. of England late on Saturday. Temperature was in excess in Scotland N. and England N.W., but was in defect in all other districts. The highest maximum reported was 63° at Arlington, N. Devon, on the the 30th, but in most of the districts the thermometer did not rise as high as 60°, and in England N.E. the maximum was only 51°, and at individual stations it was as low as 45°. The lowest readings for the week were 22° at Balmoral, and at Markree Castle, and 23° at Cromer. The minimum on the grass was 16° at Markree Castle.

Rainfall was below the average everywhere except in England

S.E., and the English Channel. At several of the stations the week was rainless. The amounts collected were as a rule small, but at Tunbridge Wells 1·22 inches was collected in three days. Sunshine was greatly in defect, except in Scotland N., and in England N.W., where it was slightly in excess. In England E. the district value was 12 hours (14%) as compared with an average of 34 hours (39%). The sunniest stations were Stornoway and Douglas, each with 39·6 hours (45%), while Guernsey reported 17·2 hours (20%), and Eastbourne only 11·7 hours (13%). At Westminster the total duration was 10·8 hours (12%). The mean temperature of the sea-water ranged from 38°·6 at Cromarty to 47°·4 at Newquay.

The week ended April 8th was very cold indeed, with but little sunshine. Much snow was experienced in the southern and eastern parts of England. Temperature was below the average everywhere. In England S.E. the mean was 36°·9, or 8°·3 below the normal, a lower mean temperature than had been recorded in this district, in the corresponding week, for thirty-four years. Only in Ireland and the English Channel was the district mean as high as 40°. The highest maximum (59°) was noted at Killarney, on the 2nd, and temperatures of 58° were also reported from Cullompton and Wick. The lowest readings came as a rule on the 6th, on which day a temperature of 17° was recorded at West Linton. Frost was reported at every station except Llandudno and Donaghadee. The lowest reading on the grass was 14° at Armagh and Markree. The total Rainfall was below the average in all districts except the English Channel, where it was just above the normal. At several stations the week was rainless, and in Scotland N. the total fall was only about one-twentieth of the average amount. Sunshine was deficient except in Scotland W. and England N.W. The sunniest stations were Valentia 54·7 hours (61%) and Falmouth 45·7 hours (51%). Westminster reported 26·0 hours (29%) and Birmingham only 10·3 hours (11%). The temperature of the sea-water varied from 37° at Scarborough to 50° at Scilly.

During the week ended April 15th, the weather was very fine in most parts of these Islands, but with a good deal of cloud in the North. Temperature was below the average except in England N.E., and in Scotland. During the first days of the week the maxima were very low generally, but a warm spell set in, and towards the close of the week temperatures of 65° and 66° were recorded. The highest maximum was 68° at Killarney on the 13th, but readings of 60° and upwards were reported from each district except Scotland W., and the English Channel. In the Channel Islands the maximum did not exceed 58°, and at Scilly it was only 55°. Frost was recorded in each district except the English Channel, and at Raunds and Llangammarch Wells the thermometer fell to 23°; at the latter station the thermometer on the grass went down to 15°. Rainfall was in defect in all parts, and many stations, including all those in England S.W., were rainless. Sunshine was below the average in Scotland and in England N.E., but above it elsewhere. Falmouth reported the greatest amount, 68·2 hours (73%), and Fort Augustus the least, 14·1 hours (15%). At Westminster the total duration was 34·7 hours (37%). The temperature of the sea-water varied from 39° at Cromarty to 53° at Teelin.

WEATHER INSURANCE.—An interesting application of Meteorological Statistics for the purposes of Insurance is announced by the Excess Insurance Co., Ltd., which offers for a suitable premium to issue a "Pluvius Policy" under which an agreed amount of money will be paid to any holiday-maker, or other person, who experiences in any one week, over a specified period, more than two days of rain, amounting in each day to over 0·20 of an inch. The policy will in every case specify the place, the record of rainfall at which is to govern liability, together with an indication of the authority keeping the record. In most cases the authority will be the Town Clerk, or some observer recognized by the Meteorological Office. The rates are so arranged that a payment of £1 per week as premium will provide for £8 "compensation" should the rainfall amounts exceed 0·20 inch on more than two days during the week.

Policies must be taken out seven days before the period to be covered commences.

There are other forms of policy provided for, with varying rates, both of premium and of amount payable, but the underlying principle is the same in each.

An obvious objection to the scheme is that it provides "compensation" for loss or damage when no loss or damage has, in fact, been sustained: for, although a person whose holiday is interfered with by rainy weather may have to spend money in other and unexpected directions, and so suffer pecuniary loss owing to the rainfall, there is nothing in the scheme as announced to hinder anyone remaining, for instance, in London and claiming "compensation" for rainy days in Plymouth or Scarborough. In this way "insurance" may conceivably degenerate into gambling and prove harmful.

MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD. ARTHUR EARLAND, F.R.M.S.
JAMES BURTON. RICHARD T. LEWIS, F.R.M.S.
THE REV. E. W. BOWELL, M.A. CHAS. F. ROUSSELET, F.R.M.S.
CHARLES H. CAFFYN. D. J. SCOURFIELD, F.Z.S., F.R.M.S.
C. D. SOAR, F.R.M.S.

LUMINOUS BACTERIA.—No phenomenon in nature is so striking as the production of light by living organisms; considered either from the scientific or the popular point of view it commands attention. The difficulty experienced in accounting for it is indicated by the fact that Darwin deals with it under the heading of "Special Difficulties of the Theory of Natural Selection."

Light production occurs principally among marine animals, but in these there are special organs involved. In the case of bacteria which are light-producing, it is difficult to suppose that special organs exist, they being minute uni-cellular bodies, consisting essentially of a mass of protoplasm enclosed in a cell wall; hence the possibility of a special light-producing organ is almost excluded. Light-production in living animals is essentially different from that of inert chemicals or of the phosphorescence produced by electrical means. Phosphorescent chemicals in all cases have the power of *absorbing* light and of re-emitting it either of the same, or of a somewhat greater wave-length. Bacteria emit light which is produced entirely by themselves, altogether independently of any extraneous light source; in fact, they grow and produce light better if kept entirely in the dark. In general, light can only be produced by raising the temperature of a suitable substance until it becomes luminous. It therefore follows that a great deal of the energy so converted is lost as heat; in fact, to such an extent is this the case that an ordinary electric lamp, even of the highest efficiency, does not give out in the form of light more than about five per cent. of the energy expended in raising the temperature of the filament. Bacteria produce light which is unaccompanied by any heat radiations, and so far as the investigations of the writer have yet proceeded, there is no evidence that any invisible radiations are produced by them at all. Their efficiency as light-producers is, therefore, extremely high, and were it possible to carry out on a commercial scale the process of light-production as it occurs in bacteria a tremendous step forward would be taken.

Essentially, the process is an oxidation one, as in addition to a nutritive material on which the bacteria may grow and reproduce, a supply of oxygen is necessary. The natural habitat of these organisms seems to be almost exclusively sea-water, or at least water such as is found in estuaries where an appreciable quantity of saline matter is present. They will grow and exhibit their light-producing properties on an ordinary peptone-beef-broth gelatin medium, but they do not all emit the greatest possible amount of light unless an increased quantity of saline matter is present. It was recognized that probably in sea-water would be found the necessary constituents for an artificial medium, and after a series of experiments that which best suits them is found to be an ordinary gelatin one to which has been added 2·75 per cent. of sodium chloride, ·75 per cent. of potassium chloride, and ·25 per cent. of magnesium chloride. It is important that the medium should be neutral, or very slightly alkaline: an acid medium is entirely unsuitable for their growth.

FIGURE 1.

A flask photographed by the light of the bacteria within.

The most easily procured organism of this group is the *Photobacterium phosphorescens*. It may be obtained from a dead herring or mackerel. The fish should not be washed in fresh water after being caught. It should be placed in a closed receptacle, such as a large-sized Petri dish, for about twenty-four hours at approximately 20 C. At the end of this period there will probably be some spots which phosphoresce brigbtly. Plate cultures may be made from these spots, and in three to four days at ordinary room temperature the plates, on examination in the dark, will probably show some luminous colonies. Sub-cultures may be made from these, and the organisms may be kept going in artificial cultivations on the medium mentioned for several weeks without difficulty. Fish-broth or peptone-beef-broth may be substituted for a solid gelatin medium. It is necessary, however, if brightly luminous fluid cultures are required, to resort to some method of aëration, a supply of free oxygen being essential. In any case, when making fluid cultures, the media should be thoroughly well shaken up to ensure that as much oxygen as possible is present in solution before the organisms are inoculated into it. If the maximum amount of luminosity is aimed at, oxygen may be allowed to bubble slowly through the medium directly any luminosity appears, and although the period over which the light production occurs is thereby reduced, the luminosity is extremely brilliant while it lasts.

FIGURE 2.

A picture of Lord Lister illuminated by bacteria.

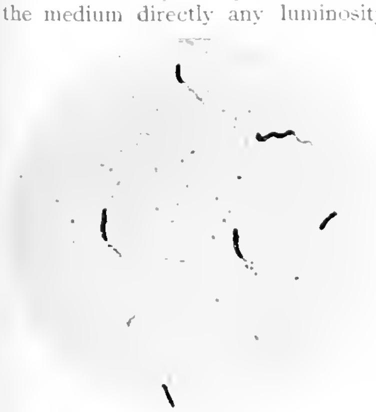


FIGURE 4.

Photobacterium balticum grown in fish-broth.

Figure 1 shows a flask of these organisms photographed by means of their own light, which will give some idea of the brilliancy to be obtained under these conditions.

Figure 2 is a photograph of Lord Lister, illuminated by means of growths on solid media. On each side will be seen tubes containing the organis[m] several of them were placed underneath thro[wing] light upwards.

FIGURE 3.

Colonies of bacteria on a Petri dish photographed by their own light.

Figure 3 is an ordinary Petri dish with luminous colonies on it. These again were photographed entirely by their own light, the colonies standing out brilliantly on a dark back-ground. The exposure in photographing these organisms is always somewhat prolonged; although their visual luminosity is high yet their photographic action is not rapid, as the light emitted does not lie in that portion of the spectrum which is photographically most active. There is the further difficulty that the light happens to lie in a region of the spectrum to which photographic plates are particularly insensitive, so that due allowance must be made for these two factors if any attempt is made to obtain a photograph of these organisms by their own light.

Some twenty-five varieties of these organisms have been described, and it is also stated that other bacteria such as the *Cholera vibrio*, are known to produce light under certain conditions. Of these twenty-five described species it is more than likely that some are not really entitled to be regarded as distinct. A broad classification of them may be made by separating those that grow at low, and those that grow at a higher temperature. There are two or three species found in Northern latitudes that thrive and produce light at 0°C., whereas there are certain other varieties which grow in Southern latitudes, particularly in the Indian Ocean, that will go on producing light at a temperature of from 30 C to 35 C. The writer has had through his hands at various times some fourteen varieties, as well as one which there is reason to think is a new species, originally identified at the Marine Biological Laboratory, Plymouth. Morphologically the organisms vary widely: the common species *Photobacterium phosphorescens* already mentioned, is a short thick rod, which when grown on a medium containing more than three per cent. of saline matter assumes a much shorter, thicker appearance, and is almost coccoid in form. Nearly all varieties change considerably in form when artificially cultivated for long periods, so that it is often difficult to identify a particular species by its microscopic appearance. Owing also to the amount of saline matter necessary in the medium, the organisms

FIGURE 5.

Photobacterium balticum grown in peptone-beef-broth.

often develop vacuoles, and assume varied shapes. They all stain easily by most of the well-known bacteriological staining methods, and in most, if not all cases, a flagellum or flagella may be demonstrated.

Figures 4 and 5 show the marked differences that occur in some species under different methods of cultivation (*Photobacterium balticum*). Figure 4 is grown on a fluid fish-broth medium. Figure 5 is grown on peptone-beef-broth containing the maximum amount of saline matter that the organism will tolerate. In each case flagella are clearly shown.

The question whether the organism itself produces light as a direct metabolic process, or whether it is an extra-cellular bacterial product that is light-producing, is still an undetermined point; but all the evidence goes to show that the light production is undoubtedly associated with the life-history of the organism. By no experimental means has it as yet been possible to isolate the light-producing material from the actively-living cell.

These organisms may be recommended to the amateur microscopist as a most fascinating field of research, in which there are still many problems to be solved; they present no great cultural difficulties, nor do they require the resources of a bacteriological laboratory in which to carry them out.

J. EDWIN BARNARD, F.R.M.S.

ROYAL MICROSCOPICAL SOCIETY. March 15th, 1911. Mr. H. G. Plimmer, F.R.S., president, in the chair. Dr. Ralph Vincent gave a lantern demonstration on "Some Photomicrographs illustrating the morphology of the organisms concerned in the production of acute intestinal toxaemia in infants." These included *Bacillus subtilis*, *B. mesentericus*, "No. 7," *B. mesentericus vulgatus*, and *B. proteus vulgaris*. The photographs showed the organisms stained, unstained and during life. Photographs were also shown of *Streptococcus lacticus*, *Bacillus acidi lactici* and *B. bulgaricus*.

Mr. F. W. Watson Baker contributed a paper on "Anomalies in Objective Screw Threads."

Mr. E. M. Nelson described a new piece of apparatus consisting of an objective mount fitted with an iris diaphragm, in which the iris was just clear of the back lens, and its movement was controlled by a collar adjustment. This piece of apparatus would no doubt be of great value to workers who employ dark-ground illumination for viewing bacteria, and so on, as in many instances, owing to defects in the illuminator, it was not possible to obtain a dark field when the objective had a wide angle. This fault was remedied by stopping down the aperture of the objective by means of the diaphragm. Mr. Nelson also described some new objectives and eye-pieces made by R. Winkel, of Gottingen, and contributed a short historical and descriptive résumé of the "Variable Microscope."

Mr. J. Murray brought forward a Report on the Rotifers collected by the British Antarctic Expedition of 1909. Forty-six Bdelloids were collected, bringing the Australian list up to fifty-four species. There were seven new species, and eight others occurred as distinct varieties. The new species were *Philodina australis*, *Callidina armillata*, *C. lepida*, *C. longistyla*, *C. serrulata*, *C. mirabilis* and *Habrotrocha strangulata*. The most aberrant form was *C. mirabilis*, which had peculiar fleshy processes on the trunk. The rotifera fauna of the Australian Alps resembled that of Britain. The arid lowlands were very unproductive. Three-fourths of the species, and all the new species, occurred in the Blue Mountains, at moderate elevations. Eight species of non-Bdelloid rotifera were also noted from the water supply and ponds in Sydney.

THE PREVENTION OF FADING OF ANILINE STAINED MICROSCOPIC PREPARATIONS. In common with many microscopists I have found that films of blood, bacteria, and so on, when stained with almost any of the aniline dyes, fade after a time when mounted in Canada Balsam. This is especially the case with methylene green, thionin, methylene blue, or methylene blue and eosin, either separately or combined as Jenner's stain, and all the modifications of Romanowsky's valuable stain, e.g., Giemsa, Leishmann, Wright.

There is no doubt but that the cause of fading in balsam-mounted preparations, judging from my own experience and from the expression of the opinion of numerous authorities on the subject, is acidity whether present at the time of mounting, or developing subsequently from oxidation of the mounting medium.

I will not enter into details of my experiments or the statement of the authorities as to the facts which lead me to the above conclusion. They have been described in full elsewhere, *Lancet*, 1911, Vol. I, page 876.

It may, I think, be stated that practically all substances of the nature of balsams, oleo-resins or cedar oil will sooner or later oxidise and become acid and, therefore, are liable to cause fading of the aniline stains.

It is not possible to obtain a neutral Canada Balsam that will remain neutral.

After numerous trials, I have found that *Paraffinum liquidum* is a neutral medium which does not undergo oxidation and, therefore, does not become acid.

I have used a pure form of liquid paraffin, namely Burroughs and Wellcome's "Parolein" and so far have found the results admirable. It is more trouble to mount in than a balsam, and the preparations require to be ringed or cemented round with some cement which is also neutral. The following is the method I use for mounting films of blood or bacteria which are spread and stained on the slide.

A perfectly cleaned cover-glass is held in a pair of forceps over the flame of a spirit lamp for a second or two to drive off any moisture on the glass, and is then laid on a clean sheet of notepaper. A very small drop of Parolein is placed on the centre of the cover-glass, and the slide with the blood film, after being slightly warmed over the flame, just enough to be sure that the glass is perfectly free from moisture, is gently let down on to the cover-glass. In a second the oil has run nearly to the margins by capillarity, and a little pressure on the cover-glass will send it completely to the margins. If the amount of oil is just sufficient to reach the margin of the cover-glass so much the better. If there is too much oil, the preparation is placed under a piece of blotting paper and the excess of oil pressed out as much as possible. One soon learns how much oil is required to make a clean preparation. A not uncommon thing is to find that the cover-glass rocks, that the oil has only covered about three parts of the square or circle. This is almost always due to the presence of a minute particle of dust between the cover-glass and slide, and is to be prevented by seeing that the cover-glass is quite clean and free from dust before placing the oil on it, and by just dusting gently the film surface on the slide. But usually it is easily remedied by running in a very small drop of Parolein at the margin of the coverglass.

To fix the cover-glass in position it is necessary to ring it round with some cement. The cement must be neutral or there will be fading, and the cement must withstand the action of the immersion cedar oil. I first ring round the preparation with Apathy's Gum Syrup made as follows: Picked gum arabic, cane sugar not candied, distilled water, of each, 50 grammes. Dissolve over a water bath and add 0·05 grammes of thymol. I test the reaction with litmus paper, and if acid I add a few drops of a solution of *Sodii carbonas*. If the cover-glass is round the cement can easily be applied on a turntable; if square, which I prefer, one paints it round with a very small brush. This sets in about fifteen to thirty minutes in a warm room. When dry I apply over it a coat of Bell's cement, which also dries quickly.

I should be glad to hear of any better cement, but whatever be its nature it must be neutral in reaction.

As regards the optical characters of Parolein, the refraction index is 1·471. That of solid Canada Balsam 1·538, that of balsam in xylol a little lower, say 1·530. The refraction index of bacteria is said, according to A. Fischer, to be 1·55.

Now the index of visibility or power of seeing an unstained, and presumably a stained, structure is greater when the medium has a very low or a very high refraction index.

Bacteria would be invisible in a medium having a refraction index of 1·55, in Canada Balsam they would be seen, in Parolein they would be seen much better, and this theoretical statement is borne out by experience. Very delicate structures like the flagella of bacteria are better seen in Parolein than in Canada Balsam.

Mr. E. M. Nelson and Mr. Merlin both state that the delicate structures, in some bacterial films I sent them, "are strong and sharp; in fact, stronger and sharper than in balsam."

I am not prepared to state that there is no better mounting medium than Parolein; I should only be too glad to hear of one that offers a reasonable chance of permanency and which has as good optical qualities. All I can say is that at present every slide that has a place in my cabinet will be mounted in Parolein; Canada Balsam has served me very badly.

ALFRED C. COLES, M.D., D.Sc., F.R.S. (Edin.), M.R.C.P. (Lond.).

THE MICROLOGIST.—We have received from the publishers, Messrs. Flatters, Milborne & McKechnie, Ltd., of Manchester, Part 4 of their quarterly journal, *The Micrologist*. In this part full details are given for the preparation of slides illustrating the Marine Protozoa, chiefly the Radiolaria—such types as *Sphaerozoum*, *Aulacantha* and *Myxosphaera* being dealt with; in the latter case the method of infiltrating and cutting sections of the colony being described. The Amoeba, its life-history, structure, cultivation and the preparation of microscopical mounts, is dealt with by Mr. Gordon McKechnie. It would be an advantage if some indication were made as to what other organisms can be treated in the same manner as that described for Amoeba; for instance, would the same treatment suit *Paramoecium*, *Stentor*, and so on? Included in this number are formulae for stains and mounting media, which cannot fail to be of use to the working microscopist. Plate IV illustrates the objects dealt with and of the slides sent out with this number we have received two—*Amoeba* and *Sphaerozoum*—the latter making a very pretty object with a low-power and dark-ground illumination.

QUEKETT MICROSCOPICAL CLUB.—March 28th, 1911. Professor E. A. Minchin, M.A., President, in the chair. The death of Mr. W. M. Bywater, F.R.M.S., on March 1st, was announced. He was one of the founders of the Club, and its first secretary.—Mr. A. C. Banfield exhibited and described a new quartz mercury vapour lamp, manufactured by the Brush Electrical Company. The quartz tube used in the new form is about four inches in length. The lamp is extremely rich in ultra-violet rays, and will sterilize a Petri-dish cultivation in less than one minute. The peculiar mercury spectrum gives a unique opportunity of easily obtaining strictly monochromatic light in large quantity, with a choice of several wave-lengths, that at λ 5461 being the most powerful source of monochromatic light at present available.—Mr. E. M. Nelson, F.R.M.S., described the best method of obtaining dark-ground illumination. Place the bull's-eye at right angles to the edge of the flame. Adjust its height so that the horizontal optical axis of the bull's-eye cuts the brightest part of the edge of the flame. Focus the bull's-eye so that a sharp image of the flame is thrown upon a wall, distant, say, five feet. Place the lamp, without altering these adjustments, on the left-hand side of the microscope, and ten to twelve inches from the mirror; remove substage condenser and objective, and place a low-power eyepiece in position. Incline the plane mirror and adjust the height of the lamp so that the bright part of the flame falls centrally upon it. Then incline the mirror so that the full beam is reflected up the microscope tube. From a distance of six or eight inches look at the bright spot of light at the eye-lens. This should be an evenly-illuminated bright disc. Replace condenser and objective, centre and focus substage in usual manner and proceed with the work in hand, selecting a suitable black st[illegible] not too large, and a dark field of maximum brightness [illegible] set of apparatus will have been obtained. To obt[illegible] [illegible]darkest possible ground many objectives require the [illegible] to be increased, sometimes considerably. Mr. C[illegible] exhibited, at Mr. Nelson's request, the lamp [illegible] described.—Mr. A. A. C. Eliot Merlin, F.R.M.S. [illegible] "Some New Diatomic Structure discovered with a [illegible] apochromat."—Mr. James Murray, F.R.S.E., F.Z.S., [illegible] "Water Bears or Tardigrada." As the name T[illegible] is already appropriated by vertebrates the group is [illegible]sified as order Arctiscoida, family Xenomorphidae. [illegible] paper describes four new genera and their relationships, [illegible]cluding with a synopsis of the ten genera and one hundred and twenty species at present admitted.—Mr. M. Ainslie exhibited and described a "finder" for the microscope, useful with powers up to about one-sixth of an inch. It consists of a hinged and pointed arm clamped to one corner of the stage. When it is wished to record the position of an observed object, the point is inked and allowed to make a mark on the label to the left of the object. It is intended for use with either a mechanical stage or sliding bar.

ORNITHOLOGY.

By HUGH BOYD WATT, M.B.O.U.

BIRDS FROM NEW GUINEA.—The newly arrived collection referred to in the last number of "KNOWLEDGE" was shown in the Board Room of the Natural History Museum, South Kensington, on the 5th April, and *The Times* of the following day gives a brief report on it. The collection includes eleven species and several dozen specimens of Birds of Paradise and their congeners of the crow and starling group. There are nine examples of the magnificent flame-coloured Bird of Paradise (*Xanthomelas ardens*) hitherto represented in Europe by only two specimens in Holland and an imperfect skin in Genoa. Amongst the larger birds is an ibis (much like the sacred ibis), and, in addition to the more distinctively tropical kinds mentioned last month, one or two sheldrakes and ducks. A familiar British bird occurs in the form of a young male common cuckoo taken in December last, presumably on migration from northern regions to Australia. The collection is very rich in the groups of smaller birds. The genera best represented are sunbirds, flower-peckers, honey-eaters, and flycatchers, also cuckoo-shrikes, ground-thrushes and bee-eaters. The material will enable the distribution of many species to be worked out better than hitherto; and results of even more importance are anticipated from the regions of the great snow mountains which the expedition hopes to attain, and where the avi-fauna is far less known than in that part of Dutch New Guinea from which the collection now under review has come.

A BLACK EGG.—In *The Field* of 25th March last, an egg uniformly black in colour is figured, sent by a correspondent from his duck-house, where ordinary wild ducks and others called by him "East Indians" are kept together. The last-named are described as black, with bottle-green on the wings and hackles, and are probably the Cayuga duck, which comes from South America. It is explained that eggs of this melanistic variety of duck sometimes partake of the colour of the plumage, but the black colouring does not penetrate the shell, being due to an oily pigment which can be rubbed off. After successive layings the colour fades and eventually disappears.

A NOVEL BAIT FOR WOOD-PIGEONS.—Intoxicants have recently been recommended and tried as an assistance in getting rid of the wood-pigeon pest. Mr. J. L. Courthope, M.P., suggests that corn be soaked in spirit and distributed in the feeding places of the birds, which will eat the grain, become intoxicated, and then be easily caught and killed. We believe that gin has been used in some such way in Herts, with effective results.

BIRDS IN LONDON AND THEREABOUTS.—Mr. A. Holte Macpherson contributes his welcome annual "Notes on London Birds" (1910) to *The Selborne Magazine* for April (pages 69–97). These notes have now continued for twenty-one years without a break, and are of much value as giving personal observations, mostly in the West-end parks. The literature of London birds is an extensive one, but it is to be hoped that Mr. Macpherson may be induced to publish a review or survey of his observations in a more permanent form. Instructive comparisons would not be a-wanting in it. In the course of 1910, a great crested grebe was seen on the Serpentine on 29th January, and another on the Round Pond, Kensington Gardens, on 11th July. Mr. Macpherson had only once seen this fine species in London previously, and points out that it is remarkable how it has increased near that city during the last few years. Virginia Water and Richmond Park are named as haunts of the bird, to which we would add Ruislip Reservoir. Greater London holds within its area the "Brent Valley Bird Sanctuary," an account of which is published in a small work under this title by Mr. Wilfred Mark Webb, Honorary Secretary of the Selborne Society, of which a third and revised edition, profusely illustrated, has just been issued (The Selborne Society, 42, Bloomsbury Square, London, W.C., 34 pages, price 6d., or in paper boards, 1/-). The Sanctuary has been maintained now for about six years with results which redound to the praise of the Committee who so vigilantly look after it, and are gratifying to all who care for our native birds. Nesting boxes, made on the spot, have been used since 1908 as a method of attracting birds and have proved quite successful, being largely used. Within this limited area of nineteen acres, possessing no outstanding natural advantages, thirty-six species (almost entirely smaller woodland birds) have now nested, and eighty-six species in all, including occasional visitors, have been observed in or close to the place.

A MIGRATION "RUSH."—The Irish newspapers report that a migratory movement of an extended character was observed on 29th–31st March, conspicuously in South-east Ireland. The weather conditions were still and dark, the moon being in her dark phase, and at the same time fog prevailed. These conditions are conducive to migrants showing themselves. The migrating flights seem to have been attracted by the lights of the towns, just as they often are by lighthouses. In New Ross a swarm of starlings descended on the town about ten o'clock and the streets were littered with them. House-windows were broken and numbers of birds entered the houses. In Kilkenny many hundreds of birds fell dead in the market-place and elsewhere. In Carlow the destruction which befel the birds is said to have been caused by them coming into contact with telegraph and other wires. Immense flocks of Curlew passed over this town on the night of 29th March, in a N.E. direction, being recognised by their shrill whistling.

The other kinds of birds named in the reports are thrushes, blackbirds, redwings, and sparrows, but, no doubt, many species were unrecognised. Amongst them probably occurred some of our first summer visitants for this season.

CROSSBILLS IN THE BRITISH ISLES.—An account of the irruption of crossbills which took place in 1909, is given in the April number of *British Birds* (Vol. IV, pages 326–331). First observed at Fair Isle, on 23rd June, 1909, the arrivals continued until about 10th August. The birds appeared rather later in southern districts than in the north, and by the latter part of July their numbers were decreasing in Scotland. In England they were much in evidence during July and increased until well into August. During the winter they were recorded from all the English counties except Cumberland, Notts, Huntingdon, Cambridge, Dorset, Devon and Cornwall; and in Wales from Denbigh, Merioneth, Montgomery and Brecon. It is remarked that records are far more numerous from the country lying to the south and east of a line drawn from the Wash to Portland Bill, the sandy soils occurring therein being much planted with pine trees. These trees provide natural food supply for the birds.

Nesting was recorded as early as 12th January, 1910, near Thetford, Norfolk (three nestlings), and the latest records are 25th May, from Sussex and Kent. All the nests known were in Scots pine, except two in spruce and two in larch. Only a small proportion of the visitants nested, the following counties yielding records, viz:—Kent, Sussex, Surrey, Hants, Berks, Essex (two), Suffolk, Norfolk, Somerset (one), Gloucester, and Staffs (one), also probably Lincoln and Bedford.

The departure of the birds began in the winter of 1909–10, and this movement was at its maximum from February to June, with a few records for later dates. The visitation thus extended over a period of rather more than twelve months.

It should be added that the bird spoken of is now designated by modern ornithologists as *Loxia curvirostra curvirostra*—the Common Crossbill.

Mr. H. F. Witherby follows the paper above summarized by an article (pp. 332–334) on its status as a British bird, of which the following is an abbreviated summary, viz.:—

ENGLAND AND WALES.—An early autumn immigrant (mid-June to August), irregular in most districts. Periodically (every three to ten years) arrives in great numbers, and becomes much more generally distributed, frequently staying over the following spring and into summer. Authentic records of nesting are so few and far between that the bird cannot be classed as a resident, but only as a migrant, breeding sporadically (nesting counties are named by Mr. Witherby). Crossbills have been found this spring (1911) to be breeding in localities in which they bred last year, the first time they are known to have nested in two successive years in the same district.

SCOTLAND.—Immigrant as in England, but not so regular. Breeds sporadically and rarely in Southern Scotland (counties named).

IRELAND.—Now resident but not indigenous. Apparently only migrates to Ireland in years of "irruptions." Following that of 1887-8 became established as a breeding bird.

The Scottish Crossbill, *Loxia curvirostra scotica* Hart, which is confined as a breeding bird to Scotland, is resident in Northern Scotland, where it breeds in certain localities (named). Has occurred sporadically in winter in very small numbers in Southern Scotland (counties named).

PHOTOGRAPHY.

By C. E. KENNETH MEES, D.Sc., F.C.S., F.R.P.S.

THE MEASUREMENT OF SURFACE BRIGHTNESS.—Under this title a paper was read at the Royal Photographic Society, on March 28th, 1911, by Messrs. J. S. Dow and V. H. Mackinney, describing a small portable photometer under the name of the "Holophane Lumeter," which is intended for the measurement of the intensity of the light reflected from various objects.

In the instrument, the surface whose brightness is to be measured is observed through an aperture in a white opaque surface, the discs surrounding the aperture being illuminated by means of an opal glass behind which is an Osram lamp, run off an accumulator. The area of the opal glass can be restricted to any required extent by means of black sectors, and the intensity of the illumination read to one per cent. by means of scales, the maximum opening representing an intensity of one foot candle.

The accuracy claimed for the instrument is about five per cent., which will clearly be sufficient for most practical purposes.

By means of two supplementary black glasses the light from the external surface can be cut down to one-tenth or one-hundredth of its original amount, and the maximum intensity measurable can thus be made ten or one hundred foot candles.

This range seems to me insufficient, and it would probably be better to add other densities to extend the scale to one thousand and ten thousand foot candles.

The instrument, in use, appears to be very convenient, the greatest difficulty in photographic use, however, being due to the colour effect of daylight, which makes matching distinctly difficult. It is possible that this might be completely avoided by the aid of an orange screen to tint the daylight beam, but such a screen would require careful adjustment.

There are numerous directions in which such an instrument can be of use in photography; in the first place, it is obviously of importance to know the range of contrast which exists in photographic subjects, and this is a point on which hitherto experiments have been difficult to make, and on which views of considerable diversity have been expressed.

Messrs. Hurter and Driffield measured the maximum difference of intensity in landscape subjects by taking a photograph of a scene in which was included a square of white cardboard in sunlight and a piece of black velvet in shadow; the plate was developed together with another plate from the same box which had been exposed behind a sector wheel to a candle, and the densities of the patches representing the white cardboard and the black velvet were measured and compared with the densities of the known exposures on the other plate. As a result the white cardboard in sunlight was found to reflect thirty times as much light as the black velvet in shadow.

FIGURE 1.

In their paper, Messrs. Dow and Mackinney mentioned that the maximum range of intensity which they had measured in a subject between the brightest white magnesia and the darkest dead black which they had been able to obtain was as thirty to one: so that apparently the result obtained by Messrs. Hurter and Driffield for the maximum range in ordinary photographic work may be considered as confirmed.

Some measurements made by means of a similar, but much less convenient, portable photometer two or three years ago, gave the writer only one to four as the range of intensity in a street scene on a dull day, so that probably the range in most landscape photographs is of the order of one to eight or one to sixteen, a range which is capable of being represented within the "period of correct exposure" of a plate.

Another use for the instrument, suggested by the authors of the paper, was the findi[illegible]posures, and although several speakers in the subseque[illegible]ussion considered that the variation in the actinic value [illegible]light would make the instrument of but little value in th[illegible]n, it seems to me that in some branches of photograph[illegible]ld prove of very great value indeed.

While it is improbable that such an apparatus, which is necessarily of some size, will displace the handy and simple sensitive paper actinometer for landscape work, yet in the technical studio it has many advantages. In copying prints by daylight in this climate difficulty is often introduced by the rapid variation of the light while working; even if the first exposure prove quite correct on development, the light may change sufficiently to spoil it before a second exposure is made.

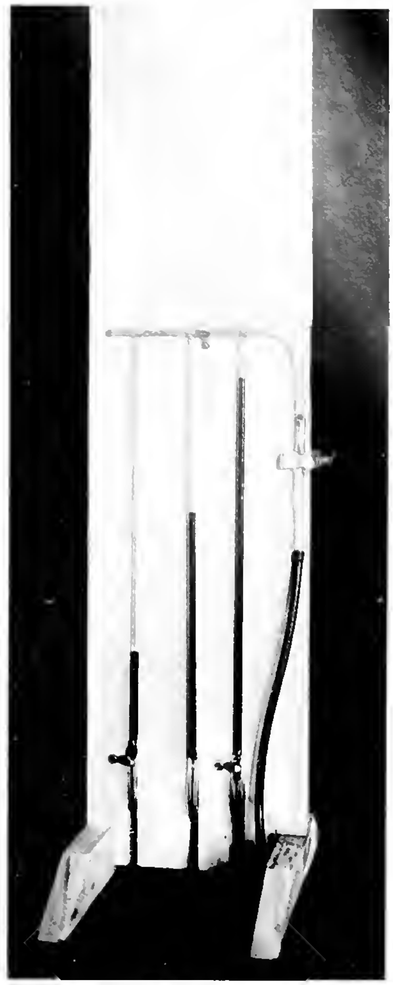


FIGURE 2.

The use of an actinometer in such work is almost impossible because of the time required for the exposure of the actinometer paper, but the "Lumeter," which enables a measurement to be taken in a few seconds, would probably save many plates. In black and white work, again, where what is required is the maximum exposure which can be given without producing any deposit in the parts of the plate representing the blacks in the original all that would be required to render the calculation of the exposure absolutely mechanical would be to find out what exposure to one foot candle for a given plate and stop would just fail to produce an impression upon the plate, and then make a measurement of the light reflected from the blacks of each subject.

In enlarging, also, a measurement of the light falling upon the enlarging easel through the densest parts of the negative should, after one or two preliminary trials, enable the correct exposure to be calculated with considerable ease.

A HYDROSTATIC APPARATUS ILLUSTRATING THE LAW OF DEVELOPMENT.—The development of a photographic plate proceeds according to the equation which represents what in chemistry is called a mono-molecular reaction of the first order, although development is, of course, a heterogeneous reaction, of which the surface of the silver bromide is the variable. The law of development is very simple, and is, that the rate of development at any time is equal to a constant to the difference between the ultimate density that can be obtained if the development be indefinitely prolonged and that which already exists, that is: Rate = Constant $(D_\infty - D)$.

In order to make this plain a little piece of apparatus can be made which supplies an almost perfect analogy. It consists of a glass cylinder, to the bottom of which is attached a piece of glass capillary tubing, and then a piece of thin glass tubing, bent so as to be vertical like the cylinder (Figure 1).

A coloured solution is put into the cylinder, and then by turning on the tap it passes through the capillary and rises in the vertical tube until the level is the same as that of the liquid in the cylinder. The rate of rise in the vertical tube is rapid at first, and then becomes slower and slower until the level is attained.

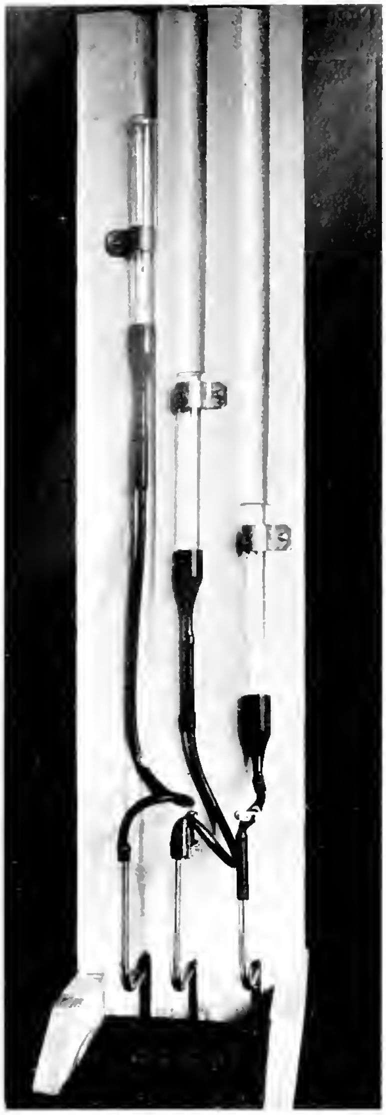


FIGURE 3.

A measurement of the time taken to rise one centimetre, when the difference between the level in the tube and that in the cylinder was twelve centimetres, gave fifteen seconds. When the difference of level was six centimetres the time was thirty seconds, and when the difference of level was three centimetres the time taken was sixty seconds; so that if H is the height in the cylinder, and h the height in the tube:

Rate of rise is proportional to $H-h$,

or: Rate = Constant $(H-h)$.

We see that for this apparatus H exactly corresponds with D_∞, the ultimate density of a plate, and h corresponds with D, the density already attained.

Just as the constant for the glass apparatus depends on the size of the capillary, so the constant for development depends on the rate of penetration of the developer and the products of the reaction through the film, or the diffusion.

In general, however, when we deal with the development of a plate, we have to deal, not with one exposure, but with many different degrees of exposure received on different parts of the plates and giving rise to different ultimate densities in these parts.

In order to see the effect of this we may construct another simple apparatus (Figure 2) consisting essentially of three separate apparatuses similar to that described above, three identical tubes being arranged in front and connecting by means of identical capillary tubes with three cylinders at the back but, these cylinders are arranged so that the heights are variable, and three different heights, H1, H2 and H3, are given to the three tubes. Now if we start this apparatus we shall find that h2 rises faster than h1, and h3 faster than h2. In fact, while at first the levels in all three tubes were equal, after they have risen the levels are very different, the level of h2 being above that of h1, and h3 higher still. Figure 3 shows the apparatus after the levels have risen.

Transferring this to a plate with three different exposures capable of giving ultimate densities D1, D2 and D3, we see that it will mean that while at first they are all equal, as development proceeds the contrast between d1, d2 and d3 will increase until finally an ultimate contrast will be reached, dependent on the value of D3.

In order to measure the contrast between the levels in our three tubes the most obvious thing to do is to draw a line through the three points. The *slope* of this line will then be a measure of the contrast, and clearly the rate of increase of slope will be proportional to the difference between the ultimate steepness attainable and the steepness already attained.

PHYSICS.

By A. C. G. EGERTON, B.Sc.

RAYS OF POSITIVE ELECTRICITY.—Professor Sir J. J. Thomson gave a lecture on a "New Method of Chemical Analysis," on Friday, 7th April, at the Royal Institution.

If an electric discharge is passed through a large vacuum tube whose cathode is a tube of fine bore, positively charged particles stream back from the cathode moving in the opposite direction to the cathode rays. Sir J. J. Thomson has made a thorough investigation of these rays, which were called by Goldstein, their discoverer, "Kanalstrahlen." The apparatus employed to study these rays, consists essentially of two glass vessels connected by a narrow tube; the cathode is a fine bore metal tube provided with an ebonite plug which fits the tube connecting the two vessels. The one vessel is the discharge tube, the other the observation tube; the anode is situated at the side of the discharge tube. The discharge tube is made very large, so that a high potential discharge can be passed through the tube at very low gas pressures without danger of puncturing the glass tube. Cathode rays stream away from the cathode into the discharge tube. "Kanalstrahlen" stream through the fine tube, which constitutes a portion of the cathode, back into the observation vessel. Here they have to pass through a powerful magnetic field and electric field, so arranged that the magnetic field deflects them vertically, and the electric field horizontally. They impinge after undergoing this deflection on to a photographic plate or a willemite screen; the former is affected by the rays and registers their position and intensity, the latter by the phosphorescence set up gives a visible impression of their deflection.

The deflection of the rays is such that they may be divided into two classes—primary and secondary rays. The primary rays give short parabolic arcs having their heads in the same vertical line, which shows that the minimum electrostatic deflection undergone by the particles is the same whatever the nature of the gas. This means that the maximum potential difference through which the particles have fallen is the same, or that they take their origin close to the cathode. The secondary rays are produced by the primary rays in their passage through the gas in the observation tube, and their position of formation can be found by altering the distance through which the primary rays are under the influence of the magnetic and electric fields. Sir J. J. Thomson has found in this way that the secondary rays are due to dissociation of systems in the undeflected Kanalstrahlen, due to collision with negatively electrified corpuscles, giving rise to a negatively electrified and a positively electrified portion. The reverse can also take place within certain velocity limits, namely the collision of a positive ray with a negative corpuscle and consequent production of an uncharged particle. The study of the shape of the curves produced by the action of the particles on the photographic plate shows that either of these two actions may occur.

Sir J. J. Thomson, in his lecture at the Royal Institution, pointed out how the results of this investigation may be applied to develop a new method of chemical analysis, which is applicable to minute quantities of vaporisable substances, and which, without the necessity of using pure materials, will give directly the atomic weights of the substances under investigation. For the relative positions of the ends of the small parabolic arcs due to the primary rays are proportional to the masses of the particles constituting the rays. Furthermore, the velocity of the rays is so great that the production of particles not completely stable under ordinary circumstances are enregistered on the plate.

Professor Sir J. J. Thomson has been able to obtain evidence of the momentary existence of CH_1, CH_2, and CH_3. Furthermore one gas does not necessarily give rise to only one type of ray, but one parabolic arc may be due to the atom with two positive charges (O^{++}), another to the atom with a negative charge (O^{-}) or a positive charge (O^{+}), another to the molecule (O_2^{+}), another to a more complicated molecule (O_3^{+}), or more complicated still (O_n^{+}). It appears that a negatively charged molecule is not obtainable easily, because in the molecule the electrons are more firmly bound and held together by their mutual influence, whereas in the atom they are freer; consequently, when a collision occurs with a negative corpuscle, the latter may attach itself to the atom but not so easily to the molecule. Sir Joseph Thomson illustrated this point in his lecture by recourse to a simple experiment with magnets. Compass needles were balanced on points on a card, suspended from the roof, which hung close to a magnet. When the compass needles were free to move, the whole card was attracted by the magnet: when the compass needles were removed and laid at random on the card, the latter was not attracted to the same extent.

This new method of analysis, by means of high vacuum discharges, will be excessively valuable in investigating the charges which more complicated atoms undergo and will no doubt lead to many new discoveries and unlock the secrets of the atom. Strange lines appear in these spectra (*e.g.* 65 possible Hg^{+}) which are not readily explainable.

ACTIVE NITROGEN.—Professor R. J. Strutt delivered the Bakerian Lecture on April 6th to the Royal Society. The subject of his lecture was the afterglow from the passage of the electric discharge through nitrogen. We mentioned it in the Physics Notes for February. If pure nitrogen be passed through a discharge tube continuously at a low pressure by suction with a Grede pump, on leaving the discharge tube, it glows with a yellow light and is highly active. It combines with iodine causing the latter to glow brilliant blue, gives a compound with phosphorus—that which is no doubt produced during the exhaustion of Sir Oliver Lodge's high tension valves by means of phosphorus—and causes the metals, when warmed sufficiently to give off vapour, to emit light giving their characteristic line spectra. Professor Strutt illustrated this point in a most beautiful manner by showing the green glow emitted by a small piece of thallium placed in the tube through which the active nitrogen passed. Professor Strutt considers the nitrogen to be in the atomic form.

SEISMOLOGY.

By CHARLES DAVISON, Sc.D., F.G.S.

THE RECENT ERUPTION OF TAAL VOLCANO IN THE PHILIPPINE ISLANDS.—In the island of Luzon, nearly forty miles south of Manila, lies lake Bombon. Near the centre of this lake, from Volcano Island, there rises Taal Volcano, which, by its eruption last January 30th, caused so much damage to the surrounding villages. The crater walls vary in height. At no point are they lower than four hundred and ninety-two feet, at the highest they rise to nine hundred and ninety-six feet.

When the United States Government took over the Philippine Islands at the close of the last century, they acquired the services of a Jesuit priest, the Rev. M. Saderra Maso, who for many years had studied and published valuable reports on the earthquakes and volcanoes of that unstable group of islands. Being appointed an assistant-director of the U.S. Weather Bureau, Father Saderra Masó has continued his useful work, one of the latest results of which is the investigation of the recent eruption of Taal Volcano. Of his interesting report on this eruption a summa[illegible] given in the present note.

During the night of January 27t[illegible] the volcano issued the first warnings of the coming erupt[illegible] Instead of the usual clouds of white steam, great puffs [illegible] smoke were emitted from the main crater, accompanied [illegible] sounds and tremors. On January 28th and 29th, [illegible] earthquakes became more frequent and stronger, un[illegible] at 2.20 a.m., on January 30th, they culminated in a tr[illegible] explosion, the sound of which is said to have been he[illegible] distance of two hundred and fifty miles. A huge black c[illegible] rose from

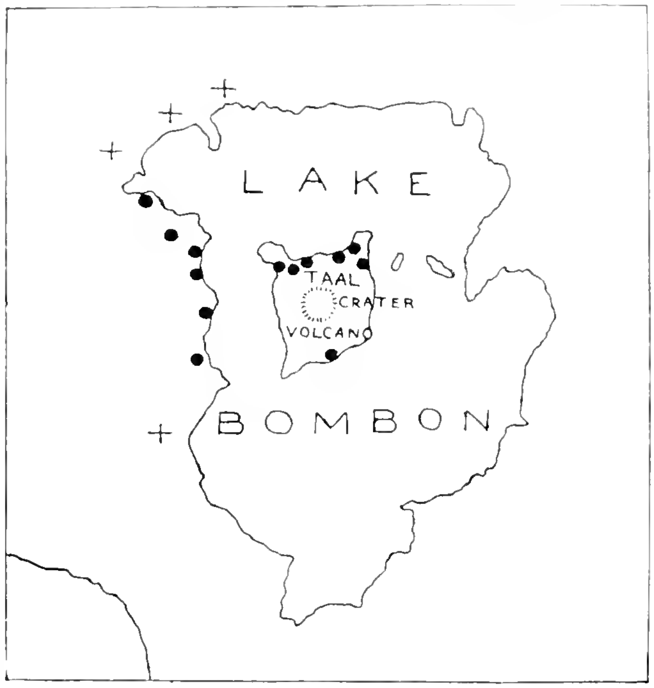


FIGURE 1.

the crater, lit up by flashes of lightning, vivid sparks and bursting globes of fire. A heavy fall of boiling mud followed the explosion, and destroyed all the vegetation and the flimsy houses on Volcano Island and along the western and north-western shores of the lake to a distance of ten miles from the crater, and caused the death of between one thousand two hundred and fifty and one thousand three hundred of their inhabitants. On the accompanying sketch-map, reproduced from Father Saderra Masó's report, the black dots indicate the towns and villages that were obliterated, and the small crosses those that were damaged.

After the eruption, there was a rush of air towards the volcano, which was noticeable for many miles around. Barometers registered a rapid fall of atmospheric pressure, which at Batangas (seventeen miles from the volcano) amounted to about one-twelfth of an inch, and at Manila (thirty-nine miles) to one-twenty-fifth of an inch.

The distribution of the volcanic mud was governed by the direction of the prevailing wind, which was from the south-east. On Volcano Island and the western and north-western shores of the lake, the mud formed a layer from two to three feet in thickness. With increasing distance, its thickness gradually diminished, until beyond a distance of fifteen miles only grey gritty dust was deposited. The finer dust was, of course, carried still farther, and, on the morning after the eruption, some fell at Manila. On the south-eastern shore of the lake no mud was to be seen, and only a little was deposited on the eastern and north-eastern shores.

After the great eruption of January 30th, no other outburst of any importance took place, and the earthquake-shocks soon diminished both in frequency and strength until they practically ceased on February 7th.

Along the shores of the lake, the damage was increased by the waves produced in the lake, which reached a height of ten feet. Here and farther inland, some injury was caused by earthquakes, more by the continual shaking than by the actual strength of any shock, for none of them attained a destructive degree of intensity. At the observatory of Manila, nearly one thousand shocks were recorded between the evening of January 27th and February 7th, none of which in that city reached an intensity greater than the fourth degree of the Rossi-Forel scale of intensity. In other words, the strongest were capable of making doors, windows, fireirons, etc., rattle; they produced a trembling sensation like that felt on a station platform when an express train passes. Other shocks, of the third degree, were just sufficiently strong to be felt by human beings. The great majority of the shocks were of the second and first degrees of intensity; they were microseismic movements requiring rather delicate instruments for their detection. The following table, founded on that given in Father Saderra Masó's report, shows the number of shocks of each degree registered at Manila from 11.6 p.m. on January 27th to February 7th.

	Intensity (Rossi-Forel Scale).			
	4	3	2	1
January 27	...	2	3	21
„ 28	10	21	31	135
„ 29	9	9	28	67
„ 30	8	10	16	62
„ 31	16	16	28	139
February 1	12	11	18	89
„ 2	4	3	9	61
„ 3	...	2	7	46
„ 4	2	2	3	32
„ 5	1	...	3	23
„ 6	...	...	1	14
„ 7	...	1	...	11

It will be noticed that the shocks were most frequent on the day following the beginning of the eruption and on that after the great explosion. As this occurred at 2.20 a.m. on January 30th, it is evident that the explosion caused a temporary relief of the internal strains, such as might well give rise to the old view according to which volcanic eruptions were the safety-valves that shielded us from earthquakes.

ZOOLOGY.

By Professor J. Arthur Thomson, M.A.

BIRD - MARKING. — The Aberdeen University Bird-Migration Inquiry, of which Mr. A. Landsborough Thomson is the Secretary, aims at collecting more definite information on the subject of the Migration of Birds by means of the method of placing rings on the feet of a large number of birds in the hope of hearing of the subsequent movements of some proportion of them. To this end the rings are inscribed with the address "Aberdeen University," and a number (or number and letter combination) different in each case. The rings are placed on young birds found in the nest, or on any old ones that can be captured without injury. The rings are of aluminium and extremely light, and do not inconvenience the birds in any way. The marking work is chiefly carried on in Scotland, notably in Aberdeenshire, but is not confined thereto. The Inquiry has the support of Mr. J. A. Harvie-Brown, Mr. Wm. Eagle Clarke, Mr. Wm. Evans, and other well-known Scottish ornithologists, and similar Inquiries exist in England and abroad.

The cooperation of all who take any interest in Natural History questions is earnestly solicited in order to secure the best results:

1. It is particularly requested that all who may shoot, capture, or kill, or even hear of any of our marked birds should let us know of the occurrence. As accurate particulars of date and locality as possible are desired, but, above all, the number (or number and letters) on the ring. Indeed, except where it has been possible to reliberate the bird uninjured, the ring itself should always be sent; or the ring and foot, or even the whole bird. We always refund postage if asked to do so.

2. Cooperation is invited in the actual work of marking, of any who are specially interested, and have some knowledge of birds, and also time and opportunity for the work. The necessary rings, schedules, and postage stamps, are supplied by us without charge, and we undertake to let the marker know of each case of a bird marked by him being recovered, and to let him have copies of printed reports so far as possible.

The following results obtained at an early stage of the work will serve to indicate what is to be expected from it; these are merely a few records which happen to be of considerable individual interest:—

A Widgeon duckling (*Mareca penelope*), one of five marked in June, 1909, on Loch Brora, Sutherland, Scotland, was taken in a duck-decoy in Province Groningen, north-eastern Holland, on 3rd September, 1909. This bird was thus only three months old when it was found more than 500 miles from its birth-place. A second member of the brood was shot on the Trent, near Retford, Lincolnshire, England, in January, 1911, having worn the ring for a year and a half.

An adult Swallow (*Hirundo rustica*) caught and marked at a farm near Tunbridge Wells, Kent, England, in June, 1909, was re-caught at the same farm in June, 1910.

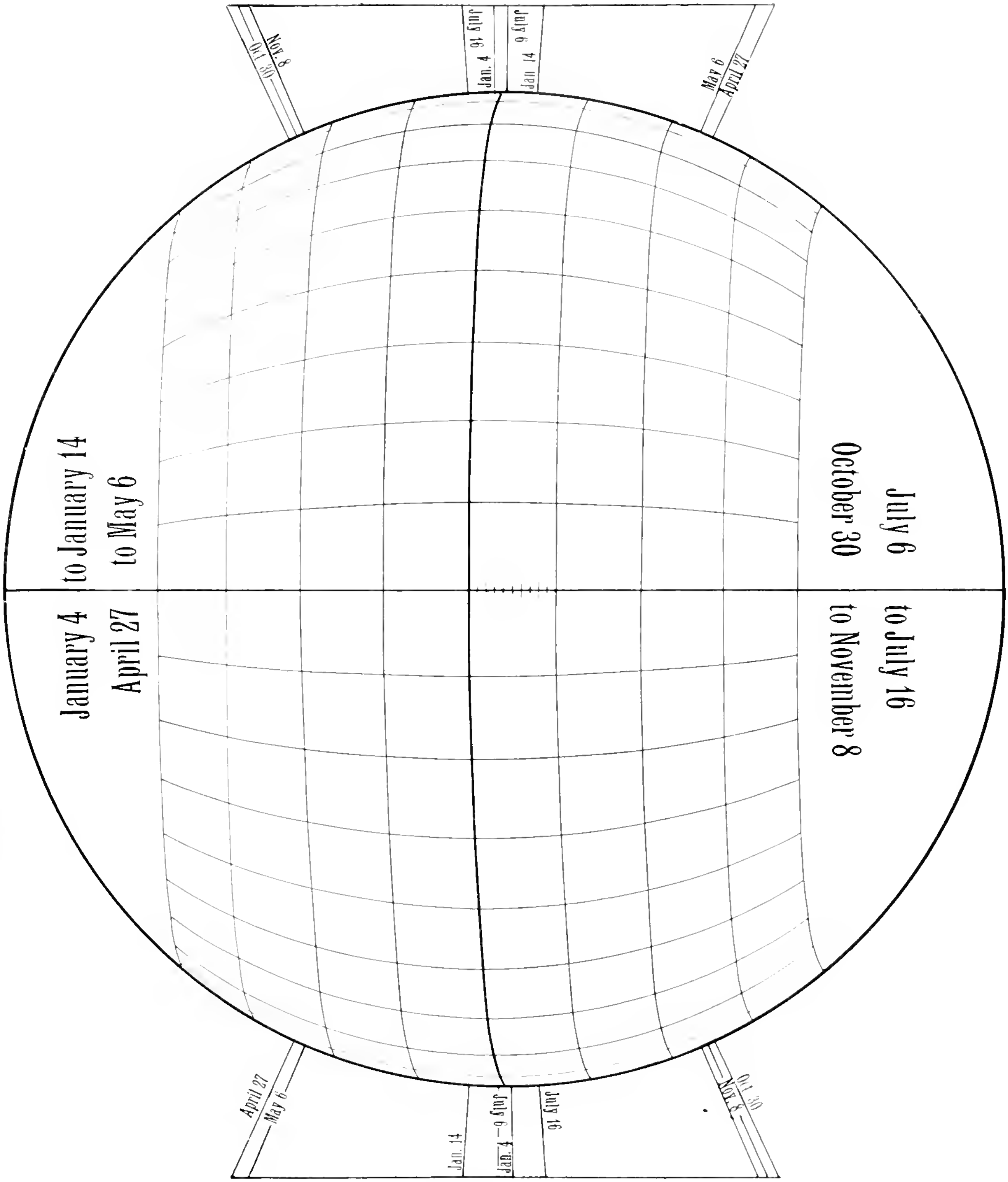
Five Lapwings (*Vanellus vulgaris*) marked as chicks in the North-east of Scotland, in the summer of 1910, were shot respectively in Counties Tipperary, Roscommon, Cork, and Limerick, Ireland, and in Southern Portugal, during the winter 1910–11.

A Song-Thrush (*Turdus musicus*), one of a brood marked as chicks in the nest at Skene, Aberdeenshire, in early June, 1910, was shot near Leiria, Portugal, in early November of the same year. The localities are about one thousand two hundred and fifty miles apart.

DISCS FOR SOLAR PROJECTION.

By JOHN McHARG, M.A.

In the series of maps for solar projection of which an example is printed on the following page, the graduation to intervals of 10° in latitude and longitude is only carried to the fortieth parallel of latitude. For convenience in estimating the diameters of sunspots, a portion of the central meridian is divided into degrees, one of which is equal to seven thousand five hundred and fifty-four miles. The heliographical latitude of the centre and the position-angle of the solar axis are considered positive, the former when the North Pole is tilted toward the observer, and the latter when it is inclined from the north point toward the east; this happens on the dates when the directing lines at the right-hand side of the map are above the equator. It will be observed that with the exception of a brief period about the time of the solstices, the above quantities have the same sign throughout the rest of the year. The solar image, when projected on the disc by a refractor provided with an astronomical eyepiece, suffers reversal from left to right, after the fashion of images in a plane mirror or that of the sun in a diagonal. The correct position-angle of the disc may be easily obtained by stretching a hair tightly across the field of the eyepiece a little beyond its focal plane. This is then turned till the image of a spot runs along the hair, or in its absence by depressing the image till a mere thread of light remains above the crosswire. The coincidence of equators of image and disc is then secured by causing the appropriate directing line on the disc for the date to coincide with the image of the crosswire, intermediate positions to those given being supplied by estimation or measurement.



V. Latitude of Centre ± 4°.

REVIEWS.

AERONAUTICS.

Elementary Aeronautics.—By A. P. Thurston. 126 pages. 126 illustrations. 8½-in. × 5½-in.

(Whittaker & Co. Price 3/6.)

Anything from the pen of Mr. Thurston, the able associate of Sir Hiram Maxim in his later experimental work, must of necessity be of interest, and the book having the above title bears this out. The book abounds with up-to-date experimental results and diagrams relative to curved surfaces. Although a few of them are chiefly of academic interest most are of a highly practical value.

Another interesting feature is the large number of reproductions from photographs of artificial stream lines formed from cloud vapour of ammonium chloride. The author introduces some new work on stability although he would appear to have overlooked one important aspect of the problem. We all thank Mr. Thurston, and congratulate him on giving us this book.

T. W. K. C.

The Theory and Practice of Model Aëroplaning.—By V. E. Johnson, M.A. 148 pages. 61 illustrations. 7¾-in. × 5-in.

(E. & F. N. Spon. Price 3/6 net.)

There is nothing but praise to dispose upon this little book. The author has modestly dedicated it to those interested in the minor branch of model aëroplaning, but there is no student in any branch of aëronautical engineering who will not learn something from this book. From end to end it is full of reliable information. Great pains have been exercised to exclude not only misleading but doubtful matter, and there is a complete absence of all "padding."

Although written in simple language and without a mass of mathematical formulae, it is yet the most truly scientific work on model aeroplaning that has yet appeared, and one that all taking interest in this subject must obtain.

T. W. K. C.

Principles of Aeroplane Construction.—By Rankin Kennedy, C.E. 137 pages. 50 illustrations. 8½-in. × 5½-in.

(J. & A. Churchill. Price 5/- net.)

A considerable amount of this book might with advantage have been omitted, being based on a somewhat doubtful mass of mathematical work and out of date methods.

This criticism does not apply throughout, for in the second half the author discusses the propeller and especially the Hélicoptère in a very lucid manner, disposing of some of the fallacies concerning the latter, with some well-timed remarks. On the whole this book, I think, might be described as "not sufficiently up to date."

T. W. K. C.

How to Build an Aeroplane. 2nd edition. By Robert Petit. 118 pages. 93 illustrations. 8½-in. × 5½-in.

(Williams & Norgate. Price 2/6 net.)

This book has reached its second edition. The translators have taken the opportunity to correct several errors which crept into the first edition and it now forms a very concise little book dealing with aeronautical design. Considered from the point of view of the "builder," for whom the title would suggest that this book was principally intended, it still leaves much to be desired, hardly half-a-dozen pages being devoted to constructive detail. On page 84 the author rightly alludes to the fine construction of the ***Antoinette Monoplanes*** but refers to the figure on the opposite page which is of a ***Wright Biplane***, the very antithesis of construction. We had hoped to see this error in the first edition corrected in the second. Perhaps the translators will see to this in the next edition. In other respects they have done their work very well indeed.

The book is written in plain language, clearly printed on good paper, and sold at a popular price. It will, we are sure, be widely read.

T. W. K. C.

"*Birdflight as the Basis of Aviation.*"—By Otto Lilienthal. With a biographical introduction and addendum by Gustave Lilienthal. Translated from the second edition by A. W. Isenthal, A.M.I.E., F.R.P.S. With a portrait. 142 pages. 94 illustrations, and 8 litho plates. 9½-in. × 6½-in.

(Longmans, Green & Co. Price 9/- net.)

At the present time, when so much interest is taken in Aviation, the publication of a second edition of Lilienthal's well-known book on "Birdflight" is very appropriate. The translator claims, we think with justice, that Lilienthal was the Father of gliding experiments. He is almost the Father of the aeroplane, since it is quite evident that the experiments upon gliding led to the practical development of the aëroplane. We believe we are correct in saying that it was in experimenting with a power-driven glider that Lilienthal, unfortunately, lost his life. The translator has done his work very well. It is difficult to find any of those slips in translation that are sometimes only too much in evidence, particularly when the original is in German. The idioms in German and French are often very difficult indeed to give the English equivalent of; and the translator too often gives a literal interpretation, which is oftentimes almost nonsense. In the present instance, the translator understands his subject thoroughly; he is an enthusiast also, and we believe he has given us what the master wrote.

The appearance of Lilienthal's book also, is of peculiar interest just now, when the Ornithopter, which should be a direct copy of bird wings, and so on, has so far not been able to obtain even a very small footing in the aviation world. The practical construction of Ornithopters has been announced, and the usual claims made for them, which according to Lilienthal's investigations should be maintained; but they appear to get no farther. Lilienthal made a very careful study of birds at first hand; and the book before us is full of very useful information, indeed, upon the mechanism of birds' wings, how the bird uses them; and in particular, the action of the wings of sea birds. He appears to have made a very exhaustive study, not only of the birds that we find flying over our fields, but also of those sea birds—the albatross, the sea gull, the stormy petrel, and others—whose flight is apparently so different to that of the land birds. Sea birds are able to rise vertically from the ground, according to Lilienthal, and to maintain flight against the wind, without any exertion whatever. He evidently looked forward to the day when man would be able to do the same. It is, perhaps, interesting to note that the development of the aeroplane, so far from being in the direction of reduced power, is going headlong to the opposite extreme. The early aëroplanes were equipped with engines of 25 H.P.; those a little later at 35 H.P., and the figure has steadily increased, till the machines which have done the best work in a certain sense, during the last few months, have been equipped in engines of 100 H.P.; and aviators and engineers who are catering for aviators' wants are scheming to produce engines of larger and larger horse-power. Aviators are impressed with the well-known law, that the pressure supporting any given surface varies directly as the square of the velocity of the machine through the air, or what amounts to the same thing, of the air past the machine. Unfortunately, there is another law, viz., that the power required varies as the cube of the velocity. Lilienthal believed in reducing the power, and we believe that a careful study of the experiments he made, and of the laws which he worked out, will lead to a reduction of power, and to a real advance in aëroplanes, on the lines upon which he worked.

Inventors of aëroplanes appear to have availed themselves to a considerable extent of the facts which his experiments brought out, but to have parted company with him at a certain point. Possibly in a little while the course may be reversed.

We heartily recommend the book to anyone who wishes to get a sound knowledge of the principles of bird flight, and of the classical experiments that Lilienthal made.

S. F. W.

ASTRONOMY.

Annuaires Astronomiques pour 1911 et 1912 de l'Observatoire Royal de Belgique publié par les soins de G. LECOINTE, Directeur Scientifique du Service Astronomique. 1911—209 pages; 1912—467 pages (7-in. × 5-in.)

These well-known Annuaires, which have been published each year since 1834 without interruption, give in an accessible form practically all the astronomical data required by amateur astronomers together with considerable meteorological and magnetic data often required by practical astronomers.

There is no work in English which corresponds to these Annuaires, but most astronomers have felt the need of such handbooks which give in a concise form, without the academical detail of the Nautical Almanac, the chief observable phenomena.

Each edition contains a useful map of the world illustrating the time zones and showing which countries have adopted the standard time system.

The Annuaire for 1912 is specially interesting as it summarizes the observations made upon Halley's comet from the date of its re-discovery in 1910 and four plates illustrate the comet's changes during the period it was under observation. A further plate shows a star chart with the path of the comet at the time of inferior conjunction and now that the elements of the comet are so well known it may be possible to at least trace the comet photographically through a much longer period than has ever been done before.

The Annuaires are fairly comprehensive and explanatory and can be recommended as a useful "companion" to practical observers.

W. S.

William Thomson—Lord Kelvin.—By DAVID WILSON. 56 pages. $8\frac{1}{2}$-in. × $5\frac{1}{2}$-in.

(Glasgow: John Smith & Son. Price 2/- net, cloth; 1/- net, paper.)

Reviewing books would be a very pleasant pastime, if they were all so fascinating as this one. It is thoroughly enjoyable—delightfully original. Much sound philosophy and a true glimpse of a great man of true scientific spirit is included in fifty-six pages of real literature abounding with amusement. Read how Lord Kelvin was the "righteous soul in harmony with things in general." There is a chapter which ends "failing to realise the deep and irresistible power of capillary (and other) attractions"! There is no doubt as to the deep attractiveness of the book.

A. C. E.

BOTANY.

(1) *The Liverworts, British and* [illegible] By SIR EDWARD FRY. 74 pages. 47 illustrat[illegible] [illegible]-in. × 5-in.

(Witherby & Company. Pr[illegible])

(2) *Mosses and Liverworts.*—By T. H. R[illegible] 211 pages. 10 plates. $8\frac{1}{2}$-in. × $5\frac{1}{2}$-in.

(Sampson Low & Company. Price 4[illegible])

These two books are alike in many respects. Both attempt to deal in a more or less "popular" style with a remarkable group of plants, which has, by many botanists, been regarded as occupying a central position in the vegetable kingdom, and forming a transition from the green algae on one hand and the great fern and flowering plant alliance of the vascular plants on the other. This group, the bryophyta, has, until recently, been divided by general consent into two classes—the Liverworts and the Mosses—though there are signs that this twofold division is breaking up and will be replaced by a more scientific system of classification based upon the results of recent work on the morphology and development of these interesting plants.

(1) Sir Edward Fry's little book is chiefly a mixture of borrowings from ancient and modern authors, and cannot be said to present anything like an accurate view of the structure, biology, classification and relationships of the Liverworts. The extremely small portions of the book that appear to be based upon the author's own studies are chiefly remarkable for eccentric spellings, such as "autherizoids" and "amphigastra," strange interpretations of the functions of wrongly described structures, and some of the worst drawings in a badly-illustrated book.

However, it is just possible that some amateur naturalists into whose hands this book may fall will find in it something to stimulate curiosity concerning the much-neglected Liverworts, and to impel them to obtain a more reliable guide to the study of these plants. For the structure and development of these plants, it is quite evident that we have as yet no "popular" work that can be recommended to the general reader, though the botanical student will find practically all he requires in the works of Campbell and Goebel. It is only fair to mention that Sir E. Fry gives the names of these works in the last few pages of his little book. As little books of this kind appear to find a sale, we must admit that with all their faults they may serve a useful purpose.

(2) Mr. Russell's more comprehensive and ambitious work has quickly passed into a second edition—a fact which testifies rather to the growth of interest in the Mosses and Liverworts than to the merits of this particular book. Certainly this book will aid the beginner to recognise some of the commoner British species belonging to these groups, though the author is obviously much less familiar with the Liverworts than with the Mosses. The book is written in a bright and interesting style, and the author has wisely refrained from much generalisation and discussion on the morphology, biology, and classification of these plants. Some of the illustrations are fairly good, but perhaps the best feature of the book is the chapter of nearly forty pages on the collection and preservation (including microscopic mounting) of specimens.

It may appear somewhat harsh to criticise adversely such books as Sir E. Fry's and Mr. Russell's, since the avowed object of the author in each case is merely that of arousing interest in the plants dealt with and pointing the way to more advanced and systematic study with the aid of larger works. If the writers of such books would simply confine themselves to what they are more or less familiar with—the general characters of the commoner species and their habitats, and methods of collection and preservation—they would entirely disarm the criticism which, as it is, they provoke by their ill-informed and totally unnecessary treatment of the scientific aspects of the subject. If it is considered necessary to touch upon these topics, it would be much better to give a series of quotations from reliable books or papers by scientific writers, or to invite the coöperation of a scientific naturalist—or at the very least to submit their manuscript to an expert for revision. If either of these courses were adopted, something might be done to remedy the slipshod and inaccurate character of "popular" books on Botany and Nature Study.

F.C.

CHEMISTRY.

Bacteriological and Enzyme Chemistry.—By G. J. FOWLER, D.Sc., F.I.C. 328 pages. 32 illustrations. 7½-in. × 5-in.

(Edward Arnold. Price 7/6 net.)

Just as the border line between physics and chemistry is rapidly breaking down, so, too, in another direction, is the division that formerly separated chemistry from biology. Not only has chemistry made clear many previously obscure physiological processes, but the principles of the new branch of the science have found technical applications in many directions. In fact, so important has biological chemistry now become that the Institute of Chemistry has established a special examination in the subject, and one of the objects with which this book was written was to provide a general introduction to the numerous books which must be studied by those reading for this examination. For this purpose the book will be found admirably suited, and, in addition to this, it is so simply and clearly written that it may be read with interest by the general reader.

After a good description of the characteristics of chemical action in living bodies, and the methods used in bacteriological work, it gives a clear outline of the principles of organic chemistry; and this is followed by an account of the specific actions of various enzymes and bacteria, together with a description of their application in various industrial processes, such as the fermentation of indigo, the purification of sewage, and in agriculture.

It is to be regretted that while in some of these descriptions the author has availed himself of the scientific assistance of specialists in different branches, he has neglected to do so in others, the result being that his accounts of technical processes are of very unequal value. Thus, some of his statements about the manufacture of vinegar are inaccurate, and others only partially true, while the process described as that in general use is one that has been obsolete for very many years.

It is stated (page 149) that, according to Pasteur, the oxidation of the completed acetic acid to carbon dioxide and water is effected by other organisms, such as yeasts, and so on. Now, it is a fact that the acetic bacteria themselves oxidise the acetic acid as soon as they have exhausted the alcohol; and a reference to the original treatise of Pasteur shows that he wrote the very opposite to what is stated by the author, viz.—"When vinegar loses its acidity this is solely due to a slow combustion process which is brought about by *Mycoderma aceti.*"

Another inaccuracy occurs in the description of the fat-splitting enzymes, where it is stated that mutton and beef fats are compounds of glycerine and stearic acid. Both of these substances are undoubtedly present in the fats, but the commercial beef "stearine" is far from agreeing in composition with the chemical compound "stearin," for it contains palmitic, oleic and other fatty acids—in some cases in greater proportion than stearic acid.

But these errors are trifling in comparison with the general excellence of the book, and the author may be congratulated upon having maintained interest in his subject without sacrifice of its scientific value.

C. A. M.

Alchemy: Ancient and Modern.—By H. STANLEY REDGROVE, B.Sc. (Lond). 141 pages. 16 illustrations. 8¾-in. × 5½-in.

(William Rider & Son. Price 4/6 net.)

Most of the modern books upon Alchemy suffer from the drawback of having been written without due appreciation of the scientific basis underlying many of the old theories, or, on the other hand, with an exaggerated importance attached to what was obviously meant as mystical symbolism.

The author of the present book, however, is not only a man of scientific attainments, but is, as his writing shows, strongly in sympathy with the mystical trend of the alchemists, and the result is an exceedingly interesting study of their doctrines.

In no other book with which we are acquainted is the striking manner in which modern chemical thought tends to approximate the philosophical views of the alchemist so clearly brought out. As the author shows, the alchemists first formed their theories, and then tried to find for them experimental support, whereas in modern chemistry experimental investigation has gradually led to the formulation of theories, which, on the physical side, are little distinguishable from those of alchemy. Thus the notion of one primordial form of matter, upon which was based the alchemists' hopes of transforming baser metals into gold, has been rendered more than probable by recent researches in radio-activity. In the earlier part of the book, a good outline is given of the views of the alchemists upon matter and their mystical application to the moral world, and this is followed by brief historical sketches of the leading alchemists, which are well illustrated by reproductions of old engravings. It was perhaps inevitable, that this biographical part of the book should lack the interest of the philosophical portion. The last chapter, in which are contrasted the ancient and modern views upon the transformation of the elements, is particularly interesting.

The author's general attitude towards the question of the transformation of metals into gold in the past, is that of the agnostic, but most readers will be inclined to think that his agnosticism leans to the side of credulity in attaching much weight to the testimony of Helvetius.

C. A. M.

PHYSICS.

The Gyroscope.—By V. E. JOHNSON, M.A. 52 pages. 24 illustrations. 7½-in. × 5-in.

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

The book is an experimental guide to the interesting phenomena connected with gyroscopes. It gives instruction how to make gyroscopes and experiment on them to the best advantage, in order to show their properties. It leads up to the construction of a mono-rail car, balanced by one or two gyroscopes. The author has left theory alone, wisely in a short book of this kind. But those who wish to know something of the phenomena connected with rotating masses, will do well to execute some of the experiments described; while others no doubt would be much interested by merely carrying out the experiments as a pastime. An explanation on page 43 would be improved by substituting "and" for "in the latter"; as it stands the explanation appears incorrect.

A. C. E.

An Elementary Text-book of Physics. General Physics.—By R. W. STEWART, D.Sc. 414 pages. 187 illustrations. 7½-in. × 5-in.

(Charles Griffin & Co. Price 4/6 net.)

Dr. Stewart's text-books are the essence of clearness and lucidity of explanation. This is the first volume of the series of Physical Text-books, and deals with physical measurements, dynamics, statics, hydrostatics and the properties of matter. The text-book contains just the necessary amount of detail to give the student a thorough grounding in the subject. Chapters as, for example, that on the balance, or that on the determination of density, are exceptionally clear on subjects that many elementary text-books skimp over.

The general arrangement of the book is very excellent. The student indulges in units and measurements of the fundamental units till Chapter V., then velocity, acceleration, and circular motion are dealt with. It is pleasing to find the latter subject treated in its proper place and with due regard to its practical importance. Succeeding chapters deal with force, work and energy in a very clear manner. Then comes statics, with a chapter on the balance, followed by hydrostatics, properties of matter, determination of densities, and finally the main properties of matter in the gaseous state. The book ends with a valuable up-to-date chapter on pumps.

A. C. E.

Physical Measurements.—By A. W. DUFF and A. W. EWELL. 258 pages. 78 illustrations. 8½-in. × 5½-in.

(J. & A. Churchill. Price 7/6 net.)

The book will be a great help alike to those taught and to the teacher. In the first case the book is not too long, not too minute in detail, but the descriptions are concise and to the point. In the second case the book covers a fairly wide field, so that it aids the teacher in selecting experimental studies for any particular class of students. Another valuable feature is its numerous references both to practical treatises such as Kohlrausch's "Physical Measurements," and also to smaller class text books.

In the introduction, which gives general advice as to the taking of observations, their possible and probable errors, and the plotting of curves, occurs this sentence:—"Much time in the laboratory will be wasted unless some preparation be made before coming to the laboratory . . . . this may usually be done at home in a few minutes, whereas it might require an hour or more in a laboratory where a number of people are moving around." This is very true. The man who is researching would not come to the laboratory and spend half-an-hour picking up the thread of the previous day's work; he comes generally with a fixed intention of trying some particular experiment which he has carefully planned out. So, too, it should not be that the student should have to spend much time reading through the directions for carrying out an experiment during his attendance at the laboratory, only to carry them out like a cook following a recipe. A little previous study, a preliminary lecture, and a little personal instruction, is more desirable; then the experiments will be carried out intelligently, and without the necessity of elaborate descriptions of the mode of procedure.

One would like to have seen a more complete account of the use of a cathetometer, of specific gravity measurements, and of thermometer corrections; po[illegible] it is most desirable that a student who subsequent[illegible] should have a practical knowledge.

A. C. E.

ORNITHOL[illegible]

Britain's Birds and their Nests. [illegible]BOROUGH THOMSON, with an introduction by J. [illegible] THOMSON. 340 pages. 132 plates. 10½-in. [illegible]

(W. & R. Chambers, Limited. Pri[illegible]

This book, which is illustrated by Mr. Ran[illegible] ured drawings, is a careful compilation of the most important and interesting details with regard to British-breeding birds, in which the writer has incorporated unpublished records of his own and of many competent observers whom he counts amongst his friends. The text is written in language which is easily understood, and the system and nomenclature adopted are those followed in the second edition of Howard Saunders' "Manual of British Birds."

As regards the colouration of the birds and the eggs, the plates will prove very useful. In some of them, however, one particular flower, which is characteristic presumably of the habitat of the bird, has been dragged into the picture and emphasised in such a way that it detracts somewhat from the intention of the drawing.

Professor Arthur Thomson contributes an introduction in which he treats birds from a biological point of view, emphasising the interest to be gained from their study, but saying that while the living bird attracts most minds, and provides a man with enough to keep him busy all his life, half the wonder will be missed if there is not also some analysis of structure. He touches on the behaviour, migration, and development and evolution, as well as the practical importance of birds, and concludes with a plea for the efforts which are being made towards bird protection, partly by legislation, partly by the education of public opinion (e.g., as regards the use of feathers in decoration, other than those from domesticated birds, like the ostrich, and from birds shot for food) and partly by the establishment of bird sanctuaries, some of which have already been attended with remarkable success; for when a bird has been exterminated, its loss is irreparable.

W. M. W.

NOTICES.

A NEW FIELD GLASS.—We have received from Messrs. C. P. Goerz's Optical Works, Limited, a list of their Frieder Binoculars, among which a new introduction, the "Neo-Frieder," calls for attention, as it has several special features, among which are its excellent definition, its increased field of view, which means, of course, that more of the field looked at is seen, while there is enhanced stereoscopic effect and greater illumination and brightness of the picture consequent upon the employment of larger object glasses.

SCIENTIFIC PHOTOGRAPHIC PLATES.—There must be many who are seeking for photographic plates for various scientific purposes, and to these we commend the descriptive list of those issued by Messrs. Wratten and Wainwright, of Croydon. A great deal of useful information is incorporated, and reference is given to special booklet which this firm has prepared, dealing with particular scientific work.

A CINEMATOGRAPHIC HAND-CAMERA.—The Aëroscope, of which details have reached us is practically a hand-camera loaded with four hundred and fifty feet of film and worked by means of a small air engine. It is brought out by the Aëroscope Company, 18, Charing Cross Road, W.C.

PRESERVATION OF THE EYE-SIGHT.—The receipt of a small booklet entitled "Eye-Sight Preserved," containing many useful hints, reminds us that Mr. Aitchison, who is responsible for it, is always ready to test eye-sight and give advice without charging any fee.

NEW APPARATUS.—Among the new instruments which Messrs. Zeiss have recently put upon the market are telescopic spectacles which have been introduced for the benefit of persons suffering from extreme myopia. Another is the cardioid ultra-microscope, devised by Dr. Siedentopf, which is adapted for the examination of colloid solutions, diluted precipitates, and the observation of micro-chemical and photo-chemical reactions. We may mention also the new oral illuminator for the use of dental surgeons and the new method of illuminating operating theatres in hospitals with a search-light and distributing mirrors.

ASTRONOMICAL LECTURE.—Mr. Frank C. Dennett informs us that he still has a few dates vacant for the delivery of his lecture on "The Sun, its Structure and Influence," illustrated by an unique set of lantern slides. Mr. Dennett's address is 6, Eleanor Road, Hackney, N.

THE BRITISH ASSOCIATION.—A preliminary programme has been issued for this year's meeting of the British Association, which, as already announced, is to take place at Portsmouth, on August 30th and following days.

The opening meeting will be held in the Town Hall on Wednesday evening, August 30th, when Sir William Ramsay, K.C.B., will assume the presidency and deliver his inaugural address. In the same hall the first evening discourse will be delivered on Friday evening, September 1st, by Dr. Leonard Hill, on "The Physiology of Submarine Work," and the second, on Monday evening, September 4th, by Professor A. C. Seward, on "Links with the past in the Plant World."

A BIRD'S-EYE VIEW OF THE HISTORY OF ASTRONOMY.

By W. ALFRED PARR.

"For it is my opinion that the occasions by which men have acquired a knowledge of celestial phenomena are no less admirable than the discoveries themselves." Thus wrote Kepler in memorable words at the beginning of the seventeenth century, and few will deny that the history of the oldest and grandest of the sciences possesses a fascination far transcending that of many another record of human activity. In no other sphere of knowledge is the gradual unfolding of human genius so palpably shown as in this slow endeavour throughout the centuries to unravel the mysteries of the stars, for the movement of the mind has been constantly onward, and the problems of astronomy have ever called its highest energies into requisition.

To chronicle, as concisely as may be, the salient features in the more modern aspect of this upward struggle, is the object of the following Table, which purports to present in its vertical columns a chronometrical, and in its horizontal columns a contemporary miniature history of astronomy, embracing the chief biographical, theoretical, and instrumental details of any given period. In order to bring the whole within reasonable dimensions the vertical spaces have been arranged in periods of fifty years, beginning with A.D. 1500, the epoch immediately succeeding the Revival of Science in Europe, thus the various landmarks in the evolution of modern astronomy appear in close perspective, showing, in a more graphic manner than is otherwise possible, how completely each stage in the progress of the science has depended on those that preceded, besides affording a comprehensive mental picture of this later development as a whole. The method adopted not only imparts a sense of proportion to the conception of history which can never be gained from a mere perusal of abstract dates or a study of isolated periods, but also permits of the separate study of the contained matter in a specific way, for the descending columns give a compressed history of any particular *subject*, while the horizontal columns treat of any particular *period*.

Before, however, entering upon a detailed study of the Table itself, it will be well to premise, in as brief a manner as possible, an epitomized account of the leading discoveries which were made during the whole of the pre-Copernican period.

PRIMITIVE ASTRONOMY.

Astronomy was cultivated from the earliest times in Egypt, India, and China. The path of the sun and moon amongst the stars forming the Zodiac, and the primary divisions of the year and month were determined, the motions of the five planets, Mercury, Venus, Mars, Jupiter, and Saturn studied, and the Obliquity of the Ecliptic measured by the nations of antiquity, the most systematic astronomical observations being those of

THE CHALDEANS

who map out the Constellations about 2000 B.C., and who discover that the Phenomena of Eclipses repeat themselves in the Saros Period, or cycle of eighteen years. The next great advance is made by

THE GREEKS.

B.C. 636 Thales of Miletus holds the earth to be a sphere, and predicts a solar eclipse. (The *Gnomon* is in use, and *Sundials* are constructed.)

„ 582 Pythagoras, according to his disciple Philolaus (B.C. 400), speculates upon the motion of the earth.

„ 409 Eudoxus of Cnidus expresses the planetary motions by the aid of geometry, and sets up the hypothesis of *Moving Spheres*, afterwards extended by Callippus (B.C. 330).

„ 395 Heraclides of Pontus is the first to teach the doctrine of the *Earth's Diurnal Rotation*.

„ 300 Aristillus and Timocharis determine the relative positions of the principal stars of the Zodiac, thus preparing the way for Hipparchus.

„ 280 Aristarchus of Samos is the first to propound the *Heliocentric System*. (Employment of the *Armillary Sphere*.)

„ 250 Apollonius of Perga devises the system of *Eccentrics* and *Epicycles*.

„ 160 Hipparchus, the greatest astronomer of antiquity, establishes the science on a firm footing by his catalogue of 1,080 stars, and his discovery of the *Precession of the Equinoxes*, as well as by his precise observational methods ensuring accurate results. (Employment of the *Astrolabe*.)

A.D. 130 Ptolemy of Alexandria elaborates in his "*Almagest*" the *Epicycles* and *Deferents* of his predecessors, thus discarding the juster heliocentric views of Aristarchus. The *Ptolemaic*, or *Geocentric, System* is dominant for fourteen centuries.

After this time the Alexandrian school of astronomy declines until after the *Mohammedan Conquest* in 642, the next advances being made by

THE ARABS.

„ 813 Almamon founds a school of astronomy at *Bagdad*, and has Ptolemy's "*Almagest*" *translated* into Arabic.

„ 850 Albategnius, the most celebrated astronomer of the Arabs, makes accurate observations, and compiles valuable *Astronomical Tables*.

„ 903 Al-Sufi revises the Alexandrian *list of stars*.

„ 1000 Abul Wefa discovers the *Moon's Variation*.

„ 1433 Ulugh Begh establishes a well-equipped *Observatory* at *Samarcand*, and compiles a valuable *Star Catalogue*.

After this time Eastern astronomy comes to an end, but Western Europe continues the cultivation of the science introduced by the Arabs into Spain, the first advances being made by

THE MOORS.

„ 1038 Alhazen discovers the *Law of Refraction*.

„ 1080 Arzachel, of *Toledo*, publishes his *Toletan Tables*, and repeats the observations of Albategnius with greater accuracy.

„ 1230 The Arabic version of Ptolemy's "*Almagest*" is *translated* into Latin, and about

„ 1270 Alfonso X. of Castile produces at Toledo the *Alphonsine Tables*, compiled by the best mathematicians of the Moorish universities.

The impulse thus given to astronomy by the two latter events draws the attention of Western learning to the science, and John Holywood's (Sacrobosco) publication of a Treatise on the Sphere about 1230, and Nicolaus von Cusa's speculations on the Planetary System about 1440, prepare the way for the advent of Copernicus.

CHRONOMETRICAL CHART OF THE DE

PERIOD.	BIOGRAPHICAL.	THEORETICAL.
A.D. 1500 (Time of— Henry VIII. Edward VI.)	COPERNICUS, 1473–1543 (Works in Polish Prussia). TYCHO BRAHÉ, 1546–1601 (Denmark and Bohemia).	The GEOCENTRIC SYSTEM of *Ptolemy*, dominant for fourteen centuries, is brought to renewed prominence by *Purbach* (d. 1461) and *Regiomontanus* (d. 1476), but the HELIOCENTRIC SYSTEM is definitely revived by *Copernicus* in 1543.
1550. (Mary, Elizabeth.)	GALILEO, 1564–1642 (Italy). KEPLER, 1571–1630 (Bohemia and Germany). SCHEINER, 1575–1650 (Germany).	*Tycho*, by collecting a vast mass of valuable observations, prepares the way for the theories of *Kepler*, who introduces the DYNAMIC CONCEPTION into Astronomy by his *Three Laws* of the planetary motions, which form the connecting link between the theories of *Copernicus* and the discoveries of *Newton*.
1600. (James I. Charles I. Commonwealth.)	HEVELIUS, 1611–1688 (Germany). HORROX, 1619–1641 (England). HUYGENS, 1629–1695 (Holland). NEWTON, 1642–1727 (England). FLAMSTEED, 1646–1719 (England).	*Galileo*, by his telescopic discovery in 1610 of JUPITER'S SATELLITES and the PHASES OF VENUS, firmly establishes the Copernican doctrine, and lays the foundation of OBSERVATIONAL ASTRONOMY. *Scheiner*, from the observation of SUNSPOTS, discovered in 1610 by *Fabricius* and *Galileo*, determines the Sun's rotation. *Horrox* predicts on dynamical principles, and is the first to observe (with *Crabtree*) a TRANSIT OF VENUS in 1639.
1650. (Charles II. James II. William III. and Mary.)	HALLEY, 1656–1741 (England). BRADLEY, 1693–1762 (England).	*Riccioli*, *Hevelius* and *Grimaldi* lay the foundation of SELENOGRAPHY by constructing lunar charts. *Huygens* discovers the true nature of SATURN'S RING in 1659. *Newton*, by the publication of the "*Principia*" in 1687, establishes the UNIFICATION OF CELESTIAL AND TERRESTRIAL SCIENCE, and shows *Kepler's Laws* to proceed from the action of GRAVITATION. *Flamsteed*, whose lunar observations aid Newton's calculations, forms the FIRST MODERN STAR CATALOGUE.
1700. (Anne, George I. George II.)	WM. HERSCHEL, 1738–1822 (England). LAPLACE, 1749–1827 (France).	*Halley* predicts on *Newtonian Principles* the RETURN of the COMET OF 1682, makes the first determination of STELLAR PROPER MOTION, and the first SOUTHERN STAR CATALOGUE. *Bradley* discovers the ABERRATION OF LIGHT and the NUTATION OF THE EARTH'S AXIS, thus laying the foundation of accurate stellar astronomy.
1750. (George III.)	BESSEL, 1784–1846 (Germany). FRAUENHOFER, 1787–1826 (Germany). JNO. HERSCHEL, 1792–1871 (England and S. Africa).	*Wm. Herschel*, by his discovery of BINARY STELLAR SYSTEMS, shows NEWTON'S LAWS to extend throughout the universe. He discovers URANUS in 1781, and by his telescopic researches becomes the pioneer of DESCRIPTIVE ASTRONOMY. *Laplace* summarizes Astronomical Mathematics in his "*Mécanique Céleste*," 1799, and publishes the NEBULAR HYPOTHESIS, 1796.
1800. (George IV. William IV. Victoria.)	LE VERRIER, 1811–1877 (France). ADAMS, 1819–1892 (England). SCHIAPARELLI, 1835–1910 (Italy). SECCHI, 1818–1878 (Italy). HUGGINS, 1824–1910 (England). JANSSEN, 1824–1907 (France). LOCKYER, 1836– (England). VOGEL, 1842–1907 (Germany). E. C. PICKERING, 1846– (America). GILL, 1843– (England and S. Africa).	*Bessel* first MEASURES the DISTANCE OF A STAR by determining the Parallax of *Sixty-one Cygni*, and furthers accurate Astronomy by his Star Catalogue, 1818, founded on *Bradley's* observations. *Jno. Herschel* extends his father's SURVEY OF THE HEAVENS to the S. HEMISPHERE. *Adams* and *Le Verrier* give to gravitational Astronomy its crowning distinction by the THEORETICAL DISCOVERY OF NEPTUNE in 1846. *Draper*, *Bond*, *De la Rue* and *Rutherford* (1840–1864) are pioneers in CELESTIAL PHOTOGRAPHY.
1850. (Victoria.)	YOUNG, 1834–1908 (America). CAMPBELL, 1862– (America). HALL, 1868– (America).	The Science of ASTRO-PHYSICS is established on the interpretation by *Kirchhoff* of the FRAUENHOFER-LINES in the SOLAR SPECTRUM, 1859. *Secchi* forms the first classification of STELLAR SPECTRA in 1863. *Huggins* inaugurates SPECTROSCOPIC PHOTOGRAPHY in 1863 and discovers GASEOUS NEBULAE in 1864. *Janssen*, *Lockyer*, *Young*, *Hale* and *Deslandres* advance SOLAR PHYSICS. *Schiaparelli* demonstrates the CONNECTION between COMETS AND METEORS, 1866, and discovers the MARTIAN "CANALS," 1877. *Vogel* publishes the FIRST SPECTROSCOPIC STAR CATALOGUE in 1883. *Gill* and *Mouchez* inaugurate the INTERNATIONAL PHOTOGRAPHIC CHART of the Heavens in 1887. *Pickering*, *Vogel* and *Campbell* demonstrate SPECTROSCOPICALLY the existence of BINARY STELLAR SYSTEMS.
1900. (Victoria, Edward VII. George V.)		*Vogel* at Potsdam, *Lockyer* at London, and *Hale* at Mount Wilson, affiliate the work of the Astronomical Observatory with that of the Chemical Laboratory in their STUDY OF THE PHYSICAL ELEMENTS OF STELLAR EVOLUTION.

…PMENT OF ASTRONOMY. By W. ALFRED PARR.

INSTRUMENTAL.

The instruments known to the Ancients (e.g., The GNOMON, ARMILLARY SPHERE, ASTROLABE, QUADRANT and SEXTANT) continue in use.
Bernard Walther (d. 1504) introduces the use of CLOCKS in astronomical observations.

Tycho equips his OBSERVATORY URANIBORG with greatly-enlarged and accurately-divided QUADRANTS and SEXTANTS, and invents the method of sub-dividing the degrees on the arc of an instrument by transversals.

Hans Lippershey invents the REFRACTING TELESCOPE in 1608, and *Galileo*, constructing one in 1609 for himself, magnifying thirty-two times, applies the instrument to Astronomy, while *Kepler* improves it in theory.
Hevelius is the last to make observations without TELESCOPIC SIGHTS, but *Gascoigne* invents the FILAR MICROMETER about 1640, and *Picard* definitely inaugurates the adoption of the TELESCOPE IN CONJUNCTION WITH THE QUADRANT.

Huygens adapts the PENDULUM TO ASTRONOMICAL CLOCKS in 1656, and invents the COMPOUND EYEPIECE, while both he and *Hevelius* improve definition by employing TUBELESS ("AERIAL") REFRACTORS over one hundred feet long.
Gregory proposes a form of REFLECTING TELESCOPE in 1663, but *Newton* constructs the first in 1668.
Roemer invents the TRANSIT INSTRUMENT AND EQUATORIAL, about 1690.
PARIS OBSERVATORY erected 1671; GREENWICH OBSERVATORY, 1675.

Graham, Bird, Cary and *Ramsden* are the most celebrated constructors of MURAL QUADRANTS about this period.

Dollond invents the ACHROMATIC REFRACTOR, 1758 (suggested by *Hall*, 1733).
Guinand improves the manufacture of OPTICAL GLASS, 1799, enabling *Fraunhofer* to construct LARGE REFRACTORS.
Wm. Herschel advances the construction of REFLECTORS and erects his FORTY-FOOT TELESCOPE in 1789.

Fraunhofer applies the SPECTROSCOPE to Astronomy 1815, adapts CLOCK-WORK MOTION to refractors 1824, and erects the FIRST HELIOMETER 1829.
Reichenbach, Repsold and *Troughton* effect IMPROVEMENTS in INSTRUMENT-MAKING early in this century.
Lord Ross erects his great SIX-FOOT REFLECTOR at Parsonstown, 1845.
The first regular observatories of the S. Hemisphere (Paramatta, 1821; Cape, 1829) are founded.

The first regular application of PHOTOGRAPHY TO ASTRONOMY is made with the *Kew* PHOTOHELIOGRAPH in 1859, but the greatest advances are made after the adoption by *Huggins* in 1876, of the GELATINE DRY PLATE.
The ASTRO-PHYSICAL OBSERVATORIES of Potsdam and Meudon, founded 1874 and 1886.
The FIRST GREAT REFRACTOR (*Newall*, twenty-five inches), erected 1870; LICK, THIRTY-SIX INCHES, 1888; YERKES, FORTY INCHES, 1897.
The EQUATORIAL COUDÉ erected at Paris, 1882.
Chandler introduces the ALMUCANTAR in 1884.
Hale devises the SPECTROHELIOGRAPH in 1889.
Turner introduces in 1895 the COELOSTAT, being a modification of the SIDEROSTAT.

The MOUNT WILSON SOLAR OBSERVATORY is established in 1905, and equipped with horizontal and vertical COELOSTAT TELESCOPES, SPECTROGRAPHS, and SPECTROHELIOGRAPHS, besides the CHEMICAL AND PHYSICAL APPARATUS OF THE LABORATORY.

GENERAL.

During this century Astronomy is still under the INFLUENCE OF GREEK TRADITION, and is at first solely GEOMETRICAL, treating of the motions of the heavenly bodies.

Rise of the DYNAMIC CONCEPTION in Astronomy, which after *Galileo* is PHYSICAL, and after *Newton* GRAVITATIONAL, treating of the appearance and mutual attraction of the heavenly bodies.

Rise of DESCRIPTIVE ASTRONOMY and COSMOGONY with *Wm. Herschel* and *Laplace*.

Rise of CHEMICAL ASTRONOMY, after *Fraunhofer*, treating of the composition of the heavenly bodies. Astronomy now gradually widens its sphere and establishes a UNIFICATION OF THE SCIENCES, by extending terrestrial and planetary gravitation to stellar systems, and by showing the essential identity of cosmical matter throughout the visible universe.

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, 1911.

A SCIENTIFIC USE FOR THE STEREOSCOPE.

By A. H. STUART, B.Sc., F.R.A.S.

STUDENTS whose geometrical studies have been confined to the geometry of two dimensions frequently find considerable difficulty when problems in three dimensions are presented to them. Ordinary drawings afford very little help and there remain only two methods by which assistance may be offered, viz., models and stereoscopic drawings. Of these the latter are undoubtedly the easiest to make and the cheapest to produce.

The most elementary knowledge of perspective is all that is required to make stereoscopic drawings of all the usual problems in solid geometry. Figure 1 shows a simple method of drawing a cube in perspective. A figure is drawn for each eye, the

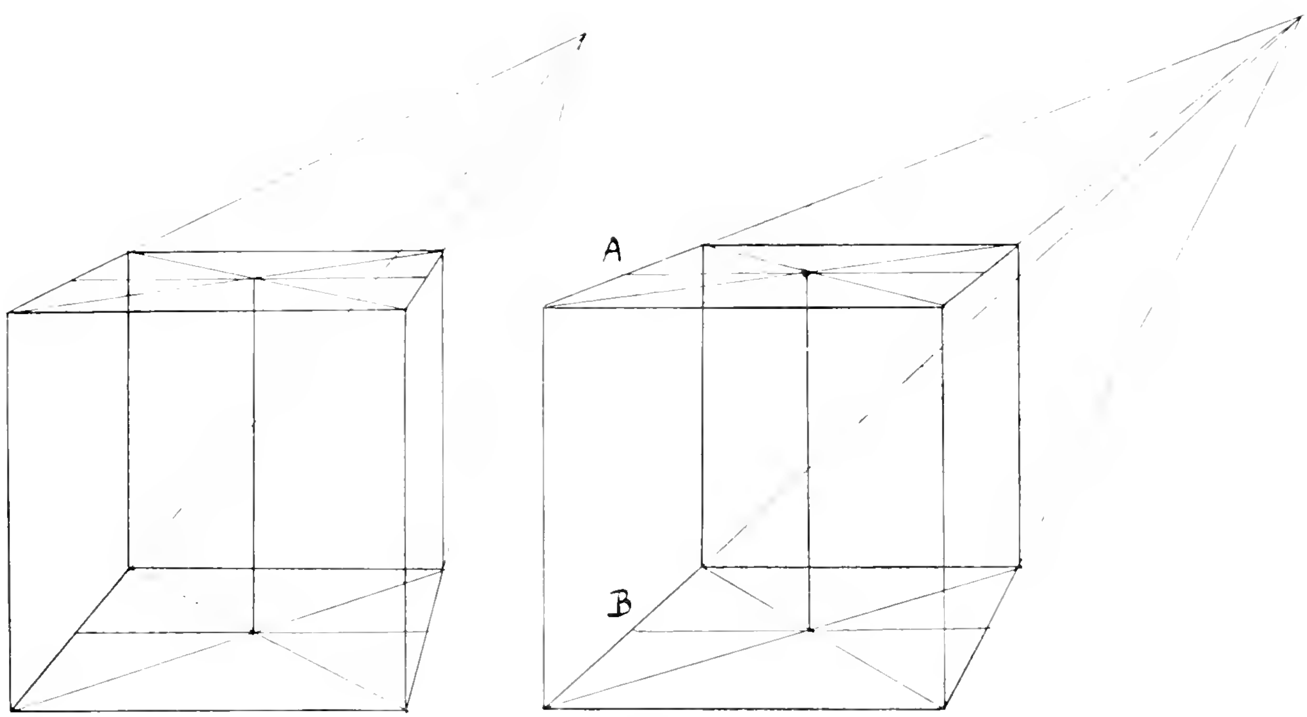


FIGURE 1.

vanishing point of the figure for the right eye being separated from that of the figure for the left eye by a distance about equal to that between the two

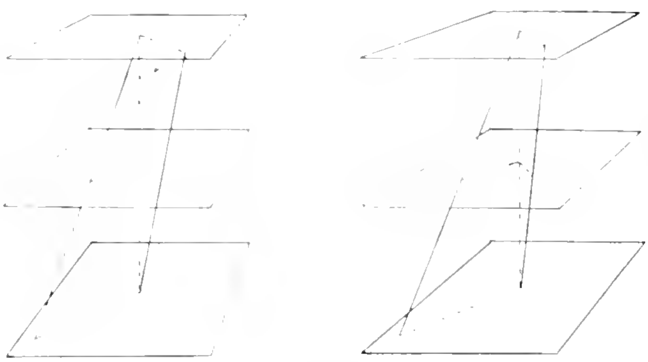


Figure 2.

eyes. (In adults this is about 3 inches, while in boys of about fifteen years of age I have found the average to be about 2·5 inches). For all practical purposes the front face of the cube may be represented by a perfect square. The figure also shows the method of obtaining the axis of the cube. It must be remembered that the geometric centre of a face is not necessarily the stereoscopic centre. If the point of intersection of the diagonals is taken, no mistake can be made. Similarly, to obtain the middle point of an edge, draw a line parallel to an edge which is at right angles to the former through the point of intersection of the diagonals. This will cut the edge at the required point. Thus, in Figure 1, A and B are the stereoscopic centres of the edges on which they stand.

I have found it convenient to make the drawing first on a large piece of drawing paper and then prick through the necessary parts on to the paper which is to form the finished slide. This not only has the advantage of not showing the construction lines in the stereoscope, but a large number of figures of different subjects may often be pricked off the same drawing. From the cube a vast number of figures may be derived by the exercise of a very little ingenuity.

Figure 2 represents the figure of a theorem in Euclid, Book XI. By examining this drawing in the stereoscope the figure stands out in relief in a most striking manner, and brings home to the mind of the student the whole meaning of the theorem at once. The construction of these figures by the student is quite an education in itself, in addition to providing him with figures equal to models in every way.

Nor does the mathematical student monopolize the benefits to be derived from the use of the stereoscope. Figure 3 shows how an ill-formed crystal of the octahedral system is derived from the perfect octahedron: a matter which is by no means clear to every student of chemistry. Again, Figure 4 shows the graphical formula of one of the optically active forms of tartaric acid. For obvious reasons, if a figure requires lettering only one of the figures should be lettered.

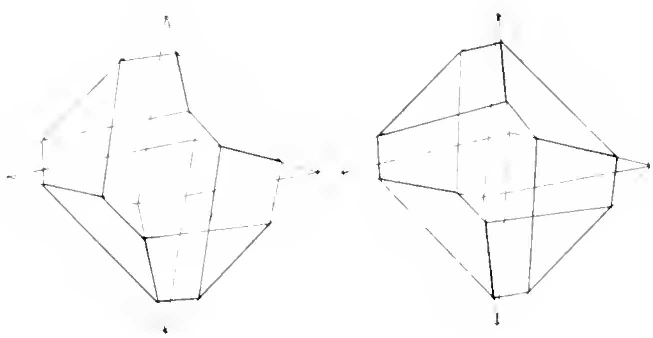


Figure 3.

I have found stereoscopic drawings of geometrical solids very useful in demonstrating to physics students the theory of stereoscopic vision. It is perfectly obvious to them that the two drawings of the solid are not alike, and yet, when their images are superimposed by the lenses of the stereoscope, they give the idea of relief as plainly as the solid itself would do.

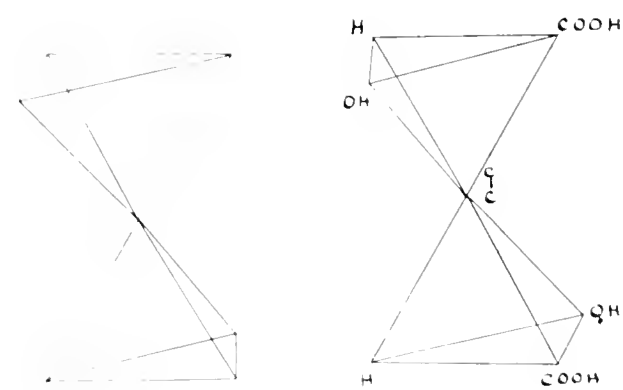
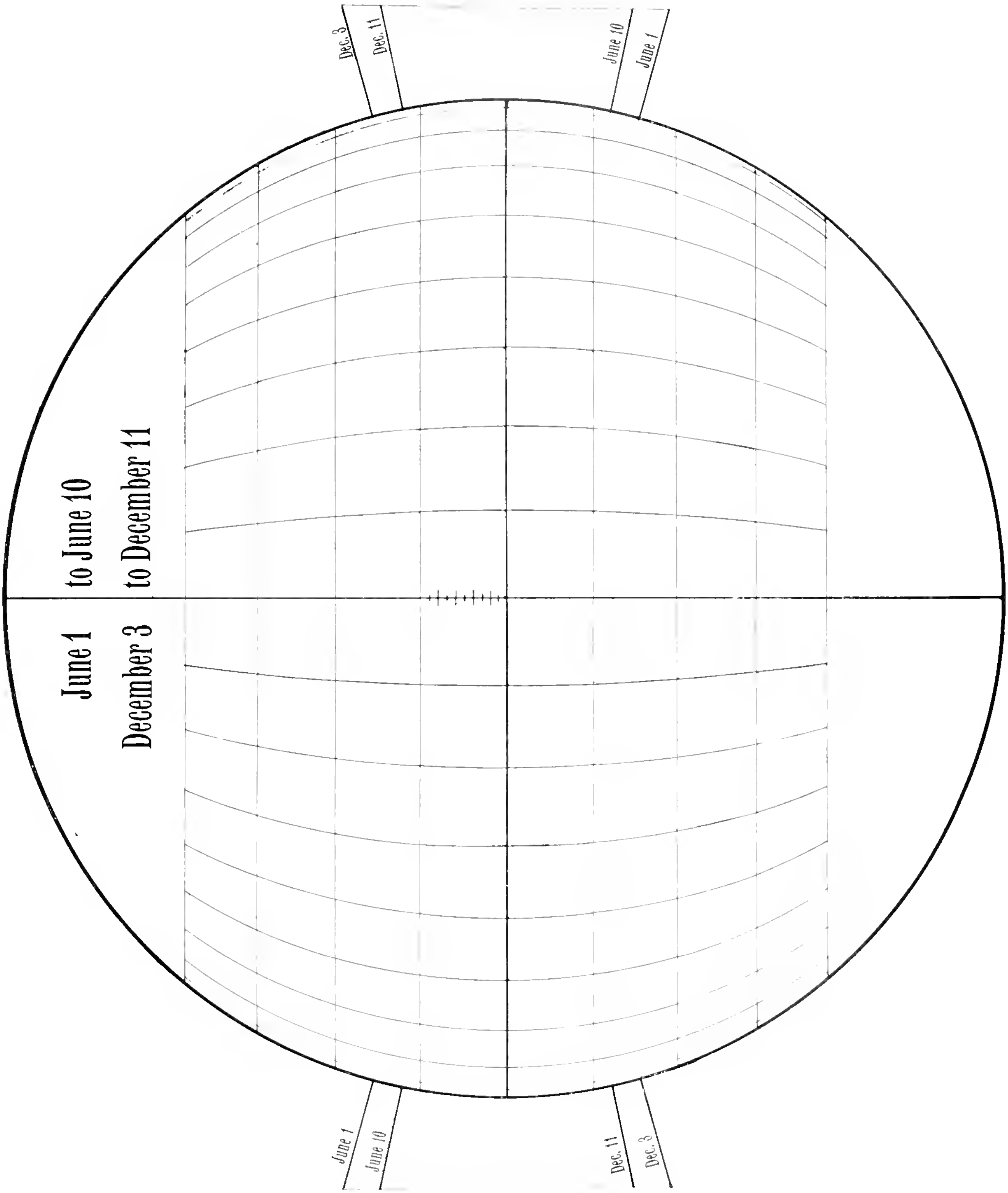


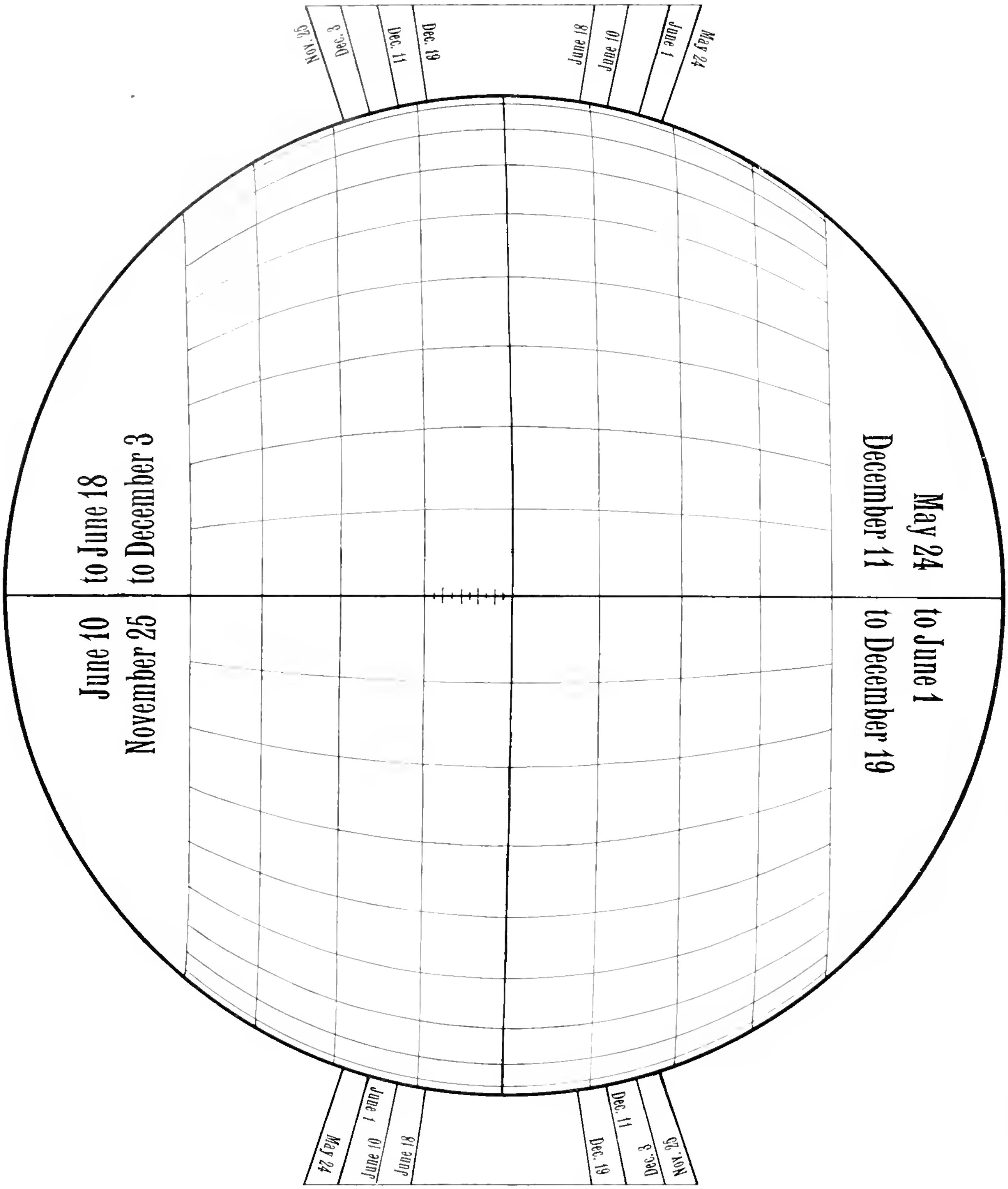
Figure 4.

DISCS FOR SOLAR PROJECTION.

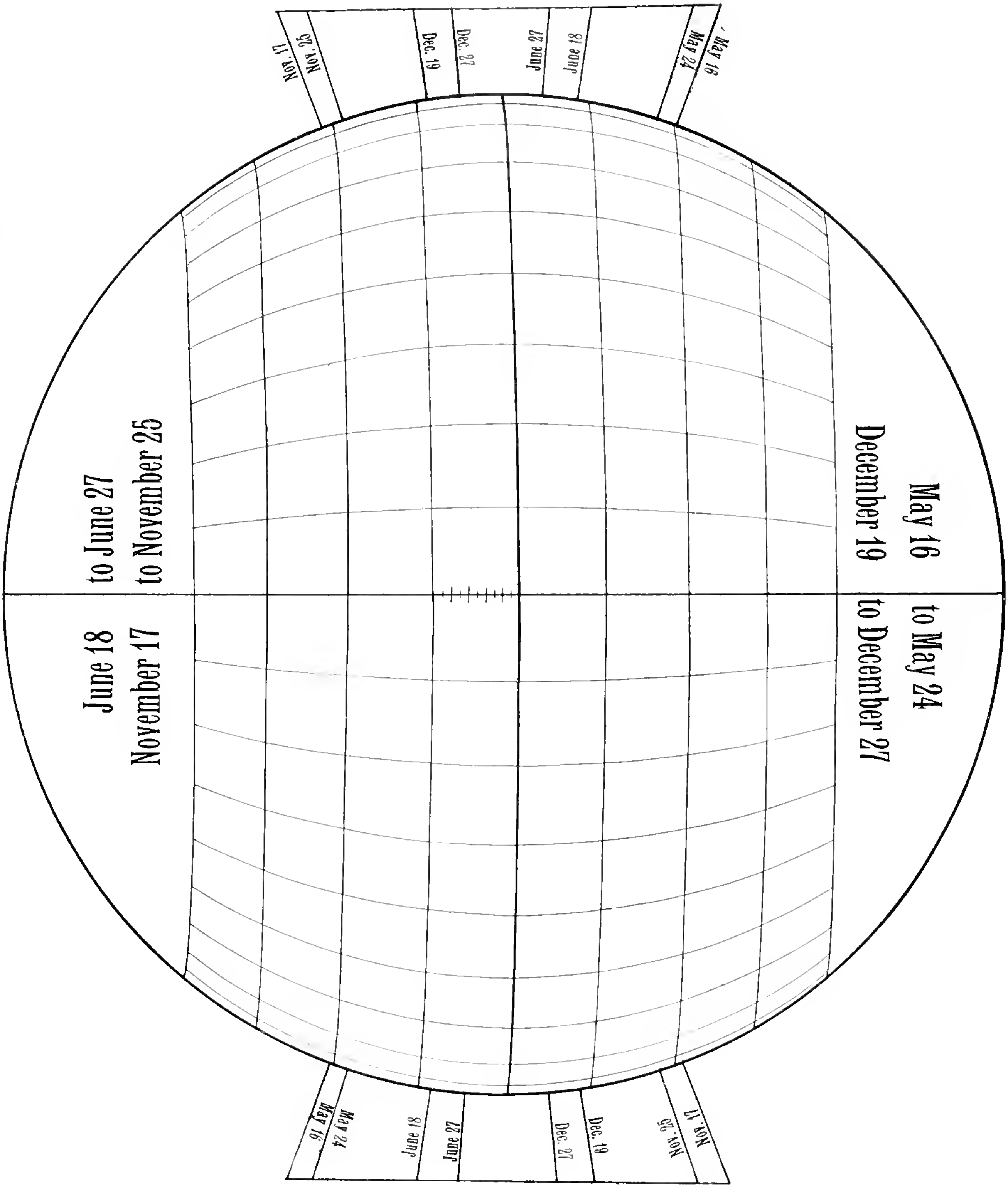
We give here three more of the Maps for Solar Projection belonging to the series described in "Knowledge" for May, prepared by Mr. John McHarg, which can be used from June 1st to June 27th.



I. Latitude of Centre 0°.



II. Latitude of Centre ± 1°.



III. Latitude of Centre ± 2 .

THE AUSTRIAN RESEARCH VESSEL "ADRIA."

By DR. ALFRED GRADENWITZ.

The research vessel of the Association for the Advancement of Scientific Investigation in the Adriatic, was built on the D'Este shipyards by the Stabilimento Tecnico of Trieste. Though being of rather modest dimensions, she is most sea-worthy and, on account of her excellent appointments, can be considered a model of her kind. The "Adria" is mainly intended for the oceanographical and biological investigation of the Adriatic, working in conjunction with the Austrian Zoölogical Station at Trieste.

FIGURE 1. The Laboratory on board the "Adria."

The chief measurements of the ship are as follows:

Length over all	... ...	20·5 metres.
Maximum width	... ...	4 ,,
Height	... ...	2·4 ,,
Draught	... ...	1·5 ,,
Capacity	... ...	45 tons.

The hull is made of wood, the frame and keel being of oak, and the inside and outside planking of pitch-pine. A skin of copper plate protects the hull below water against the attack of ship worms.

The various teak wood structures erected on deck for covering the rooms located in the hull are only ·70 metres in height, which greatly reduces the side-pressure of the wind. Ample space is provided on the plane deck plates, for installing all kinds of apparatus and doing scientific work. These structures are fitted sideways with quadrangular skylights and protective gratings as well as with hinged hatch lids. The deck is encircled by an iron railing, the lower apertures of which are closed by netting: the upper bars are fitted with pulleys for lowering oceanographic instruments. The front part of the bow (as far as the mast) is set apart for fishing operations and, therefore, is equipped with the most various outfits, comprising a winch for the rapid hoisting of instruments and nets able to raise a weight of several hundredweight from the bottom to the surface of the sea. While being generally operated by electricity, this winch can as well be worked by hand. On its axle are mounted four drums actuated separately and which are designed for plain ropes, cables, piano wires and anchor chains respectively. The rope carrying a net or heavy instruments travels from the winch over a crane fixed to the mast, thus facilitating the

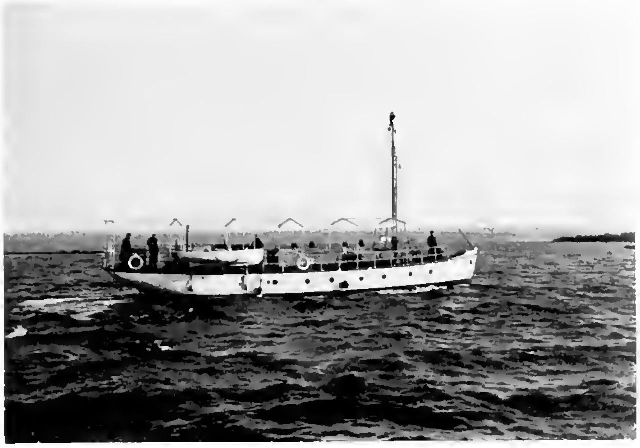


FIGURE 2.
The Research Vessel "Adria" under weigh.

transport of even the heaviest net bags over a shallow trough made from water-tight linen and on which the catch is searched and sorted. Close to the mast there is further a conduit for discharging sea-water so that the whole catch can at any moment be immersed in water.

Behind the mast are arranged the structures forming the roofs of the laboratory located below deck, the combined saloon and bedroom, and finally, the engine room. The rudder, which is actuated with extreme ease through a worm engaging directly with its shaft, is located astern, with a view to utilising as much space as possible for fishing operations, as well as on account of the greater simplicity and safety.

FIGURE 3.
An Oceanographical Specialist at work.

Of special importance are the sea-water tanks for receiving any marine animals and plants caught by the net. As these manifold organisms should be taken home alive, the "Adria" is equipped with what could fitly be called a complete aquarium, comprising three wooden cases lined inside with sheet metal and which contain three to four removable sheet metal aquarium tanks serving at the same time for the transport of marine animals from the ship to the shore. The wooden cases which, when closed, can be used as benches, are provided with conduits for sea water and compressed air, enabling any animals and algae to be kept in circulating or ventilated water. In the hind part of the vessel is installed a large tank likewise containing circulating sea water and compressed air and which takes up nearly the whole width of the ship. This is intended for receiving big fish and marine animals.

The supply of sea-water to the aquarium tanks is effected during the time the ship engine is at work, that is, throughout the course of the vessel, by a pump coupled to the propeller shaft, while an electrically-operated centrifugal pump is resorted to during intervals in its operation. The compressed air is generated by a compressor connected to the ship motor which allows air to be compressed in cylindrical iron vessels to four atmospheres, reduced by a throttle valve to one-twentieth of an atmosphere. The compressed air also serves to actuate the whistle of the ship.

The compass, a fresh-water tank and an ice tank are likewise located astern.

On each side of the vessel is suspended from a crane a launch four metres in length. These launches, one of which is equipped with a gasoline motor of two-and-a-half horse power, are intended for landing at and exploring such parts of the coast as are not accessible to the "Adria."

As regards next the arrangements provided below deck, the copper tank containing the fuel (gasoline, petroleum or alcohol) is located in the very front of the fore-ship, being separated by a fire-proof metal partition from the bedroom of the crew. This tank has a capacity of about nine hundred kilogrammes, which enables the vessel continually to sail about fifty hours, covering a distance of about four hundred and fifty knots. As the motor is mostly stopped by night, a new fill of fuel generally is required only every five days.

The bedroom of the crew also contains anchor chains, tows, tent covers, nets, and flags. A special room is provided for photographic work.

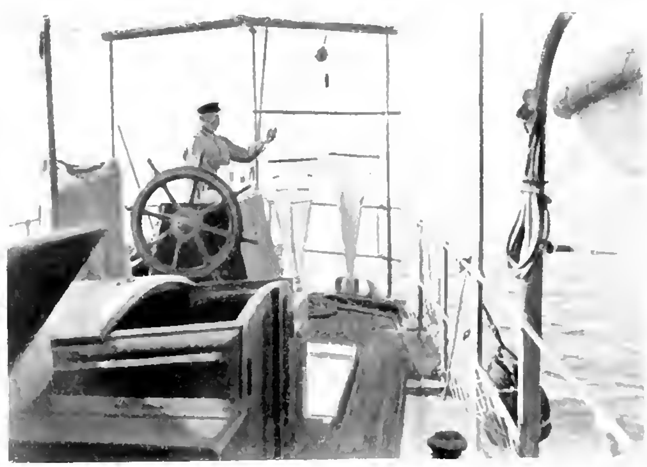


FIGURE 4.
The Plankton Nets being hoisted astern.

The Laboratory (see Figure 1), like the adjoining saloon, is dominated by a roof structure and derives its light partly from the side-windows of the latter and partly from four circular hatchways in the ship's walls. On its longitudinal sides are arranged lockers ·90 metre in height for stowing away instruments, on the top of which ample room is provided for performing all sorts of operations and installing scientific apparatus. The laboratory further comprises a compressed-air conduit with six discharges, allowing small aquarium tanks to be thoroughly aërated. Two additional berths can be made up on the instrument lockers in cases of emergency. As the ship engine works with remarkable smoothness, microscopes of modest magnifying power can very well be used in a quiet sea, which is the more advantageous as the plankton of the sea should be examined while still alive, at least for its main characteristics. The Laboratory is, of course, equipped with all sorts of oceanographic and other instruments.

In the middle of the ship, viz., in the part taken up on steamers by the engine and boiler, is located a spacious, well-aërated and lighted saloon, which serves as dining as well as bedroom. Alongside its longitudinal walls are installed four berths with chests of drawers and on its transversal walls four wardrobes, one of which has been converted into a pantry, containing an ample supply of crockery.

The engine plant is located in the hind part of the vessel. The engine is a seventy-five horse-power motor, constructed by the Wolverine Works, at Grand Rapids, Michigan, imparting to the ship a speed of nine knots, which, thanks to the excellent design of its carburettor, can be operated at will with gasoline, petroleum, or alcohol. This motor is of a very substantial construction and remarkably simple manipulation and superintendence, being started merely by a pressure on the lever of the electrical ignition, in order afterwards to go on working quite automatically, needing inspection only from time to time. This engine has repeatedly stood severe tests in a rough sea with excellent results. In order to afford greater stability in a gale and heavy seas, the vessel has been equipped with a triangular sail and a jib.

This engine is coupled to the air compressor supplying air for aërating the aquarium tanks and operating the ship's whistle. In the same part of the vessel is located the electric plant which comprises a two horse-power gasoline motor coupled to a dynamo, generating electric current at sixty-five volts tension for operating the winches and lighting the vessel. It is supplemented by an accumulator battery of thirty-six cells, resorted to in cases of emergency and when the dynamo is stopped. Scientific work can thus be continued even by night, allowing, *e.g.*, the air bubbles from bottles immersed in the sea to be watched with a view to ascertaining the course of water currents. The installation of a search-light will likewise be of much importance for biological and oceanographic purposes. Finally, there is a possibility of operating directly from the dynamo or accumulator battery, a sea-water pump for keeping up the water circulation in the aquarium tanks.

Adjoining the engine room is the ship's kitchen which, in spite of its diminutive dimensions, perfectly suffices for its task. It is equipped with an economiser stove for coal firing and all necessary kitchen utensils.

Apart from its use as a research vessel the "Adria" is also to serve for instructional purposes, in connection with periodical journeys of scientific discovery for the benefit of undergraduate students.

SCIENCE AT THE CORONATION EXHIBITION.

For a third time a science section has been arranged at the Shepherd's Bush Exhibition, and this year the Committee, of which Sir Alexander Pedler, F.R.S., is Chairman, has brought together a number of very interesting exhibits. We hope to deal with some of these in detail, but at the moment we may point out that a feature of the Astronomical division is a series of transparencies, while there are collections of sundials and astrolabes, as well as some remarkable models sent by Greenwich Observatory. The Meteorological Office illustrates its useful work and there are some instruments on view. Anthropology is represented by measuring instruments, old and new; by a series of casts of the oldest known skulls; and by Dr. Gray's Perseveration apparatus, described by him in "Knowledge" for December, 1910. It is kept in a small bureau in the right hand corner (going from Uxbridge Road), of the first building devoted to science, and visitors may be tested upon application. Fifty years' work of the Geologists' Association is represented by collections made upon the well-known excursions of the society, and there is a good series of fossils showing changes in structure of the teeth of *Ceratodus*. The fossil eggs of fishes are noteworthy, and the specimens of the spines of sea urchins which, though alike externally, show internal structure which is characteristic of the various species.

The apparatus employed for investigations on the rusting of iron is a special exhibit in the Chemical division in which also coloured compounds, new drugs, and the making of Vanadium steel are illustrated. Physics is necessarily chiefly represented by apparatus. The Biological exhibits are not extensive but call for special attention. The London School of Tropical Medicine sends a detailed exhibit including a prehistoric skull showing that trepanning was practised long ago. University College, Bristol, exhibits some excellent models showing electric installations in connection with the growing of crops in field and in greenhouse. The Selborne Society makes a display of the English nesting boxes recently introduced with much success. The Agricultural exhibits illustrate the work of the Board of Agriculture in the way of distributing maps, of fisheries, and the study of plant diseases as well as of forestry. The Earthquake-recording instruments shown have been of practical value in connection with railway work and the balancing of engines. The Royal Geographical Society sends facsimiles of the maps of celebrated explorers and one or two relics. Oceanography occupies itself with submarine cables, and in this division is shown a number of photomicrographs of minute forms of marine life, such as were found at very great depths.

CONCERNING DIMENSIONS GENERALLY, AND THE EFFECTS OF THE FOURTH DIMENSION IN PARTICULAR.

By A. L. ANNISON.

THE word dimension is the general term used to indicate extension in space, whilst space itself is nothing more than the abstract idea of infinite extension in all known directions.

There are said to be three dimensions, namely, those of length, breadth and thickness, and all our conceptions of shape and size are formed relatively to one or more of these three, which seem quite adequate for the expression of our ideas. The existence of others must, therefore, seem extremely problematical, and if at times a guess is hazarded as to the fourth dimension, its nature is assumed to be quite different from that of the other three; so much so, indeed, that in some instances it is held to consist of time itself.

Now it is one purpose of this article to show that from certain facts which we shall proceed to examine, the existence of an infinite number of dimensions may justifiably be deduced. It will be shown that these dimensions are of the same nature as the three with which we are familiar, and that our ignorance of their existence is due to some personal limitation whereby we are unable to form any mental image of the shape and size of a body, beyond that small portion of it which is bounded by a surface extending only in the first three dimensions, the others, therefore, seeming to be nothing more than purely abstract ideas derived from mathematical expressions.

Notwithstanding this, however, we shall also be able to show that some of the effects of the fourth dimension are of such a nature as to be appreciable in spite of our limitations; and the latter part of this article relates to the nature of these effects and under what conditions they can be produced.

The basis of our 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; $x^2+y^2+z^2+u^2+v^2=r^2$, of a five-dimensioned one, and generally x^2+y^2+ – – (η terms in all) $=r^2$ of an η dimensioned one, where η may be any number between 2 and ∞.

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.

Now the pictures that we can conceive consist of nothing more than the figures formed by enclosing a portion of space, either by a line or lines (plane figures) or by a surface or surfaces (solid figures); the line and the surface are the materials with which we construct these figures. We cannot, however, construct a four-dimensioned figure of any kind, although we have the necessary material, namely, what for want of a better name must be designated the volume.

The inability of our imagination in this respect must be due to some limitation in our powers of perception, for it is from the impressions of external objects, as seen by the eyes, that we form our mental images of figures, regular or irregular.

Now it will be shown that our eyes cannot appreciate any figure with more than three dimensions. It might be argued from this, that it does not follow that there are such figures to be seen, but from an examination which we shall make of the undoubted fact that all visible bodies by which we are surrounded are at least three-dimensioned, the existence of these more complex figures can be inferred.

By the term "body" employed above, is meant something that has an independent existence and is, therefore, an object as distinguished from an attribute.

All bodies, as we shall see, are defined by their apparent size and shape and are, therefore, figures of some kind, regular or irregular; but on the other hand all figures are not bodies, for every two-dimensioned figure is only found as a bounding surface of a three-dimensioned one, and by itself is quite as abstract as colour, taste, and all other attributes.

So far as we know, however, the three-dimensioned bodies appear to be self-contained and independent of any higher dimensioned body; they do not seem to exist merely as the sections of four-dimensioned figures.

It will be shown that this can be accounted for by the limitation of our powers of observation, and

..at there is no cause why four and other dimensioned figures should not exist: from this it follows that the only figures which are not the sections of higher dimensioned ones must be those possessing an infinite number of dimensions: in other words, these last mentioned figures are the only ones that can have an individual existence.

The first point for us to determine is the possession by every visible body of at least three dimensions: we shall then proceed to show that they must be inferred to possess an infinite number of such dimensions: and finally to examine the effects produced by certain four-dimensioned figures, firstly when moving in the direction of the axis of the fourth dimension and secondly when expanding and contracting in the three-dimensions with which we are familiar.

Now all visible bodies must necessarily have dimension of some kind.

The impressions of things external to our mind are received and transmitted to it by means of the senses and their organs: and we must consequently remain utterly ignorant of anything that does not appeal to at least one of our senses.

We find that all sense impressions conveyed to us have their origin in objects that possess extension in space. Colour, scent, light, sound, taste, heat and cold, all are invariably found to proceed from such a body: and conversely there is no visible body that has not extension in space, a possession which is indeed its primary attribute, all others such as colour, taste, and so forth being of secondary importance.

When we proceed to consider those things that have dimension, we find that some only of them have an independent existence and therefore comply with our definition of a body. Others, which are figures only, and nothing more, do not exist apart but are only attributes of a body. Thus we find that a solid such as a cube is an actual object, but a surface such as the square merely forms part of the solid: we do not find one existing alone, absolutely dispossessed of thickness.

The straight line is nothing more than part of the boundary of a plane figure: and so far is it from possessing an independent objective existence that it is even unimaginable; for geometrical purposes we have to allow it some degree of thickness, although we thereby convert it into a plane surface.

The solid, then, is a body, because in addition to its length and breadth it possesses thickness: whilst lines, having merely one dimension, can only serve for the construction of a plane figure, and the plane figure by itself, having only two dimensions, is no more an object than the line: it is an abstraction that serves as an attribute of a three-dimensioned body.

Now all visible bodies are found to have three dimensions: there is no body, either artificial or natural, that has not length, breadth and thickness. Our next step is to enquire why this is so. On the one hand it may be because there are no one or two dimensioned bodies: and, on the other, because we ourselves, on account of some inherent limitations in our power of sight, are unable to perceive them. This last hypothesis, however, is obviously untrue, for not only do we see that part of a body which possesses only length and breadth, that is to say its surface, but that is all we can see.

It is, therefore, obvious that we could detect the presence of any plane surface, such as a square, if such a figure ever had an independent existence.

Let us imagine a square of this nature to come within the sphere of our observation. What characteristic impression would it produce on us?

Well, suppose that we first of all observed it when looking in a direction at right angles to the plane in which it lies: it would then appear as a square. Now let us move as though we were about to pass by its upstanding edge on one side, in order to attain a position at its rear. With our eyes directed on it the square would apparently diminish in width, but not in height, becoming narrower and narrower, until nothing but a small strip remained: and even this would finally disappear when one reached the edge of the figure: the square would be completely invisible, since it has no thickness. Then, as we passed beyond its edge and towards the rear, the surface would reappear, and increase in apparent width, until it regained its full size and shape.

Now such a phenomenon as this has never been seen, and it therefore follows that there are no bodies with only two dimensions: and further that there cannot be any with simply one, for if there were, a two-dimensioned body could be constructed therefrom.

In the course of the foregoing arguments it was remarked that we could only perceive the surface of a body: and that, therefore, if we looked at a plane surface, we only observed its length and breadth, the thickness remaining unperceived and undetermined. Our next point of inquiry will endeavour to explain why we only see the plane, and how it is that we can ascertain the existence of the third dimension.

The eye is, of course, the organ of sight: it comprises a lens and a screen called the retina. This screen consists of a surface, and is analogous to the sheet on which magic lantern pictures are displayed, the eye lens being equivalent to the compound lens of the lantern.

Now, it is impossible to produce anything but a flat picture on the lantern sheet: the image of a globe, for instance, cannot be projected so as to possess length, breadth, and thickness: the length and breadth can be displayed, because the screen itself is a plane surface, but the thickness can only be simulated by a skilful distribution of light and shade.

Similarly the image impressed on the retina is essentially two-dimensioned: and for this reason we are frequently led to mistake a round body for a flat one; the moon, for instance, always appears to be flat.

The image produced by the eye being invariably a plane figure, we should be unable to determine whether a body were two or three dimensioned if neither we nor the body surveyed could move relatively to one another.

As it is we are enabled to survey a sphere, a cube, a tree, a house, or any other object from innumerable points of view within our three-dimensioned space and thus to inspect its surface or surfaces and satisfy ourselves that it is indeed a solid; our opinion is formed from the multitudinous images impressed on the retina of the eye as we move about from point to point or avail ourselves of the motion of the body which serves to display its various parts before ourselves, the observers.

Now just as we mistake solid figures for plane ones, so in a like manner when we survey a four, five or infinitely dimensioned figure we should imagine it to be three-dimensioned: for it would completely satisfy the investigations we could make, by looking at it from all possible points of view within our three-dimensioned space: of course, its shape as regards the fourth and higher dimensions would remain inscrutable to us, so that we could not possibly foretell their existence or non-existence: but they might be there all the same, for we could prove nothing to the contrary.

Now proceeding briefly to summarise the conclusions attained we may state that:—

(1) Algebraical equations of one, two and three variables can be graphically represented: and certain of these equations with two or three variables are the laws of certain plane and solid figures. In particular $x^2+y^2=r^2$ represents a circle and $x^2+y^2+z^2=r^2$ represents a sphere. If in the last-mentioned equation we put $z=o$, we obtain the first equation which can be shown graphically to represent a section of the sphere.

There are an infinite number of equations in this series, and if we take the next higher one $x^2+y^2+z^2+u^2=r^2$ and put $u=o$, we obtain the equation of the sphere: in other words the sphere is a section of this four-dimensioned figure: we do not, however, mean to imply that it cannot also be the section of other four-dimensioned figures, since obviously it can be, precisely in the same way that a circle might be the section of a cylinder, cone, or other solid.

The four-dimensioned figure is the section of a five-dimensioned one, and this progression is continued to infinity, the infinitely dimensioned figure being the only one that is not a section of a higher dimensioned figure. In spite, however, of the necessary existence of these complex figures we are not acquainted with any of them from the four-dimensioned one upwards.

(2) All our ideas of figures cannot be more than three-dimensioned because of the limitations in our powers of observation.

(3) There are no one or two-dimensioned bodies; all bodies appear to be three-dimensioned, and two-dimensioned figures are only found in reality as sections of these bodies. This is in accordance with the algebraical equations from which it can be deduced that the straight line is the section of a circle or other two-dimensioned figure, and the latter a section of a three-dimensioned figure such as the sphere.

(4) That the sphere is apparently not a section of a four-dimensioned figure, but appears to belong to that highest type of figure which extends in all possible dimensions (supposed to be three in number), is a fact that is not in accordance with what we should expect from the algebraical equations; but it can be brought into agreement therewith by allowing for our undoubted inability to appreciate more than three dimensions, together with the certainty that any four or higher dimensioned figures would appear three-dimensioned to ourselves.

(5) Paragraphs 3 and 4 explain why all visible bodies appear to possess three dimensions and neither more nor less, and since there are no one or two dimensioned bodies, there is no justifiable reason why there should be any three, four, or finitely dimensioned ones; on the other hand, all bodies must be infinitely dimensioned, although we, by reason of our personal limitations cannot perceive more than three of these dimensions.

(6) Obviously space itself, the ether and other bodies, must also be infinitely dimensioned.

Now from any body such as one whose algebraical equation is $x^2+y^2+\ldots$ (∞ terms in all) $=r^2$, we can take a section, obtaining thus a figure whose equation is $x^2+y^2+\ldots$ ($\infty-1$ terms in all) $=r^2$, and then a section of this, and so on until we obtain the four-dimensioned figure $x^2+y^2+z^2+u^2=r^2$, the sphere $x^2+y^2+z^2=r^2$ and the circle $x^2+y^2=r^2$. Conversely, starting with the circle, we can say it is the section of a sphere, a cone, a cylinder, or some other solid figure; and similarly the sphere is the section of a four-dimensioned figure which may belong to the spherical type, the conical type, the cylindrical type, or some other.

Our purpose now is to take the sphere, cone, and cylinder and show how they would appear if we were only two-dimensioned, and how we could distinguish one from the other; and then, arguing by analogy to show how the four-dimensioned figures of the spherical, conical, and cylindrical types would similarly appear to us with our three-dimensioned faculties, and how the effects produced by them would be characteristic and distinguishable from one another.

The simplest way to proceed is to hypothecate the existence of a two-dimensioned being, one who can only perceive length and breadth and is absolutely ignorant of the existence of thickness; his observations must be confined to what takes place on a plane surface which, consisting of infinite length and breadth, will be to him what space is to us.

The only figures of whose existence he can possibly be aware must be two-dimensioned ones, and these only if they lie in his plane of observation. Such figures would be presented when a solid was intersected by the plane surface. Now we can imagine a solid to move downwards towards the surface from above and to pass completely through it. Before and after the passage of the solid, no part of it would be seen by the being, but during the event, he would observe a series of sections, each consisting of a plane figure.

Now these sections, of course, would be definitely correlated to one another, since one and all belong to the same body, and from their change or constancy in size and shape, it would be possible for the being to determine the nature of the solid figure. Thus from the fact that he saw a circle of unvarying diameter, he could hypothecate the existence of a cylinder; and similarly, if the circle were one that appeared to increase or decrease in diameter, it could be ascribed to the existence of a right circular cone, sphere, or some other solid figure whose cross section was a circle.

Furthermore, the particular kind of solid could be deduced, for they would each produce a different and characteristic change in the size of the circle. A sphere, for instance, would produce a circle at first no larger than a point, but which would increase gradually until it became a great circle of the sphere and then decrease again to a point. A right circular cone, assuming it to approach apex first, and parallel with the axis of the third dimension, would also first produce a circle no larger than a point; this would also gradually grow, but it would not subsequently decrease like that produced by the sphere. Furthermore, provided that both cone and sphere moved downwards with uniform velocity, there would also be this difference—that any point on the circular section of the cone would move radially outwards with a uniform velocity, whilst any point on the similar section of the sphere would move outwards with variable velocity; and its acceleration would be just as characteristic of the sphere as the uniform velocity was of the cone. Any other figure would produce a characteristic acceleration.

Now just as the sphere and cone moving downwards along the axis of the third dimension presented the phenomenon of a plane figure (the circle) growing equally in the two dimensions of the plane, so would the spherical figure of the fourth dimension (equation $x^2+y^2+z^2+u^2=r^2$), and the cone-like figure of the same degree, each moving downwards along the axis of the fourth dimension with a uniform velocity, present to us the phenomenon of a solid figure (the sphere) growing equally in the three dimensions of space; in the first instance with characteristic acceleration, and in the second with uniform velocity; and just as it is possible to account for any imaginable change in the size and shape of a plane figure by the hypothesis that it forms part of a solid figure moving downwards along the axis of the third dimension, so similarly is it possible to explain any increase or decrease in the length, breadth and thickness of a solid figure by the hypothesis that it forms part of a four-dimensioned figure moving downwards along the axis of the fourth dimension.

It is likewise possible to explain the propagation of ether and other vibrations, originating from a point, in the same way; for we know that such vibrations, starting from the point, advance at a uniform rate in all directions, so that the wave front of each vibration consists of a sphere constantly growing outwards at a uniform velocity, the precise phenomena that would be produced by a downward movement along the fourth dimension of some four-dimensioned cone-like figure.

There is this objection, however, to such a theory, that if ether is infinitely dimensioned, there is no reason why the vibrations should not extend equally in all of them, so that the shape of each wave front would be represented by the formula $x^2+y^2+\ldots$ (∞ terms in all)$=r^2$, and it is impossible to presuppose this figure to be the section of any other figure or for it to be caused by motion along a dimension not included in the equation, for all the dimensions are included therein.

There is, however, another point of view from which to regard the propagation of these vibrations.

It is known that before the discharge of an electric spark, the ether in the neighbourhood is in a state of tension; it might be regarded as being attracted towards the point where the electrical charge is collected.

Now suppose for the moment that we regard the ether as only three-dimensioned, and ourselves to be only capable of appreciating two dimensions; and let the charged point lie in the plane of our observation. The ether will be attracted to the point from all directions, and we may imagine the space about the point divided up into an infinite number of contiguous cones of ether, all with their apices at the charged point; in the normal state of affairs, with no electrical charge in the neighbourhood, these cones would become cylindrical tubes, and the conical shape is therefore always an unstable one, tending to revert to the cylindrical form as soon as the point is discharged. It is obvious that in undergoing this change of form on the discharge taking place, all we should appreciate would be an ether disturbance travelling outwards from the point in the form of an ever-increasing circle; for we could only observe the lateral expansion of the cone whose axis was perpendicular to our plane of observation; all the other cones in their expansion would immediately extend above or below our plane, and thus become unobservable.

Now similarly, since we observe an electrical disturbance to travel outwards in an ever-growing sphere, we may imagine the ether in the neighbourhood of the charged point to be composed of a series of four-dimensioned, cone-like figures; or assuming that the disturbance travels outwards in as many dimensions as possible, to be composed of infinitely dimensioned cone-like figures, each of which has for cross section a figure whose equation is $x^2+y^2+\ldots$ ($\infty-1$ terms in all)$=r^2$.

AN INEXPENSIVE APPARATUS FOR THE SYSTEMATIC SEPARATION OF SEDIMENTS BY MEANS OF HEAVY SOLUTIONS.

By CHARLES R. MAPP, F.R.M.S.

HEAVY solutions, such as those of Klein, Sonstadt, Rohrbach, or Braun, offer a ready and fairly satisfactory means of separating sediments, sands, and comminuted rocks into groups varying in specific gravity, and thus materially assist the laboratory examination of such material for the identification and estimation of the component minerals either qualitatively or quantitatively. In using them, however, numerous small difficulties present themselves, and the process becomes both lengthy and tedious unless carried out in definite steps, which, by repeated use, become quite mechanical.

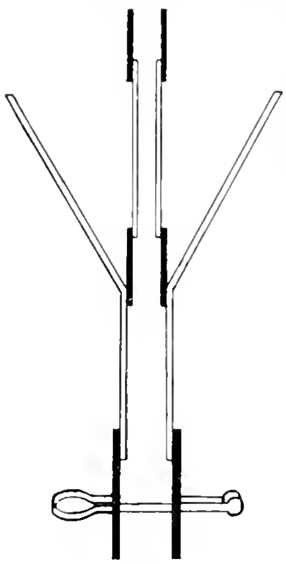


FIGURE 1.

Having recently had occasion to so examine numerous specimens of Liassic and Keuper rocks, a simple piece of apparatus which could be made easily and at small cost became desirable. Unforeseen defects occurred frequently, which rendered modifications necessary, but the apparatus described below will be found to work satisfactorily for ordinary purposes. It is a modified form of one described by Dr. J. W. Evans (see *Geol. Mag.* 1891, page 67).

It can be made readily with a glass funnel, a spring clip, a thistle funnel, and glass and rubber tubing. Figure 1 represents a section of the complete apparatus. The funnel is cut off about half an inch below the shoulder, and to the cut end is attached a piece of rubber tubing about one inch long. A spring clip like those employed with burettes, either of Mohr's or Hofmann's pattern, is fixed on this indiarubber tubing. The remaining portion consists of a piece of glass tubing, having the same, or nearly the same, bore as the stem of the funnel, with a short length of rubber tubing at each end. The construction is better seen in Figures 2 and 3. The lower end is provided with indiarubber tubing of such a size that it forms a fairly tight fit when pressed down into the funnel stem, while it is of smaller bore than the glass tubing. Since it has to be stretched to fit on to the glass tube, the portion which projects over the glass, and which should be about half an inch long will form a truncated cone, which will securely close the entrance to the stem of the funnel when pressed down with a rotating motion. At the upper extremity there are two separate pieces of glass, which are used at different stages in the manipulation. In the diagram (Figure 2), X is a piece of glass rod, or of glass tubing closed at each end, which can readily be inserted into the short length of rubber tubing to render that end air-tight. In Figure 3, Y is the head of a thistle funnel, which can be similarly inserted.

Now as to the method employed in fractionating the sediments. The funnel can be fixed on the ring of a retort stand or other convenient support. The heavy solution of the particular specific gravity to be used is now poured in carefully, to within a reasonable distance of the top of the funnel. It will be found to be a good plan to place the bottle under the funnel, and after cautiously opening the clip slightly, to let a small quantity of the liquid flow out, both to remove any air bubbles and to ensure that the whole surface of the rubber tubing is wetted.

The sediment or grains of matter to be separated, which should previously have been washed and dried, or treated in any way chemically, are now poured on to the surface of the liquid. The stopper with the part X in the upper end, may next be used to stir the sediment thoroughly into the liquid. The object in having the upper end closed by X is to keep the stopper full of air, and so prevent any of the liquid entering it by capillary attraction, in which case grains are invariably taken up by the liquid, interfering with the success of the separation at a later stage. The stopper is now laid aside, and the liquid is allowed to settle for several hours. If the heavy liquid used is hygroscopic, the

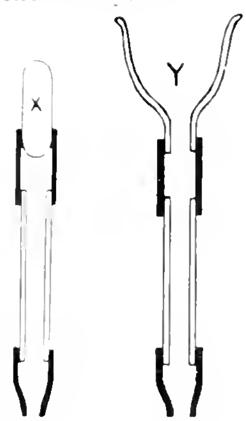


FIGURE 2. FIGURE 3.

funnel should be covered by a piece of clean paper. The heavy mineral grains should now collect in the portion between the clip and the neck of the funnel. When no further movement can be detected the stopper is plunged below the surface of the liquid, and moved carefully to and fro several times, to rid it of any grains which have been carried down on its lower extremity, and then inserted in the neck of the funnel with a rotary motion which fixes it firmly in the neck. The plug X is removed and the thistle funnel head Y inserted in its place. A second funnel with a folded filter paper in it is placed in the neck of the solution bottle which is placed beneath the apparatus.

The clip is next opened quickly, and the liquid from the portion below the stopper flows out carrying with it the heavy grains. More fresh liquid is now poured into the thistle funnel which flows down and washes any adhering grains out. The clip is then closed again. The filtered liquid flows back into the bottle and can be used again, while the grains are retained on the filter paper (funnel A) Figure 4.

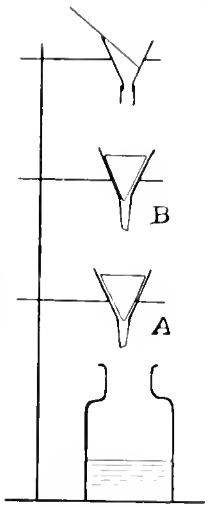


Figure 4.

The stopper is now removed, and put aside to be washed. A third funnel with filter paper is also placed in the neck of the bottle which is again placed below the apparatus. The clip is opened again and all the liquid flows out carrying with it the lighter portion of the grains. An additional amount of liquid poured in the separating funnel will also flow out and carry with it any remaining grains which have adhered to the funnel or tubes. The liquid will filter into the bottle, while the grains will be retained on this second paper (funnel B). All that now remains to be done, preparatory to mounting for examination, is to wash the grains thoroughly. The liquids used being fairly expensive, it is also desirable to perform this washing economically. The following suggestions are offered with a view to collecting the washings from the various funnels, papers, and grains, for concentration. If all the washings are so retained in a stock bottle and periodically treated suitably, great saving is effected, since the resulting concentrated solution may be used for fresh separations.

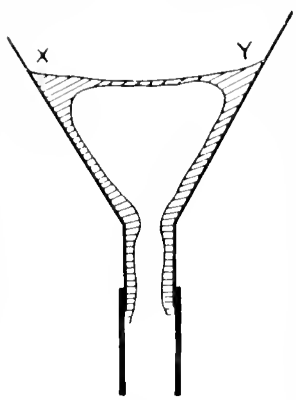


Figure 5.

There will thus be three funnels to be washed:—(1) the separating funnel; (2) funnel A with the heavy grains; (3) funnel B with the lighter grains.

It is suggested that a retort stand with three narrow rings, or any stand with three supports capable of holding the three funnels in such a position that they are vertically over each other, be used. Figure 4 gives a diagrammatical representation of the arrangement.

In the top ring is the separating funnel, with the spring clip removed and the stopper resting in it. In the middle ring is funnel B which has the filter paper holding the lighter grains. The lowest ring supports funnel A which has the heavy grains on the filter paper. It is advocated that these funnels be arranged in this order for the following reason. Any grains, which will belong to the lighter portion of the separation, which have not been washed down from the separating funnel, will fall down to funnel B with the washing water, and so join the proper set of grains. If funnel A were placed in the middle there would be a danger of these grains getting into the wrong set.

A fine spray of distilled water is directed on to the surface of the top funnel from a wash bottle, and this water, after cleaning that funnel, passes down through B and A, finally entering the stock bottle of washings placed underneath. Five or six such washings should suffice to clean the grains and apparatus.

The filter papers bearing the grains may next be dried in a steam oven, or in any dry place free from dust.

The chief defect in this apparatus, which is common to all similar ones, is that the separation is not entirely reliable, owing to surface tension and similar small attractions which are inevitably present in the liquid. Figure 5 shows the chief regions where these operate. In the shaded portions the grains are under slight attractions, due to the above-mentioned causes; consequently heavy grains which get into these marginal parts, may not sink properly.

At X and Y particularly, there is a tendency for the grains to climb up the sides of the funnel, above the mean level of the liquid, where the meniscus touches the sloping glass sides. Great care and perseverance are necessary to overcome this and other inevitable difficulties.

By keeping three sets of this apparatus in use on one stand for liquids of different densities, the grains may be sorted into four sets.

Using liquids of Specific Gravity, 2·7, 2·9, and 3·1, the following sets may be obtained:—

(1) Specific Gravity less than 2·7.

(2) Specific Gravity between 2·7 and 2·9.

(3) Specific Gravity between 2·9 and 3·1.

(4) Specific Gravity greater than 3·1.

By increasing the number of liquids, the grains may further be differentiated into more restricted sets.

THE VINEGAR INDUSTRY.

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

NOTWITHSTANDING the fact that the manufacture of vinegar is one of the oldest industries in this country, and that in London alone there is an output of several million gallons a year, it is surprising how little is known by the outside world of the way in which it is made.

This is largely the result of the policy of secrecy with which each firm of vinegar-makers jealously guarded its methods during the last century: although, as they were working upon practically identical lines, they had little to conceal from one another.

To such a pitch was this craze for secrecy carried that some of the firms made use of thermometers with marks upon them instead of a scale, while others went even further, and deceived their workmen by the use of thermometers in which the scales were of set purpose graduated incorrectly.

In all the British factories, which in the year 1840 numbered forty-eight, the methods of working had been handed down within the works themselves, and few attempts were made to reduce to a minimum the chemical and mechanical losses inevitable during the manufacture.

During the last quarter of a century, however, there has been a great improvement in this direction, and many of the factories now have up-to-date apparatus and are under scientific direction, though numerous examples of the primitive works, universal fifty years ago, still survive.

There has been little alteration in the general principles of manufacture in any of the works, the process still following the three stages of preparing a saccharine infusion of a cereal, of fermenting the sugar in this into alcohol, and of transforming the alcohol into acetic acid by the action of bacteria.

Although wine vinegar is made to a small extent in this country, the product chiefly sold is derived from malt, or from a mixture of malt with grain or sugar, and would therefore be more correctly described by the now obsolete term *alegar*.

The first stage of its manufacture is very similar to the *mashing* process in a brewery. The malt, or mixture of malt and grain, is first crushed between rollers and heated in a mash-tun with water at a gradually increasing temperature, until, after two to three hours, the whole of the starch of the grain has been converted into sugar by the enzyme, diastase, present in the germ of the malt.

FIGURE 1.
B. Kützingianum.
(Hansen).

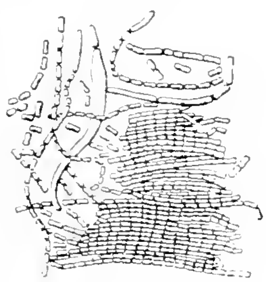


FIGURE 2.
B. aceti.
(Hansen.)

FIGURE 3.
B. pastorianum.
(Hansen).

Species of Acetic Bacteria multiplied by 1000.

When this conversion is complete the *wort*, as the infusion is now termed, is drawn off, and, without being boiled with hops, as in the case of beer, is transferred to a fermenting tun, and treated with a suitable yeast.

In some vinegar works the wort is obtained by means of the *conversion process*, instead of by mashing. In this process the grain, usually rice or maize, without malt, is treated with dilute mineral acid, such as sulphuric acid, in a closed vessel termed the *converter*. Under suitable conditions the acid hydrolyses the starch in a manner analogous to that of the diastase of malt, and produces a saccharine solution, which, after neutralisation of the residual acid with calcium carbonate and separation of the resulting insoluble calcium sulphate, is ready for fermentation.

By whichever method obtained, the wort is now *pitched* with yeast, and is aërated and kept at the best temperature to convert as much as possible of the sugar into alcohol. Upon the successful working of this stage of the process largely depends the subsequent strength of the vinegar, since all saccharine matter (including dextrins) which has escaped the action of the yeast, will also remain unaffected by the acetic bacteria. The fermented wort (now termed *gyle*), which usually contains about six or seven per cent. of alcohol, is now ready for the third stage—the conversion of this alcohol into acetic acid. This is brought about by the action of specific bacteria, termed acetic bacteria, which convey oxygen from the air to the alcohol, and transform it into acetic acid. The reaction that takes place in the process is usually represented by the formula—

$$\underset{\text{Alcohol}}{C_2H_6O} + \underset{\text{Oxygen}}{O_2} = \underset{\text{Acetic Acid}}{C_2H_4O_2} + \underset{\text{Water}}{H_2O}$$

though, in practice, many other compounds are formed, in addition to aldehyde, which is probably invariably produced as an intermediate stage in the oxidation—

$$\underset{\text{Alcohol}}{C_2H_6O} + \underset{\text{Oxygen}}{O} = \underset{\text{Aldehyde}}{C_2H_4O} + \underset{\text{Water}}{H_2O}$$

The exact part played by the bacteria in this process is still obscure, and it has not yet been ascertained whether the bacteria consume the alcohol and excrete it as aldehyde and acetic acid, or whether they contain an enzyme, the function of which is to act, as platinum black can do (possibly by setting up suitable vibrations in the alcohol), as a carrier between the oxygen and the alcohol.

Figure 4.
Vinegar Fields in the year 1800. Drawing off the Vinegar.

The isolation of the enzyme, *zymase*, from yeast, and the proof that even in the form of a dry powder it could ferment sugar into alcohol, led to repeated efforts to isolate an analogous oxidising enzyme from acetic bacteria; but, as yet, all such attempts to express from the ruptured cells a liquid which after filtration should produce the effect of the living bacteria, have ended in failure. Several species of acetic bacteria have been isolated, differing from one another in their form, in the temperatures at which they work best, and in the nature of the products that they yield. Of these the best known are the three species first studied in 1894 by Hansen and shown in the accompanying illustrations. (See Figures 1, 2 and 3.)

All are characterised by the different involution forms which they assume when cultivated upon a suitable medium, under different conditions. In each case when grown upon the surface of a nutrient liquid, such as wort, at a temperature of about 34° C. (93° F.), they form pellicles upon the surface, but the skin thus produced differs in appearance, that of *B. aceti* being moist, smooth, and slimy, while that of *B. pastorianum* is dry, and has a corrugated surface.

In the case of *B. Kützingianum* the cells are, as a rule, isolated, and the formation of chains rarely occurs, whereas the occurrence of separate cells is the exception in the case of the other two species. The cells of *B. aceti* are narrower than those of the others, and not infrequently show a form resembling a figure-of-eight, as was first noticed by Pasteur.

The pellicle or skin formed by all these bacteria is what is termed a zoögloeal form, and consists of the cells united together into a mass by the swelling and fusion together of the outside cellular membranes.

Popularly it is known as *mother-of-vinegar*, and its excessive development in the worts is an indication that insufficient air is being supplied to the bacteria.

The apparatus in which originally this acetic fermentation was effected consisted of nothing more than barrels filled with wood shavings, through which the wort, after being mixed with a little finished vinegar containing the acetic bacteria, was allowed to trickle. Hundreds of these casks were ranged above pipes communicating with the gyle store vats, and were filled by means of a flexible hose connected with the pipe. Each day the bungs were uncovered, if the weather was fine, in order to admit a fresh supply of air to the interior of the cask, this process being continued for many weeks until the acetification was complete.

The accompanying illustration (see Figure 4) represents a portion of the largest of these vinegar fields (those of Messrs. Beaufoy & Co.) at the beginning of the nineteenth century.

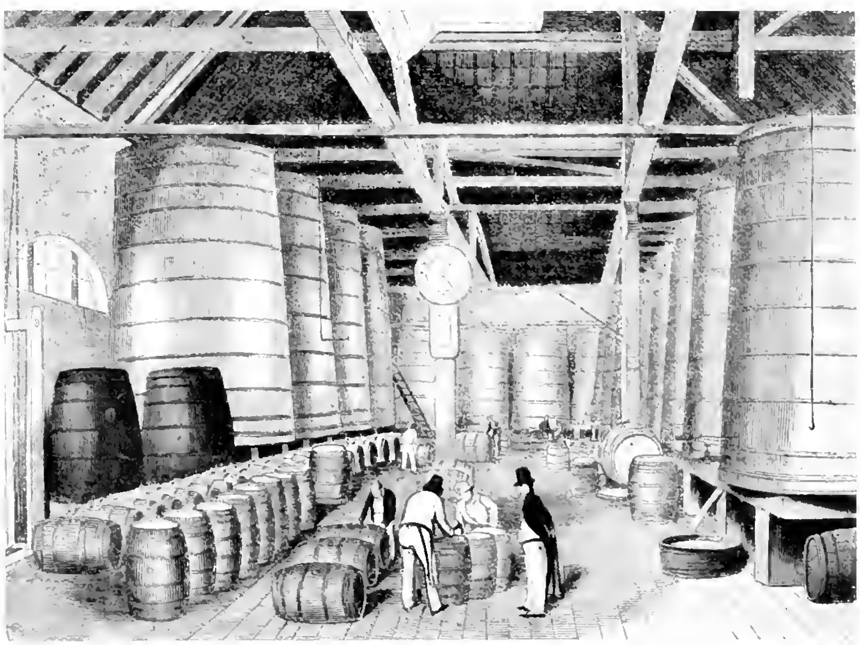


Figure 5.
A "Sending-out" Warehouse. Beaufoy's Vinegar Warehouse in the year 1800.

As these fields necessarily covered a very large area they were obviously little suited for places where land was valuable. Apart from that, *fielding*, as it was termed, was a very slow process of acetification, and involved heavy wastage.

Hence, when, in 1823, Schützenbach devised a more rapid method of acetification, his apparatus was speedily adopted in Europe, and more slowly in this country.

The acetifiers employed in what was then termed the *quick* process consisted of large vats holding from two thousand to three thousand gallons each. About two-thirds of the way down they were provided with a perforated false bottom, and the whole of the space above was filled with beech shavings, while holes for the admission of air were made in the side of the vat, just above the false bottom, and smaller holes for its escape in the top.

The gyle was constantly pumped over from the bottom of the vat to the top, and trickling down through the shavings met with a current of air, which was drawn into the vat, under the influence of the heat promoted by the reaction. About three weeks were required for the complete conversion of the alcohol into acetic acid.

The acetifying apparatus used at the present day, is essentially the same as that of Schützenbach, the chief differences being in the nature of the packing material placed in the vat, and in the method of distributing the gyle over the surface at the top, so as to insure its reaching all parts of the aërating medium.

In most acetifiers a sparger is used for sprinkling the liquid over the material, and basket work is commonly employed in place of wood shavings. The principle of the sparger is shown in Figure 6, which represents a section of the upper portion of an acetifier.

The liquid is pumped from the bottom of the vat and discharged into the funnel at the top, this funnel being boxed in to prevent loss by evaporation. Thence it flows down through the tube G, into the sparger R, which revolves smoothly upon a pivot S. In the arms of the sparger are a number of small holes through which the liquid passes, and thus causes the sparger to revolve steadily and to sprinkle uniformly the whole of the surface of the basket work, which is also shown in the figure.

A thermometer inserted through a hole in the side of the acetifier shows the temperature within the apparatus, and affords an indication whether the acetification is following a normal course.

No more striking illustration of the manner in which scientific text-books will copy errors from one another can be found than in the assertions that are put forward as to the temperatures at which acetic bacteria thrive the best.

This is commonly given as about 90° to 95° F., and according to Brannt, "the formation of vinegar ceases entirely at 104° F." Yet the writer has frequently seen the thermometers record a temperature of 110° F., and there is no doubt that in this country, at all events, the bacteria are most active at a temperature of about 105° F. Possibly, this may be the result of adaptation to the surrounding conditions, since in Continental vinegar works the temperature of the acetifiers seldom exceeds 95° F.

The conditions for successful working are, firstly a regular and uniform supply of air, and secondly the right temperature. If too much air is admitted the bacteria will oxidise part of the acetic acid they have produced and a weak vinegar will result. If too little air is available the acetification proceeds very slowly, the bacteria form themselves into the zoögloeal condition mentioned above, and the acetifier becomes clogged with slimy masses which still further stop the passage of the air, so that it forms currents in one portion instead of effecting uniform aëration.

However carefully the process may be carried out, the reaction never proceeds quantitatively in practice, and the loss of acidity, due to evaporation of the alcohol and irregular aëration resulting in the destruction of acetic acid, usually ranges from ten to twenty per cent., and may, in very faulty apparatus, reach as much as thirty per cent.

Most of the modern patents have had for their object the remedying of these defects. Thus, in some types of acetifiers, the air issuing from the apparatus is carried back again into the vat, the idea being, that the volatile constituents of the vinegar will thus be prevented from escaping.

In others, attempts have been made to accelerate the speed of oxidation, and thus reduce the period of loss, by the introduction of ozonised air, but these do not appear to have met with much success.

The key to the problem appears to be the provision of a sufficiently large aërating medium through which the air can circulate with absolute uniformity, and experiments on a large scale, made by the present writer, have shown that so long as these conditions can be maintained, the conversion of alcohol into acetic acid proceeds almost in accordance with the theoretical requirement.

After the vinegar leaves the acetifiers it is stored for some time to form the ethers to which it owes its aroma, and is then clarified by filtration through large vats containing a suitable filtering medium, such as fine sand. Finally it is diluted to the required strengths, and is sent out to the trade.

From the days of Charles II. to the reign of William IV. vinegar was under the control of the Excise, and paid duty in accordance with its acetic strength, which was determined by the Excise Officers by means of a special hydrometer, the vinegar being first neutralised by the addition of pure calcium carbonate. Not until the year 1836 did vinegar cease to be tested by the Excise Officials.

As it leaves the filtering vats, vinegar has an acetic strength of 6 per cent., and upwards, and is termed "24 Vinegar." Originally this name indicated that one fluid ounce required 24 grains of sodium carbonate to neutralise its acidity, but in the trade the name is now applied to vinegars containing 5·5 per cent. of acetic acid and upwards. In like manner, the lower strengths of vinegar are known as "16," "18," "20," and "22," the lowest of these containing 4·1 per cent. of acid.

There is no legal standard as to the permissible lution of vinegar, and a cheap vinegar containing ·5 per cent. of acetic acid is often sold under the name of "Diamond." A recommendation was recently made, however, in a report to the Local Government Board that vinegar containing less than 4 per cent. of acetic acid should not be sold, and there is a general tendency on the part of vinegar manufacturers to accept this standard, which has been upheld in undefended cases in the police courts.

With regard to what should be the composition of the other constituents in vinegar, there is no agreement either among manufacturers themselves or among scientific authorities. Should malt vinegar be brewed entirely from malted barley, or is any sort of malted grain permissible? According to the old Pharmacopoeia malt vinegar was to be brewed from a mixture of malted and unmalted grain, and if this is accepted, rice must be regarded as quite as admissible as barley. Again, maize is largely used by vinegar makers, but the opinions of authorities differ upon the point whether glucose derived from maize is permissible.

FIGURE 6.

Section of Upper Part of a Modern Acetifier.

All these variations in the materials used affect the final composition of the solid matter in the vinegar, and prevent the analyst from drawing deductions as to the origin of the product.

Thus a vinegar made entirely from malt will contain a considerable proportion of phosphates and nitrogenous substances, whereas in a rice vinegar the amounts of these constituents will be very much less, and, in the absence of special knowledge to the contrary, such a vinegar might very well be certified as containing added acetic acid.

The so-called "wood vinegar," which consists of acetic acid obtained by the destructive distillation of wood and coloured with caramel, is a perfectly wholesome article, and no objection need be taken to its sale under its own name. The legitimate vinegar maker has, however, to meet the competition of the "vinegar faker," who with the aid of no other plant than a barrel of acetic acid and a keg of caramel, is able to put upon the market a product which he sells at a cheap price under such titles as "Double refined malt vinegar." The occasional prosecution of the retailers of these concoctions does little to check the evil, for the "manufacturer" promptly leaves his "works," usually a back yard, and cannot be found. It is not long, however, before he re-appears under another name, and continues to meet the popular demand for "pure malt vinegar" at a price at which it could not possibly be made.

NOTICES.

A NEW PHONOGRAPH.—M. Litschitz, a young Russian scientific man now working in Paris, has invented a phonograph which uses photography for recording the vibrations of human voice.

He began his experiments in Russia but has continued them in M. Dastre's laboratory at the Sorbonne, and there a demonstration has been given before a small gathering of the friends of science with a rough model constructed by the inventor and M. Victor Henry.

The sonorous vibrations of the voice striking a membrane are thrown in the form of luminous images by a small mirror upon a sensitive photographic film travelling at a high speed as a band, and describe a curve upon it. Where the light acts on it, the film is rendered hard and insoluble. The other parts remain soft, and may be washed away.

For reproducing the voice the band passes before a "fente" behind which is a chest of compressed air. As the hollows of the curve move rapidly before the "fente" the air as it escapes reproduces the vibrations which caused them—in other words it reproduces the vibrations of the human voice.

The word "curve" is used here in its scientific sense. There are, in fact, "makes" and "breaks." Theoretically, the membrane which actuates the mirror may be dispensed with.

M. Dastre is convinced that the new phonograph when properly constructed, will give results far above those yielded by mechanical phonographs of the Edison type.

Photographing vibrations is not new. What is new is the combination of principles and the method of reproducing the results of the photography.

P. E. K.

STONYHURST COLLEGE OBSERVATORY. — The Report of the Director, Rev. W. Sidgreaves, S.J., F.R.A.S., for 1910, just to hand, shows a good record of work. It was found that "the year's mean barometric pressure was a little below the average, and of the month means only those of March, September and October were above their respective averages. These also were the drier months, the only ones in which the rainfall was below the monthly average. But the duration of sunshine was less than the average in September and October. The highest reading of the barometer occurred in March, and the lowest in February. The former was a fine dry month, the latter remarkable for its number of rainy days, the greatest number recorded for February in sixty-three years." During the same period no January has shown so great a rainfall as this, 8·043 inches, nor so great a fall in one day as on the 15th, when 2·07 inches were recorded. Of the one hundred and sixty-six days on which the Sun was observed the disc was free from—presumably dark—spots on no less than forty, and drawings were made on the remaining one hundred and twenty-six. The mean daily area covered by spots (1 being equivalent to $\frac{1}{5000}$th of the visible surface) fell from 3·8 in 1909 to 1·8 in 1910. It is, however, remarkable that the daily declination range of the magnetic needle increased from 13·5 in 1909 to 14·5 in 1910. During the year no very great magnetic disturbances were recorded, though January 25th, March 27th, 28th and 30th, April 1st and 27th, June 8th, 19th and 20th, August 9th, 21st, 22nd and 28th, September 29th, October 4th, 6th, 12th and 27th, and December 28th, are all recorded as great.

F. C. D.

THE FACE OF THE SKY FOR JUNE.

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

THE SUN.—On the 1st the Sun rises at 3.51 and sets at 8.4; on the 30th he rises at 3.48 and sets at 8.18. Summer commences on the 22nd, when the Sun enters the sign of Cancer at 1.35 p.m.; this is the longest day, the Sun being $16^h\ 34^m$ above the horizon. The equation of time is negligible on the 15th; hence this is a convenient day for adjusting sundials, as only the correction for longitude is needed. Sunspots and prominences are not very numerous; at the time of writing no spots are visible. The positions of the Sun's axis, equator, and heliographic longitude of the centre of the solar disc are shown in the following table. An example of a disc suitable for solar projection was shown on page 200 of the May issue.

Date.	Axis inclined from N. point.	Centre of Disc S. or N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
May 31	16° 5′ W	0° 43′ S	115° 50′
June 5 ...	14° 11′ W	0° 6′ S	49° 46′
,, 10 ...	12° 11′ W	0° 30′ N	343° 38′
,, 15 ..	10° 5′ W	1° 6′ N	277° 28′
,, 20 ..	7° 55′ W	1° 41′ N	211 16′
,, 25 ...	5° 40′ W	2° 16′ N	145 5′
,, 30 ...	3° 25′ W	2° 50′ N	78 55′
July 5 ...	1° 8′ W	3° 23′ N	12 44′

THE MOON:—

Date.	Phases.	H. M.
June 3 ...	☽ First Quarter ...	10 4 p.m.
,, 11 ...	○ Full Moon	9 51 p.m.
,, 19 ...	☾ Last Quarter ...	8 51 p.m.
,, 26 ...	● New Moon	1 20 p.m.
July 3 ..	☽ First Quarter	9 20 a.m.
June 11 ...	Apogee	10 42 p.m.
,, 26 ...	Perigee	3 0 a.m.

OCCULTATIONS.—The only naked eye star occulted before midnight is the fifth magnitude star 22 Scorpii; disappearance takes place on the 10th at 9.38 p.m. at an angle of 90° from the N. point of the Moon, and reappearance at 10.55 p.m. at an angle of 312°.

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
June 1 ..	2 57	N 13° 6′
,, 11 ...	3 44	17° 11′
,, 21 ...	4 54	21° 40′
July 1 ...	6 24	24° 21′
,, 11 ...	7 50	N 22° 37′

Mercury is a morning star in Taurus during the early part of the month. On the 1st the planet rises in the E.N.E. at 3.10 a.m.; on this date Mercury is at greatest westerly elongation of 24° 30′, from the Sun, but the elongation is an unfavourable one on account of the planet only rising 40 minutes in advance of the Sun.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
June 1	7 36	N 24° 0′
,, 11	8 23	21° 42′
,, 21	9 7	18° 35′
July 1	9 47	14° 52′
,, 11	10 22	N 10° 46′

Venus is a brilliant object in the evening sky looking W.N.W. immediately after Sunset.

The planet is extremely well placed for observation, appearing high above the horizon at Sunset and not setting till 11.20 p.m. on the 1st and 10.37 p.m. on the 30th. Moreover, the planet can readily be seen long before it is dark and even in broad daylight a small pair of opera glasses is sufficient optical aid to render it visible if directed to the correct position in the sky. The best time for observing is whilst the background of the sky is still light, for the brightness of the planet is so intense that it requires an uncommonly good telescope to observe when dark, partly because the planet is then lower in the sky and partly on account of the luminosity of the planet being strong enough to reveal any lack of achromatism in the telescope; thus in poor instruments a blue halo frequently appears to surround the image. With magnifying powers of 150 to 250, dark shadings may be seen on the planet's disc towards the terminator, the limb appearing intensely brilliant. As seen in the telescope the planet appears slightly gibbous 0·6 of the disc being illuminated, whilst the diameter of the disc is about 20″. The Moon appears near the planet on the evening of the 29th.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
June 1 ...	23 50	S 2° 10′
,, 11 .	0 20	N 0° 38′
,, 21 .	0 52	3° 23′
July 1 ..	1 18	6° 1′
,, 11 ...	1 44	N 8° 29′

Mars is a morning star in Pisces, rising nearly due E. early in the month, and later a little N. of E. On June 1st, the planet rises about 1.30 a.m., and on July 1st, about ten minutes after midnight. The planet is increasing in brightness the apparent diameter being now nearly 8″. On the morning of

FIGURE 1.
Conjunction of Mars and the Moon, June 21.

21st, at 1 a.m. the Moon is in conjunction with the planet, Mars being only 0° 12′ to the north (see Figure 1).

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
June 1 ..	14 17	S 12° 10′
,, 11 ..	14 14	12° 7′
,, 21 ..	14 2	11° 59′
July 1 ..	14 11	11° 58′
,, 11 ..	14 12	S 12° 3′

Jupiter is a brilliant object in the evening sky looking South, and is in the very best position for observation. Near the middle of the month the planet is on the meridian at 8.45 p.m., but observations may commence as soon as it is dark, since he is above the horizon at Sunset.

The planet is describing a retrograde path near α Virginis and is at the stationary point on July 3rd.

The most noticeable features as seen in the telescope are the moons, the dark belts, and the polar flattening; this latter is shown by the equatorial diameter being 41″·6 and the polar diameter 2″·7 less. If sufficient magnifying power be used with a telescope of about four inches aperture, markings and also the "Great Red Spot" on the belts may be observed, from which the period of rotation may be deduced. This is only $9^h\ 55^m$, which explains the cause of the oblateness of the planet.

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

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
June				June				June			
1	I.	Tr. E.	9 44	9	II.	Ec. R.	11 58	23	I.	Oc. D.	10 8
1	I.	Sh. E.	10 28	11	III.	Ec. R.	9 38	24	I.	Tr. E.	9 36
8	I.	Tr. I.	9 20	15	I.	Tr. I.	11 5	24	I.	Sh. E.	10 41
8	I.	Sh. I.	10 10	16	II.	Oc. D.	9 42	25	II.	Sh. E.	11 19
	I.	Tr. E.	11 31	16	I.	Ec. R.	11 26	25	III.	Oc. D.	11 42
9	I.	Ec. R.	9 32	18	III.	Oc. R.	9 42				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

The configurations of the satellites as seen in an inverting telescope and observing at 11 p.m. are as follows:—

Day.	West.	East.	Day.	West.	East.
1	4321		16	43	● 2 ● 1
2	34	21	17	431	2
3	31	4 2	18	42	3 1
4	2	314	19	241	3
5	1	34	20		4123
6		1234	21	1	2/3 4
7	1	2/3 4	22	23	14
8	32 ⊙	4	23	32	4 ● 1
9	3	14 ● 2	24	31	24
10	31	24	25	23	1 4
11	2	3/4 1	26	21	34
12	2/1	3	27		2/1 43
13	4	123	28	14	2/3
14	41	2/3	29	423	1
15	423	1	30	4321	

The circle (○) represents Jupiter; ⊙ signifies that the Satellite is on the disc; ● signifies that the Satellite is behind the disc, or in the shadow. The numbers are the numbers of the Satellites.

SATURN:—

Date.	Right Ascension.	Declination.
	h. m.	
June 1	2 47	N 13° 53′
,, 16	2 54	14° 22′
July 1	3 0	N 14° 47′

Saturn is a morning star in Aries, rising E.N.E., about 3 a.m., on the 1st June, and at 1.7 a.m. on the 30th. In consequence of the planet being in a bright portion of the sky he is, for all practical purposes, unobservable.

URANUS:—

Date.	Right Ascension.	Declination.
	h. m. s.	
June 1 ..	20 5 14	S 20° 53′ 40″
July 1	20 1 28	S 21° 5 33″

Uranus rises in the S.E. at 11.20 p.m. on the 1st, and at 9.23 p.m. on the 30th. The planet is unfavourably placed for observation, as he is low down in the sky; he is describing a retrograde, or westerly, path, about 2° S.E. of σ Capricorni; he can just be discerned with the naked eye on a very clear night, but is easily visible through a pair of opera glasses.

NEPTUNE:—

Date.	Right Ascension.	Declination.
	h. m. s.	
June 1	7 25 15	N 21° 24′ 40″
July 1 ..	7 29 33	N 21° 16′ 20″

Neptune is practically unobservable as he sets at 11 p.m., on the 1st and at 9 p.m. on the 30th.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Name.	Characteristics.
	h. m.			
June–July	16 48	21	α Scorpiids	Fireballs.
June 13	20 40	+61	α Cepheids	Streaks, swift.

Mira (o Ceti) is due at maximum on the 30th, but observations should be made before and after this date as the period is somewhat variable. The magnitude at maximum is usually about 3·0 but this, too, is variable. The spectrum at maximum is a mixed one exhibiting both bright and dark lines.

TELESCOPIC OBJECTS:—

DOUBLE STARS, &c.—γ Virginis XII.^{h} 37^m, S. 0° 54′, mags. 3, 3, separation 6″·0. Fine double for small telescopes with a magnification of about 80.

β Scorpii, XVI.^{h} 0^m, S. 19° 34′, mags. 2·7, 5·2; separation 13″.1.

ϵ Lyrae, XVIII.^{h} 41^m, N. 39° 33′, known as the "double-double" star, can just be separated by the naked eye, but with a pair of opera glasses it is readily divided into two components, ϵ_1 and ϵ_2, mags. 4·4 and 4·8. Using a 3-in. telescope and a power of about 120, each of these stars can again be divided into pairs, 3″·2 and 2″·6 apart respectively, each component being about magnitude 5·5.

M 57 (Lyra), the "ring" nebula. This nebula is the only annular nebula accessible to telescopes of about 3-in. aperture, and even then requires good seeing. It is easily found, being situated about ½ of the distance from β to γ Lyrae. The usual appearance in a 3-in. telescope is that of a rather large nebulous star, but it bears magnification well, and its annular character can easily be made out with a moderately high power.

M 80 (Scorpio). A compact [illegible]ular cluster half way between α and β Scorpii; look[illegible] a nebula in small telescopes.

QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are printed [illegible].

QUESTIONS.

41. THE EFFECT OF RIGID RAILS ON THE SPEED OF A TRAIN.—A pendulum shows that, as one walks towards it, one makes a dimple in the ground.

I have often observed the dimple which is made by a running locomotive.

As the engine is continually climbing out of consecutive dimples, a question arises—is the speed of a train lessened thereby, and would the train travel faster if the rails were absolutely rigid?

Francis Ram.

42. THE CARRION CROW.—Can any of your readers inform me whether a clutch of nine crow's eggs has been recorded? I found a nest in the Brent Valley this Spring containing eight greenish-brown eggs and one greenish-grey. The eight were at the bottom of the nest, and the other on top of the others.

Geoffrey Ker Webb.

43. ASTRONOMY.—Of what value is "Urania's Mirror, or a View of the Heavens" (published by Sleigh), consisting of 32 coloured plates, engraved by Sid. Hall, sculptor?

A. M. F.

REPLIES.

31. It has never come to my ears nor eyes that wireless telegraphy did or would have anything to do with changes in the weather, but to me it seems feasible and likely.

The entire universe is built upon vibrations, and electrical forces and storms are no exception. If it is true that wireless telegraphy may, in a measure, influence weather conditions, it is because of the vibrations of the electric and air waves it sends forth from the central station. Of course, the greater the electricity generated the greater the change in the weather. I can go no further and state why these vibrations should cause any change in the weather, but will give a few examples we have all seen or heard.

A heavy peal of thunder during an electrical storm—one that jars the house and shakes the windows—is, in almost all cases, followed by a heavy downpour of rain. The terrible convulsions of the atmosphere during tornadoes, frequent in the southern states of the United States and the hurricanes of the West Indies, are invariably followed by torrential rains. Whirlwinds coming out of a clear sky are immediately followed by clouds and storminess. The fair weather preceding an earthquake is quickly changed, after the vibrations and tremors of the earth, into cold, cloudy and rainy conditions. After all great battles, where heavy cannonading has been going on for any length of time, rain is sure to fall with the gathering of clouds soon after. Even during the American Independence celebration, rain generally falls at night in the places where the most fireworks have been set off, no matter how clear the weather had been during the day. Allow me to go one step farther and say that all the planets, as electric dynamos, are sending forth vibrations throughout space which causes the ocean tides and the varying storm and weather conditions upon ours and other whirling globes.

L. N. Pritchard.

39. ANTICYCLONE.—It is quite true that an anticyclone is not always the opposite of a cyclone as regards the actual strength of the wind, but there are certain properties of these systems which make them diametrically opposed. (1) The wind circulation is anti-clockwise in a cyclone, but clockwise in an anticyclone. (2) Pressure is highest at the centre of an anticyclone, but lowest at the centre of a cyclone; and, therefore (3) the wind circulates spirally outwards in an anticyclone, but spirally inwards in the case of a cyclone. (4) Comparatively speaking the calmest area of an anticyclone is at its centre, whereas the windiest area of a cyclone is at its centre. Thus the term "anticyclone" does not *always* infer quiet weather. There is sometimes a difficulty in that there is no hard and fast boundary between the edge of an anticyclone and that of a cyclone; one cannot always say how much of the wind's strength is due to one system or the other. Thus the term "anti" is justified in four respects, not to mention the fact that an anticyclone usually drifts or remains stationary, whereas a cyclone generally has a much faster motion in a certain direction.

C. H. E. Ridpath.

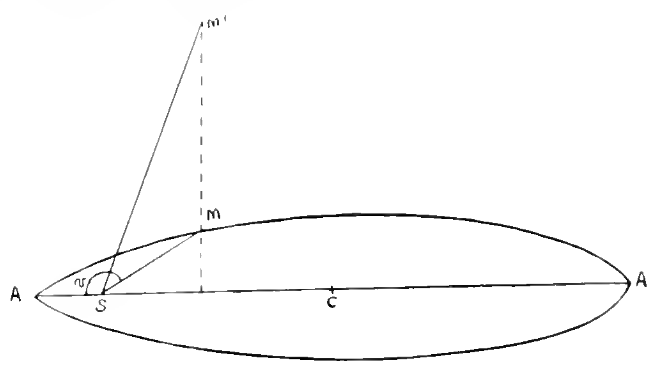
40. WATER-FINDING.—No scientific explanation is yet attainable. The supposition of those who have most thoroughly studied the phenomena is that some people can sub-consciously perceive underground water, and so on, by a kind of sixth sense, and that the sub-consciousness signals its discovery by twitching the muscles and thus moving the rod. The only scientific treatment of the subject at any length is in Professor W. F. Barrett's reports in the "Proceedings" of the Society for Psychical Research, Vols. 13 and 15. A condensation is given in his pamphlet "On the History and Mystery of the so-called Dowsing or Divining Rod," obtainable for 1s., from the Secretary, Society for Psychical Research, 20, Hanover Square, London, W.

J. Arthur Hill.

33. HALLEY'S COMET.—"Interested" asks a question with reference to the determination of the distance of Halley's Comet from the Sun, and also its velocity, at any time, say two years after passing Perihelion, April 19th, 1912.

The following easy method can be used, when the perturbations of the planets are not taken into consideration.

Let the figure represent the path of the Comet in its orbit, where AA^1 is the axis major of the ellipse described, S the Sun in one of the foci of the ellipse, C the centre, and M the Comet two years after passing perihelion. Of course A will represent perihelion point.



We assume the following data in connection with Halley's Comet:—

Periodic time	...	76·37	years.
Perihelion distance	...	·5889	Astronomical Units.
Eccentricity ...	...	·967	
Aphelion distance	...	35·411	Astronomical Units

The angle ASM described by the radius vector is called the "True Anomaly," and is generally denoted by v; the angle described by the radius vector on the assumption that it moves uniformly, is called the "Mean Anomaly"; it is usual to denote it by M. Now, if we suppose a circle circumscribed round the ellipse, and we draw through M an ordinate meeting this circle in M[1], the angle ASM[1] is called the "Eccentric Anomaly," denoted by u.

From the properties of an ellipse the equation

M = u − e sin u is easily deduced, where e is the eccentricity.

$$\text{Now } M_1 = \frac{360^\circ}{76\cdot 37} \times 2 = 9^\circ\ 25'\ 40''$$

$$\therefore 9^\circ\ 25'\ 40'' = u - \cdot 967 \times 57^\circ\cdot 3 \sin u.$$

The factor 57°·3 is introduced, since this is the number of degrees in one radian.

This equation can be solved approximately by a Graphic Method; the one used is the well-known method by drawing a Curve of Lines. As a first approximation u comes out about 55°.

To find its exact value, let u be actually 55° + θ°, where θ is small.

$$\therefore 9^\circ\ 25'\ 40'' = 55^\circ + \theta^\circ - \cdot 967 \times 57\cdot 3 \sin (55^\circ + \theta^\circ).$$

$$\text{Now } \sin (55^\circ + \theta^\circ) = \sin 55^\circ \cos \theta^\circ + \cos 55^\circ \sin \theta^\circ$$

$$= \sin 55^\circ + \frac{\theta}{57\cdot 3} \cos 55^\circ,$$

since cos θ = 1 nearly, and $\theta = \frac{\theta}{57\cdot 3}$

as θ is very small.

We therefore obtain 45° 34′ 20″ + θ°

$$= \cdot 967 \times 57\cdot 3 \left(\cdot 81915 + \frac{\cdot 57358}{57\cdot 3}\ \theta^\circ \right);$$

$$\text{or } \theta^\circ + 45\cdot 57222 = 45\cdot 387 + \cdot 55467\ \theta^\circ$$

$$\cdot 44533\ \theta^\circ = -\cdot 185$$

$$\therefore \theta^\circ = -\cdot 4157^\circ = -24'\ 26''$$

Hence, value of u is 55° − 24′ 26″

= 54° 35′ 34″.

The True Anomaly v is given by the formula

$$\tan \tfrac{1}{2} v = \sqrt{\frac{1+e}{1-e}} \tan \tfrac{1}{2} u$$

$$= 7\cdot 72 \tan 27^\circ\ 17'\ 47''$$

$$= 7\cdot 72 \times \cdot 51606 = 3\cdot 9814$$

$$\therefore \tfrac{1}{2} v = 75^\circ\ 54'$$

or v = 151° 48′ approximately.

If u be the distance of the Comet from the sun, r is given by the formula r = a (1 − e cos u), where a is the semi axis major, or 18 astronomical units

$$\therefore r = 18\ (1 - \cdot 967 \cos 54^\circ\ 35'\ 34'')$$

$$= 18\ (1 - \cdot 56028)$$

$$= 7\cdot 91496$$

Its distance from the sun would, therefore, be about eight times the distance between the sun and the earth. It would be, at this time, between the orbits of Jupiter and Saturn.

The formula to determine the velocity at any point in the orbit distant r from the sun is

$$V^2 = \frac{2\mu}{r} - \frac{\mu}{a}$$

where μ is a constant, and a the sun's axis major. Substituting 7·91 for r, and 18 for a, we find

$$V^2 = \cdot 1979\ \mu$$

$$\therefore V = \cdot 445 \sqrt{\mu}$$

The constant μ can be found from a consideration of the motion of the earth in its orbit. Since the comet describes an ellipse around the sun, μ will be the same for the earth and the comet. Using the equation

$$V^2 = \frac{2\mu}{r} - \frac{\mu}{a}$$

for the earth, and remembering that r = a very nearly, since the eccentricity of the earth's orbit is only $\frac{1}{60}$, we have

$$V^2 = \frac{2\mu}{a} - \frac{\mu}{a} = \frac{\mu}{a}$$

Now, the velocity of the earth around the sun is about eighteen and a quarter miles a second, and a = 1 astronomical unit, therefore μ = (18·25)², or √μ = 18·25. Substituting in the expression V = ·445 √μ, we have V = ·445 × 18·25 = 8·12 miles per second.

The perturbations produced by the planets will slightly alter some of the elements, but the above results may be taken as approximately correct.

(Rev.) M. Davidson.

POSTAL REFORM.

The cost of postage presses very heavily upon magazines which cannot be registered as newspapers, and it seems rather hard that a newspaper weighing several pounds can be transmitted through the post for a half-penny, when scientific journals and the transactions of societies, which tend to the spread of knowledge, and the advancement of science, may cost six, or eight, or ten times as much. We have therefore much pleasure in printing the resolutions which were passed unanimously at a large and influential meeting, convened by Mr. Edward Owen Greening, on April 6th, at the offices of the Horticultural and Agricultural Association, and we are sanguine that at last some real good may be done.

1. "That this representative gathering of proprietors, publishers, and editors of magazines and trade journals earnestly protests against the present unfair, unequal, and excessive postal rates upon periodicals published at intervals longer than a week, the British Post Office arrangements being more oppressive than those of any other civilised countries in postal charges on this important kind of literature. The present postal treatment, by restricting circulation of magazines, depresses the remuneration of authors and artists, renders it difficult for British publishers to compete with those of other countries; enhances prices to the public, and reduces the benefits which can be given to readers of such periodicals which are largely instructors in matters of science, art, manufactures, commerce, philanthropy, and religion."

2. "That in view of the huge surplus profits on postages amounting to five millions sterling per annum, and averaging over 26 per cent. on the business, we cannot accept the declaration of the postal authorities that they are unable to afford reform. We deprecate postal forecasts of possible losses on reductions, as these gloomy anticipations are always falsified in results. We claim that postal revenues are properly applicable to postal purposes, and should be used to reform evils, remove anomalies, and redress grievances of the public which uses the Post and the employés who serve it. We regard the abstraction of postal revenues by the Exchequer as a virtual act of confiscation, degrading the Post Office from its proper position into a tax-collecting department of the Government. We demand that fair treatment shall be given to us, equal to that enjoyed by publishers in America, Canada, and so on, before the postal surpluses to which we contribute are alienated by the Exchequer."

3. "That we, now present, pledge ourselves to form an organisation to press for the necessary postal reforms, and to supply resources for an effective movement.

"That we appeal to all magazine proprietors and editors regularly to devote space in their columns to public enlightenment on the questions at issue. That we appeal to our colleagues of the daily and weekly journals for their good help. That we seek the aid of friends of the Press in the Legislature to organise active Parliamentary action."

4. "That a General Committee be elected with powers to add to their number, to appoint an Executive and officers: to increase adherents to the cause by canvass and otherwise conduct our movement to a successful issue."

THE BRINE SHRIMP.

By W. T. CALMAN, D.Sc.

THE pretty little Crustacean known as the Brine Shrimp was first discovered about the middle of the eighteenth century at Lymington, in Hampshire. In those days, and for something like a century afterwards, the manufacture of salt from sea water was carried on there and at other places on our coasts, the first stage of the process being the concentration of the sea-water by exposing it to evaporation by the heat of the sun in large shallow ponds. The concentrated brine was then run into open vats known as "salterns," previous to being further evaporated by artificial heat, and it was in these vats that the Brine Shrimps, or "brine-worms" as they were called, appeared in such numbers as to give the brine a reddish tinge. They were believed to be of service in clearing the liquid from impurities, and the workmen were in the habit of transferring some of them from one "saltern" to another, when they did not make their appearance naturally, to ensure their presence when the brine had reached the proper degree of concentration. Brine Shrimps have since been found in many parts of the world in natural or artificial brine-pools and lagoons and in salt lakes, and, although a number of species have been described, there is reason to believe that they are all forms of a single variable and cosmopolitan species, *Artemia salina*, which ranges from Greenland to Australia, and from the Great Salt Lake of Utah to Central Asia.

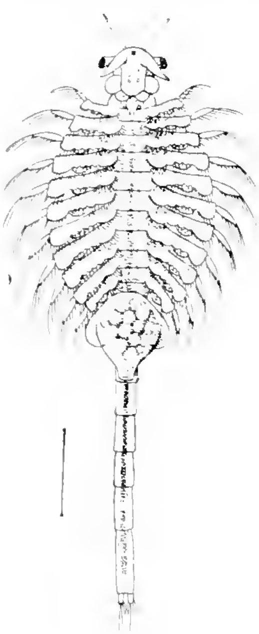


FIGURE 1.
The Brine Shrimp. *Artemia salina*. Female, from below.
The line indicates actual length. (After G. O. Sars).

FIGURE 2.
Nauplius larva, just hatched, highly magnified.
(After G. O. Sars).

The Brine Shrimp belongs to the sub-class Branchiopoda, which includes the most primitive of existing Crustacea, and it is closely allied to the "Fairy Shrimp," *Chirocephalus diaphanus*, recently described in the pages of "KNOWLEDGE" (July, 1910), by Mr. G. W. Pyman.

The body of *Artemia* is usually about half-an-inch in length. Like that of *Chirocephalus* it is worm-like and completely divided into segments, without a protecting shield or carapace, such as is found in most other Crustacea. The first eleven segments behind the head each carry a pair of flattened fin-like feet, by the rhythmical movements of which the animal swims. The hinder part of the body forms a slender tail and is without appendages. The head bears a pair of compound eyes set on movable stalks and a third eye, very small and of simple structure, in the middle line in front; the three eyes are coloured with dark reddish-brown pigment. There are two pairs of feelers, the first pair, or antennules, slender and thread-like, the second, or antennae, short and stumpy in the female, but very large in the male, and forming a pair of curiously-shaped claspers for seizing the female. The female, when fully mature, carries her eggs in a sac-like receptacle on the under-side of the body at the base of the tail. The animals are generally of a pale reddish colour, owing, as Sir Ray Lankester first showed, to the presence in the body fluids of haemoglobin, the substance which gives its colour to the blood of Vertebrates but is not often found in Invertebrate animals.

The Brine Shrimp, like most of the Branchiopoda, usually swims back downwards, and it feeds on minute floating organisms and particles of organic matter which are drawn in towards the mouth by the movements of the feet.

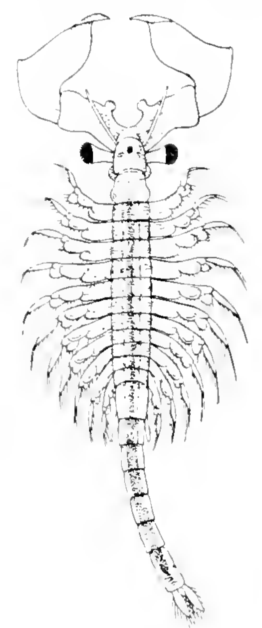


FIGURE 3.
The Brine Shrimp. *Artemia salina*. Male, from above.
(After G. O. Sars).

The phenomena of reproduction are of particular interest. Like many, but not all, of the Branchiopoda the Brine Shrimp reproduces extensively by parthenogenesis, that is to say, the females lay eggs which are capable of development without being fertilised. In some localities, in fact, it appears that males are never found, the colonies consisting entirely of females. In other localities the two sexes occur in nearly equal numbers, and reproduction takes place by fertilised eggs. There is some evidence to show that there may be two races of Brine Shrimps, the one exclusively parthenogenetic, the other sexual, but it is by no means clearly ascertained what the exact relations between the two forms are.

The eggs are globular in shape, about one-hundredth of an inch in diameter, and when deposited are enclosed in a tough shell which nables them to survive being dried. In this condition the eggs may be carried long distances in mud, adhering to the feet of wading birds, or may be blown about by the wind, and the distribution of the species from one locality to others is thus rendered possible. Sometimes, however, the Brine Shrimp is viviparous, the eggs hatching while still within the brood-sac, and before the shell has been completely formed. In either case, the young appear first in the form of tiny six-legged larvae with an oval unsegmented body and a single eye. This type of larva, known as a *nauplius*, is found in many other groups of Crustacea, such as Copepods, Barnacles, and some of the true Prawns, which in the adult state are very different from the Brine Shrimp. In the course of development the body elongates and becomes divided into segments, the eleven pairs of swimming feet successively appear, the stalked eyes grow out at the sides of the head, the three pairs of nauplius limbs lose their swimming branches and become the antennules, antennae, and mandibles, and the animal gradually acquires the form and structure of the adult.

The great variability of the Brine Shrimp, already alluded to, seems to be correlated with the varying chemical composition and concentration of the solutions in which it lives. It has been found in water containing no less than 27 per cent. of dissolved salts, while on the other hand it sometimes, though rarely, occurs in water that is quite fresh. In Central Asia, Brine Shrimps have been found living in lakes containing so much sodium carbonate that the water had a distinctly "soapy" feel. A Russian naturalist, Schmankewitsch, showed, many years ago, that it was possible, by breeding *Artemia* in solutions of varying concentration, to produce changes of form, especially in the end-lobes of the tail. Some of the characters thus produced had previously been regarded as distinctive of separate species, but there is no ground for the statement sometimes made that the experiments resulted in changing one species into another. They simply showed that the species had been mistakenly separated on variable and untrustworthy characters. The statement that some of the specimens assumed the characters of the allied but quite distinct genus *Branchipus* has since been shown to be erroneous.

The manufacture of salt from sea-water in the way described above has long since ceased in this country, though it is still carried on on the shores of the Mediterranean, and it is probably many years since the Brine Shrimp became extinct as a member of the British fauna. An accidental observation recently made at the Natural History Museum shows, however, that it is probably a very simple matter for anyone to obtain a supply of living specimens. A solution of "Tidman's Sea Salt," which had been set aside and forgotten, was found after some weeks to have about a dozen full-grown Brine Shrimps actively swimming about in it. All of these were females and carried egg-pouches full of eggs, which were deposited shortly afterwards and in a few days the larvae of a second generation were hatched from them. A fresh packet of the salt was then experimented with. About eight ounces were dissolved in five pints of tap water, and microscopic examination of the sediment showed that it contained numerous eggs. In about four days a swarm of nauplius larvae issued from these, and in the course of a fortnight they were well on the way to assume the adult form, although still very small.

It is impossible, without further trial, to say whether eggs capable of development are always present in Tidman's Sea Salt. They cannot retain their vitality indefinitely, and, in fact, a very old sample of the salt found among the Museum stores proved to be barren of life. It need hardly be said that salt which in the course of manufacture has been exposed to artificial heat, would contain no living eggs. In reply to an inquiry on this point Messrs. Tidman & Son kindly stated that their Sea Salt is manufactured abroad from sea-water evaporated by the sun's heat.

NOTICE.

THE *SOUTH AFRICAN JOURNAL OF SCIENCE.*—In the April issue of the *South African Journal of Science* appear notes on *Crotalaria Burkeana* and other leguminous plants causing disease in stock. Beasts eating *Crotalaria* develop laminitis within a few days, their hoofs grow long and, unless attended to, the beasts get so stiff in the joints that they lie down and are unable to rise again. Goats seem to be immune and it is curious to note that the same fact is recorded in the case of *Cytisus proliferus* in the Canary Islands. This *Crotalaria* is recorded from the Transvaal, Orange Free State, the Cape Province and Natal and there is one record from Zululand. It is most common on sandy soils and it is found that even if it exists in the unbroken veld in such small quantity as to be harmless, as soon as the land is cultivated and maize or kaffir corn planted, the *Crotalaria* makes its appearance along with them. The plant is said to be most poisonous when the pods, called by the Boers "Klappers," have developed. In the Eastern and Central United States *Crotalaria sagittalis* or "Rattle-box" produces a stock disease called "Crotalism" or "Missouri bottom disease," which is more frequently fatal than that induced by the South African *Burkeana*. Other species of *Crotalaria* in Australia are known to be injurious to stock. The notes also record the effect of *Lessertia*, *Melolobium* and *Cytisus*, in Africa; *Swainsona galegifolia* (Darling pea or indigo) in Australia; *Astragalus*, *Oxytropis* and *Sophora*, in America.

In the same number Dr. P. D. Hahn describes a geyser in Rhodesia, the only one that has been discovered in that country. The geyser is situated near Fulunka's Kraal, about two miles south of the Zambesi River and forty miles below the confluence of the Gwai River. It issues from a round hole, about two inches in diameter, in solid sandstone and throws up a continuous stream of water eight feet high. The temperature of the water is slightly below boiling point; the force with which the water is expelled is not great, as the geyser can be easily plugged with a stick, while a ten pound stone placed over the aperture will stop the play of water. Analysis shows the silica content of the water to be 13·65 grains per gallon. The water of ordinary springs, either deep-seated or surface, rarely contains so much as one grain of silica per gallon, while the Iceland geysers show from eleven to thirty-five grains.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, D.Sc., B.A.

ENCKE'S COMET.—Dr. O. Backlund has recently published some further researches on this comet. The observations of each return since 1891 have been compared with theory. The dates of perihelion (all expressed in Berlin mean time) are:—1895, February 4·785; 1898, May 26·898; 1901, September 15·501; 1905, January 11·916; 1908, April 30·946; 1911, August 19·0656. The mean daily motions at these returns is 1070″ *plus* the following:—3″·934, 4″·157, 3″·625, 5″·084, 5″·848, 5″·668. The other predicted elements for 1911 are:—Node, 334 29′ 32″; Omega, 184 39′29″; i. 12 34′ 32″; e. 0·845723. The most interesting feature of this comet is the acceleration of its mean motion. Dr. Backlund finds evidence that this suddenly changed its amount in 1858, 1868, 1895 (beginning), and perhaps 1904 (end). Several of these dates are near sunspot maximum, and it is suggested that the cause is to be sought in some solar disturbance.

The comet was extremely faint at its last return, in 1908, and was only obtained (by photography) at the Cape Observatory. It is not thought that this means any permanent loss of light, as it had often before been very faint when in a similar position with regard to the Earth. It is brightest at winter returns, of which the next will occur at the end of 1914; at these times it is quite a conspicuous telescopic object, and is sometimes visible to the naked eye. Before its periodicity was known it was independently discovered at three consecutive winter returns—those of 1786, 1795, 1805—which shows that it must have been a fairly conspicuous object. The following is an ephemeris for the present year, for Berlin noon:—

	R.A. H. M. S.	N.Dec.		R.A. H. M. S.	Dec.
July 1 ...	4 16 17	28° 14′	Aug. 6...	8 12 3	23° 55′
,, 5 ...	4 35 26	28° 54′	,, 24...	10 44 31	5° 46′N.
,, 9 ...	4 56 15	29° 26′	,, 28...	11 16 6	1° 2′N.
,, 13 ...	5 18 50	29° 46′	Sept. 1...	11 46 24	3 28′ S.
,, 17 ...	5 43 18	29° 52′	,, 5...	12 15 45	7 41′
,, 21 ...	6 9 40	29° 38′	,, 9...	12 44 22	11° 32′
,, 25 ...	6 37 54	29° 1′	,, 13...	13 12 17	14 59′
,, 29 ...	7 7 52	27° 54′	,, 17...	13 39 27	18 2′
Aug. 2 ...	7 39 20	26 14′	,, 21...	14 5 44	20 38′ S.

If seen at all in Europe it will be in July. It will then be about one hundred and fifty million miles from the Earth.

HALLEY'S COMET.—This is still being diligently followed at the Yerkes Observatory. *Popular Astronomy* for May contains a reproduction of a photograph taken by Mr. F. Slocum with the two foot reflector, with one hour's exposure. The comet appears quite distinctly as a short trail. It was then one hundred and ten million miles further from the sun than on September 11th, 1909, and yet very much brighter, showing that the physical brightening at perihelion persists for a long time. It will be followed at least up to conjunction with the sun, and possibly recovered in the autumn after that. Professor Barnard writes that he got good measures on April 16th, 23rd and 25th; an observation on May 2nd was doubtful owing to moonlight. The comet was of magnitude 15 in April, but is rapidly getting fainter; its diameter is about 10″. On April 23rd at $14^h\ 45^m\ 48^s$ Greenwich mean time, its right ascension was $0^h\ 53^m\ 27^s\cdot 28$, South declination 7 48′ 23″·9. This was more than a year after perihelion passage.

A query that appeared in "Knowledge" for April, page 135, asks how the distance of this comet from the sun and its speed can be calculated at any time. There are probably a sufficient number interested in this problem to justify its discussion here. I deal with it only on the assumption of elliptical motion, as the discussion of perturbations would need too much space. t denotes the interval in days since the perihelion passage of 1910, April 19·68. u is an auxiliary angle known as the "eccentric anomaly." We must find u by trial from the equation

$$t \cdot 0^\circ{\cdot}012967 = u - 55^\circ{\cdot}4216 \sin u$$

For example put $t = 731$ days, which brings us to 1912, April 19·68. The left hand side $= 9^\circ{\cdot}478$. Trying in succession 40°, 50°, 57° for u, the right hand side becomes 4°·37, 7°·54, 10°·52. Interpolating and making a few more trials we obtain the correct value of u, viz., 54°·721.

Next we find r, the distance from the Sun, by the equation

$$r = 17{\cdot}945\,(1 - 0{\cdot}96729 \cos u).$$

Substituting 54°·721 for u, this becomes 7·9197, the unit being the Earth's distance from the Sun. To bring to miles we multiply by 92,820,000.

The velocity expressed in units of the Earth's mean velocity is

$$\sqrt{\frac{2}{r} - {\cdot}055726}.$$

To reduce it to miles per second we multiply by 18·47.

In the present case we get $18{\cdot}47 \sqrt{{\cdot}252534 - {\cdot}055726}$

log. 18·47 = 1·2665
log. ·196808 = 9·29404
half this = 9·64702
log. miles per second = 0·9135
Miles per second = 8·194.

MASSES OF STARS.—Professor Lowell has an article in *Popular Astronomy* for May, on the masses of binary stars. Grouping the results according to parallax, he finds the resulting mass steadily increases with the distance. This is discussed, and shown to indicate the unreliability of the smaller parallaxes, $\frac{1}{15}$ of a second being determined as the smallest that can be trusted. The following are the final figures:

Limits of parallax.	Mass of binary (Sun = 1).
Above 0″·4	1·93
0″·2 to 0″·4	1·77
0·1 to 0·2	1·33
0·067 to 0·1	1·43
0·033 to 0·067	1·95
0·017 to 0·033	3·46
0·007 to 0·017	33·43

This shows that for the best determined parallaxes the mass of each component is very near that of the Sun. We have good reason for thinking that there are stars (such as Aldebaran and Arcturus) whose mass vastly exceeds the Sun's, but these are probably exceptional. Professor Lowell altogether discusses twenty-six pairs, and his result tends to the conclusion that the masses of the stars vary much less widely than their lustre.

BOTANY.

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

FORMALDEHYDE AS FOOD FOR GREEN PLANTS.—It has long been known that the first product in the making of organic food by green plants, from the carbon dioxide and water absorbed by their leaves and roots respectively, is formaldehyde (CH_2O), the starting-point for the formation of carbohydrates and of higher compounds. Various experimenters have endeavoured to show that plants can utilise formaldehyde as food material when presented to them, in absence of a supply of carbon dioxide, but success has only been obtained with simple freshwater Algae like *Spirogyra*. Twenty years ago, Bokorny showed that though formaldehyde is poisonous, even in very dilute solutions, yet a substance called oxymethyl sodium sulphonate (easily broken up into formaldehyde and sodium sulphite) can be used in culture solutions, in the proportion of 1 per cent., without injury to *Spirogyra*.

Grafe (*Ber. d. deutsch. bot. Ges.*, 1911) has now experimented with the French Bean, and finds that seedlings of this plant can make use of the vapour of formaldehyde. He allowed the seedlings to germinate, removed their cotyledons (containing reserve food), and placed them in vessels exposed to light. In some cases, the seedlings were supplied with air deprived of carbon dioxide, but containing formaldehyde vapour. The results showed that the plants made use of the formaldehyde vapour, producing abundant sugar in their leaves, and increased greatly in dry weight, as compared with the control or comparison plants not supplied with formaldehyde. Apparently, however, the formaldehyde prevented the formation of starch from the sugar.

A NEW FUNGUS IN THE BEET ROOT.—In the course of his work on the disease of Sugar Beet caused by Nematodes (round-worms), Nemec found a Fungus, belonging to the Chytridiaceae, in the cortex of the lateral roots. He has now (*Ber. d. deutsch. bot. Ges., 1911*), given an account of the structure and life history of this Fungus—a new genus and species called *Sorolpidium Betae*. It belongs to the Chytridium family, and therefore to the lowest forms of Fungi. It appears in the cortex cells as a nucleated mass of protoplasm, which grows larger at the expense of the cell and finally nearly fills it. Then the Fungus cell acquires a cell-wall, and its contents divide into several uni-nucleate portions or sporangia. Each sporangium then produces two, three, or four zoöspores, which escape, swim about, and infect other cells. In several respects, Sorolpidium resembles the Plasmodiophoraceae—the group to which belongs the Fungus causing finger-and-toe disease of the turnip. Nemec considers it as a link between this group and the Chytridiaceae, and as indicating the close relationship of the two groups.

LIFE HISTORY OF ZANARDINIA.—The genera *Cutleria* and *Zanardinia*, forming the small family Cutleriaceae, are of great interest, because they form a transition from the lower Brown Algae, in which the sexual cells, if formed, are nearly or quite alike in size, to the higher Brown Algae (*Dictyota* and *Fucus* series) in which the female cell is an oösphere, much larger than the male cell, and differing from it in not being motile.

The life history of *Cutleria* has already been worked out in some detail by various botanists, including Falkenberg, Sauvageau and Church. The sexual and asexual plants are very different, the former being an erect ribbon-like and much-divided structure, while the latter is a flat creeping disc of roughly circular outline. Before the connection between the two forms was discovered, the asexual form was called *Aglaozonia*, and was regarded as an entirely different plant. Careful investigation has shown that *Cutleria* may be regarded as consisting potentially of a basal disc, producing spores, and an erect branching portion producing sexual cells. The two portions require quite different conditions in order to develop fully. In the Mediterranean, the *Aglaozonia* form occurs in summer, and the *Cutleria* form in winter. In England the reverse holds good. In the north, the *Cutleria* form becomes more and more scarce, and the plant is represented by only the *Aglaozonia* form on the Scandinavian coast. Conversely, in the south the *Aglaozonia* form becomes rarer, and at Naples it is unknown, only the *Cutleria* form being found there.

The life history of *Cutleria* is a good illustration of the influence of external conditions on the course of development of the reproductive cells. Normally, the fertilised *Cutleria* egg produces an *Aglaozonia* plant, but this stage may be omitted, and a *Cutleria* plant arise directly. The zoospores produced by the *Aglaozonia* normally produce a *Cutleria* plant, and this usually produces *Aglaozonia* discs from its base; the *Cutleria* plant may undergo arrest of growth, leaving the *Aglaozonia* to continue the life history. Northern conditions favour the predominance of the asexual or *Aglaozonia* form, while southern conditions favour that of the sexual or *Cutleria* form.

Yamanouchi (*Bot. Magazine*, Tokyo, 1911) has worked out the development of *Zanardinia*, which is allied to *Cutleria*, but has a disc-like thallus only. The nuclear divisions of the ordinary cells of the disc-like asexual plant show forty-four chromosomes; the division of a zoöspore mother-cell shows reduction, so that the zoöspore has twenty-two chromosomes. The zoöspore produces a disc-like sexual plant with twenty-two chromosomes in the nuclei of its cells; the fertilised egg cell has forty-four chromosomes, and this number is present in the asexual thallus to which it gives rise.

In *Zanardinia*, therefore, there is a regular alternation of generations, exactly as in *Dictyota*, *Polysiphonia* and so on, characterised by (1) different number of chromosomes in the sexual and the asexual plants (2) one plant being asexual and the other sexual. The asexual and sexual plants are exactly similar in structure, apart from the difference in the nuclei, just as is the case in *Dictyota* and *Polysiphonia*.

MAIZE SUGAR.—Doby (*Chem. Zeitung*, 1910, page 1330) has investigated the different forms of Maize which are grown in Europe, with a view to their productiveness in the manufacture of sugar, cellulose and alcohol. Owing to its intolerance of frost, or even of cold nights, Maize is hardly grown in England, except as green fodder, its stems being sweet, owing to the presence of cane sugar. Even in the warmer parts of Germany the amount of sugar in Maize is not so high as in America, but the culture of Maize nevertheless pays well. The largest amount of sugar is obtained on removing the young cob before the seeds have been allowed to ripen. When the cob is removed the amount of sugar passing up the stem increases until it reaches a maximum, when it diminishes again owing to respiration taking place in the still growing stem. The stems, leaves, and even the axis of the cob, afford excellent material for the manufacture of paper; the unripe cobs, as well as the green stems, can be used in the manufacture of alcohol.

THE NUCLEOPROTEINS.—A large amount of work has been done in recent years, on the nucleoproteins of both plants and animals. Much of this has been collected by Brugsch and Schittenhelm in their text-book, "Die Nucleinstoffwechsel und seine Störungen" (1910). Plimmer (*Journal Chem. Soc.*, vols. 93, 94) has indicated accurate methods for the determination of the nucleoproteins according to the quantity of phosphoric acid and the purin bases, which are the results of the splitting of the nucleoproteins by hydrolysis.

The nucleoproteins differ from other proteins in consisting of a protein combined with nucleic acid, the latter containing phosphorus, and in their resistance to the action of enzymes which readily decompose the primary proteins into peptones and simpler nitrogenous substances. Being essential constituents of the nuclei of plants and animals, they play an important part in the physiology of the cell, for the existence and development of which they are essential. The embryonic and glandular cells of animals are rich in nuclear material, and contain relatively large quantities of nucleoproteins. The same is the case with the embryonic cells of plants, not only in embryos, but also in the embryonic tissues and growing points of the stem. It is clear that formation of nucleoprotein material must take place during growth of the active tissues of plants, since increase in amount of nuclear material precedes the division of the nucleus.

Zaleski (*Ber. d. deutsch. bot. Ges.*, 1911) has investigated, by analysis, the changes in amount of nucleoproteins during growth of certain plants, *e.g.*, bean stems, leaves, roots, onion bulbs, seedlings. His results indicate that during growth there is a steady increase in the amount of nucleoprotein present in the plant. He deprecates the attempt made by some writers to attribute to the nucleoproteins the qualities of "life-bearers," "inheritance-bearers," and so on, and points out that protoplasm is an exceedingly complex structure, made up of many protein substances, though its complete chemical structure is quite unknown.

FURZE THORNS.—In 1893, Lothelier described experiments on the influence of humidity and light on the development of the leaves and branches of various spiny plants (Furze, Barberry, and so on). He claimed that branches of Furze, which under normal conditions are developed as thorns, tend to lose their spiny character and to produce leafy branches. The results obtained by Lothelier were criticised later by Goebel, who contended that the leafy shoots obtained by Lothelier were simply "reversionary shoots," which can be produced at any time from ordinary Furze branches when the plant is pruned. Zeidler (*Flora*, 1911) has made a series of careful experiments with Furze plants raised from seed, and his results may be thus summarised. (1) Spine formation is hindered in moist atmosphere, also in feeble light—in total darkness seedlings as well as older plants of Furze very quickly perish. (2) Typical more or less flattened foliage-leaves, without spines, are formed on the basal portions of the shoots, when plants are grown in damp air, but these are only formed at the beginning of each season's growth, and, moreover, they may occur on plants grown under normal conditions, so that each year's growth can easily be recognised on a plant. (3) Lothelier's results were due to the fact that he did not use entire plants, but cut portions, and besides he made no control experiments which would have shown that leafy shoots may arise in cut Furze stems grown under normal conditions.

FUNGUS IN LIVERWORTS.—Garjeanne, who has already contributed greatly to our knowledge of the biology of the "fungus servant" or mycorhiza present in various Liverworts, has recently (*Flora*, 1911) made an extensive re-investigation of the subject. He shows that the infection of the rhizoids ("root-hairs") of leafy Liverworts is a widely-spread phenomenon, that different kinds of Fungi may enter into partnership with the Liverworts in this way, that some of these Fungi belong to the genus *Mucor* (to which belongs the common Black Mould found on bread, and so on). In most cases, the particular Fungus, on being isolated and cultivated, proved to be *Mucor rhizophilus*, a new species, with small gonidangia on a slightly-branched gonidiophore. It has a greatly developed mycelium, with numerous transverse walls, and produces several additional forms of spore besides the gonidia.

THE EVOLUTION OF THE FLOWER.—H. F. Wernham has commenced to publish, in the *New Phytologist* (Vol. 10, No. 3, March, 1911), what promises to be one of the most interesting of the various series of papers which have appeared from time to time—in addition to the valuable original memoirs and summaries of recent botanical research—in this the youngest of British botanical journals, which has already taken its place among the leading scientific periodicals of the day. The author concludes his introductory article with the following summary. (1) The fundamental guiding principles in the progressive evolutionary history of the Dicotyledonous flower are two in number, namely (i) economy in production of the several items comprising reproductive organs; (ii) progressive adaptation to the reception of insect visitors. (2) The second of these principles compensates the first for the decreased chance of pollination which the latter involves. (3) There are also certain tendencies which subserve these two main principles, the most widespread being (i) progressively increasing conspicuousness attained either (*a*) by enlargement of the individual flower or, as is by far the more general case (*b*) by excessive branching of the floral axes to produce aggregation of the flowers into dense inflorescences; (ii) devices of floral structure or habit which have obvious relation to insect visits, the chief of these being zygomorphy, which may occur either in solitary or loosely aggregated flowers, but is illustrated more generally by the outer florets of a close inflorescence; (iii) fusion of parts, more particularly to form tubes, the most important type of fusion being sympetaly—the formation of a gamopetalous corolla. (4) The "primitive flower" or prototype will be, of course, one in which the working of these principles is realised the least. There will be economy in production; the parts will be, therefore, produced in indefinite numbers, and there will be no great specialisation for the reception of insect visitors—no aggregation, chorisis, zygomorphy, or fusion of parts. An analogy to such a prototype is not wanting in the Gymnosperms, for we find it in certain members of the Bennettitales, and reflected in the typical flowers of certain Ranalian orders, *e.g.*, the Magnoliaceae.

CHEMISTRY.

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

MUTTON BIRD OIL.—Numerous sea birds, including the petrels and fulmars, contain a very high proportion of oil, and for this reason are greatly valued by the natives upon the Scottish Coasts, who obtain from them "oil for their lamps, down for their beds, a delicacy for their table, a balm for their wounds, and a medicine for their distemper." In the Island of St. Kilda it is only legal to kill the fulmars during one week in the year, but during that week from eighteen thousand to twenty thousand birds are destroyed. So rich in oil are these birds, that by passing a wick through their bodies they may be used as lamps.

Hitherto the nature of the oil in these birds has not been investigated, but in a recent issue of the *Journ. Soc. Chem. Ind.* (1911, XXX, 405), there is an interesting account by Mr. Hewgill Smith of the characteristics of the oil of the Antarctic petrel, the mutton bird (*Aestralata lessoni*), which during the breeding season, is slaughtered in large quantities upon the coasts of Tasmania and New Zealand. The "oil" of this bird, which has now become a commercial product, is carried in the stomach, whence it can be ejected through the nostrils as a means of defence against its enemies.

This oil, which is found in the stomach of the dead bird, is a pale yellow or bright red liquid with a faint fishy odour. When cooled to 0° C. it solidifies to a transparent mass. The specimen examined by Mr. Smith had a specific gravity of 0·8819 to 0·8858 at 15° C. and absorbed 71 per cent. of iodine. It contained a high proportion (36·9 per cent.) of unsaponifiable alcohols, and, unlike the majority of animal fats and oils, contained no glycerine. In its general composition and properties it closely resembled Arctic sperm oil and, like that oil, did not thicken when exposed to the air. It would thus be useful as a lubricant, if it could be obtained in sufficient quantity, which is, however, unlikely. The body fat of the bird was of quite a different character from this oil, being a soft brownish solid with a specific gravity of 0·9351 to 0·9380, an iodine absorption value of 89·1, and containing only 1·76 to 2 per cent. of unsaponifiable matter. This appeared to be an ordinary fat, whereas the "oil" might be classed with sperm oil among the liquid waxes. It has been suggested that the mutton bird uses the oil for feeding its young.

THE DETECTION OF COCAINE.—A test for cocaine has been based upon the fact that it combines with potassium permanganate to form pink crystals in the form of nearly square plates. This test has been studied by Mr. E. H. Hankin (*Analyst*, 1911, XXXVI, 1), who renders it much more sensitive by allowing a strong solution of permanganate to evaporate on a glass slide, and then adding a drop of a solution of alum containing the cocaine, and watching the crystallisation under the microscope. The use of the alum is to retard the action of the permanganate, and in this way it is possible to distinguish between cocaine and certain other allied anæsthetic compounds. As an illustration of the delicacy of the test, Mr. Hankin cites an instance where a man suspected of illicit dealing in cocaine had received timely warning of the visit of the police. No cocaine was found, but various pieces of paper, in which it was supposed that the drug had been wrapped were subjected to the permanganate test, and in the case of ten out of eleven pieces the characteristic cocaine crystals were seen to develop. In another case a stain upon a telegraph form, which was supposed to have been produced by the saliva of a person who had taken cocaine was examined in the same way, and here, too, an unmistakable reaction was obtained.

ACTION OF STEAM UPON CARBON AND LIME.—The possible mode of formation of marsh gas and other natural gases rich in methane is suggested by the results of experiments made by M. L. Vignon (*Comptes Rendus*, 1911, CLII, 871) upon the action of steam upon a mixture of carbon and lime. It was found that the steam was decomposed more rapidly and at a lower temperature by a mixture of carbonaceous substances and lime than by the carbon alone. Thus when the steam was conducted through the mixture contained in a porcelain tube heated to about 600° to 800° C, the resulting gas was found to contain hydrogen, methane, carbon monoxide, oxygen, and nitrogen, the proportions depending upon various factors such as the quantity of steam present, and the duration of contact between the excess of steam and the methane formed, more or less decomposition taking place in accordance with the equation—

$$CH_4 + H_2O = CO + 3H_2$$

Thus twenty-eight per cent. of methane was produced by the passage of five grammes of steam during thirty-five minutes, whereas only about eight per cent. was obtained after the passage of fifteen grammes of steam during two hours. By regenerating the lime from the calcium carbonate produced it was found possible to transform the whole of the organic substances present into hydrocarbons in the following manner

$$2C + CaO + 2H_2O = CaCO_3 + CH_4$$

and

$$CaCO_3 = CaO + CO_2$$

or combining the two equations—

$$2C + 2H_2O = CO_2 + CH_4$$

Since the methane requires a lower temperature for its formation than that of the decomposition of the calcium carbonate, the two gases may be collected separately.

It is suggested that these experiments also throw light upon the formation of petroleum deposits. When animal and vegetable remains are left in contact with water in the presence of calcareous deposits, hydrocarbons are produced, and it is quite possible that these, under the influence of various physical conditions of pressure, and so on, have been transformed into petroleum compounds.

GEOLOGY.

By Russell F. Gwinnell, B.Sc., A.R.C.S., F.G.S.

CARBON IN GOLD ORE.—The well-known auriferous conglomerates of the Witwatersrand, known as "banket," consist of beds of coarse well-rolled quartz pebbles, together with smaller pebbles, the whole being cemented into a compact rock by means of secondary silica. They are obviously shore deposits, and are of very great—perhaps pre-Cambrian-age. The gold occurs in the matrix and not in the pebbles themselves. Pyrites is commonly present, and also in places, carbonaceous or graphitic matter. As the origin of the gold appears to be intimately related to that of the other "impurities," it is a matter of considerable interest to determine the source of the carbon. This latter has been regarded as organic matter which directly precipitated the gold from solution, although this seems hardly likely in face of the fact that there is neither gold nor carbon in the finer sediments which are associated with the banket. For a fine sediment is naturally expected to yield organic matter in greater abundance than does a coarse conglomerate. Writing in the *Transactions of the Geological Society of South Africa* (Vol. XIII., 1910), on "The Mode of Occurrence and Genesis of the Carbon in the Rand Bankets," Mr. C. Baring Horwood shows that from its mode of occurrence the carbon is of later date than the bankets, and is of inorganic origin. Gold can be found not only as a film on the particles of carbon, but also actually embedded in the latter. The carbon occurs frequently in small irregular spheroids sometimes actually replacing the quartz, and it is almost invariably closely associated with pyrites when the latter is present. Furthermore, it occurs chiefly along and on both faces of partings in the banket and along planes oblique to the bedding. These facts cannot well be accounted for by any theory of organic origin. Indeed the mode of occurrence of the carbon strongly recalls the crystals of tourmaline of pneumatolytic origin, found on the surface of joint planes in the red granite of the Bushveld. The author's researches lead to the conclusion that the carbon is of deep-seated origin and owes its presence in the bankets to associated igneous magma, probably through the agency of pneumatolysis. Other authors have ascribed an inorganic origin to certain petroleums, and have included both graphite and diamond as the end products of the petroleum series. Now, great diabase dykes penetrate the Rand country, and to these one would naturally look for the source of the carbon (and incidentally of the gold). Analyses shew that carbon is distributed evenly throughout the igneous rock, which would hardly be the case if it were derived from organic fragments caught up and enclosed in the molten magma at the time of its intrusion. The fact that gold is not found, as is the carbon, distributed about equally in dyke-rock and in banket is easily accounted for by its relatively greater solubility. On this account, subsequent leaching-out of the gold has removed it from the dyke-rock. Summarily, the study of the carbon in those mines of the Rand where it is most typically developed certainly shows that its occurrence is closely associated with that of the pyrites and gold, and indicates a close relationship between its presence and that of neighbouring igneous rocks which contain carbon. The occurrence of the carbon in tiny spheroids scattered through the matrix of the bankets points to deposition from gaseous or very mobile liquid hydrocarbons, before the final cementation and induration of the bankets by the deposition of secondary silica. Taken in conjunction with the known facts of its occurrence in other parts of the world, it is reasonable to attribute its origin to magmatic vapours or solutions derived from the neighbouring basic igneous intrusions before their final consolidation.

LABRADOR, A LAND OF PROMISE.—In the *Geographical Journal* for April, Dr. Wilfred T. Grenfell sings the praises of Labrador after an acquaintance with it of twenty years. The country has been greatly neglected up to the present time and little knowledge exists of its resources beyond its coastal portion. Yet the author is confident that Labrador can and will carry, in the days to come, a population as easily as Norway does to-day. It is a better country by far than Iceland, and until the wizard hand of man was turned to New Mexico, Arizona or even to parts of Egypt and West Australia it was able to offer as good attractions to settlement as any of them. "If ever a race shall rise to people her glorious fjords and inlets, and to wrest her undoubted wealth from her forests and mines, she will, like all northern countries, evolve a people endowed with those sterling physical qualities that characterised the Vikings of old." The agricultural outlook of Labrador is not hopeful owing to the fact that the super-incumbent rocks have been removed by glaciation from the Archaean floor, which is thus laid bare over much of the country. On the other hand this fact need not injure the prospects of the development of mineral resources. While very little serious geological work has been done, the deductions of the few prospectors who have visited the country show every possibility of valuable mineral deposits. The inland resources are almost unknown, but near the coast several deposits of economic value have been found, and in some cases worked; among these are alluvial gold, antimony, mica, copper, iron pyrites and garnet. Coal which may be a continuation of the seams of Cape Breton, has been partially prospected. Finally, the beautiful plagioclase felspar Labradorite, which derives its name from the country and which exhibits an iridescent play of colours, has been worked in an island near Nain, which consists almost entirely of this mineral.

AN IGNEOUS COMPLEX AND ITS ORIGIN.—A number of instances are now known of igneous rock-masses within which are found a series of different rock-types arranged in a concentric manner. In some of these cases, on the ground of field evidence, the occurrence has been considered as a laccolith within which *subsequent differentiation* has produced the concentric complex; in others they have been held to be stocks, or volcanic necks, in which differentiation has occurred, sometimes with subsequent movement of the differentiated bodies of magma. In the *American Journal of Science* for April, L. V. Pirsson and W. North Rice describe a case which appears to be a laccolith, intruded between a granitic bathylith and a cover of mica schist. This is Tripyramid Mountain in New Hampshire, a roughly oval mass, rising about two thousand feet above the floor of the neighbouring valleys. Around an inner core of *syenite* occurs a medium grained *monzonite* which is succeeded below and outwardly by coarse-grained *gabbro*. Lamprophyre dykes (regarded as complementary to the syenite-aplite) are situated in the peripheral gabbro and in the granite against which the complex abuts. All the rock-types in the complex possess a parting or sheet-jointing parallel to a dome-surface, but there is a sharp transition-line between the different types and only slight endomorphic evidence of contact. As to the mode of origin of the complex, the authors do not consider the case as similar to that of Magnet Cove, Arkansas, which Harker has explained as being due to the doming and erosion of superposed sheets, successively injected. The common jointing is not in favour of this, nor the relative textures of the rock types, for this view would make the gabbro, which is the coarsest grained variety, the uppermost sheet. The suggestion that zonal arrangement of different rock-types in an intrusion may be due to absorption and assimilation of surrounding country-rock is equally inapplicable in the present case. For while the country rocks (granite and mica schist) are decidedly acid in character, the border facies of the complex is the basic gabbro, the intrusion becoming more acid towards the centre.

While the concentric arrangement of the complex naturally suggests a differentiation of a body of magma in place, the abrupt transition of one type into another, and the occurrence of syenite dykes in the monzonite, and probably of monzonite dykes in the gabbro, negative this conclusion, the dykes suggesting a series of successive intrusions. Apparently what best explains the phenomena at Tripyramid Mountain is a process of intermediate nature, in which both differentiation and repeated intrusions, separated by only short intervals, took place.

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

The Weekly Weather Reports issued by the Meteorological Office show that during the week ended April 22nd the air temperature was in excess of the average in all districts, by as much as 4°·9 in England, N.E. and E. The extreme maxima varied from 59° in Scotland N. (at Strathpeffer) to 69° in England E. (at Cambridge), while the minimum fell to 27° at West Linton and to 28° in the Shetlands and at Wick. Even as far South as Swarraton in Hampshire a temperature of 30° was reported. In the English Channel the lowest reading was 40°. On the ground much lower temperatures were, as usual, experienced, and at Crathes the reading was as low as 20°, at Balmoral 23°.

Rainfall was in defect in the East and South of England, but elsewhere was in excess. In Scotland N. the amount collected was three times as much as usual, and in Ireland it was twice as much. In England E. and S.E., however, the fall was very slight and at many stations the week was rainless. As a rule sunshine was less than usual. The sunniest places were Felixstowe (60·6 hours, 63%) and Guernsey (61·9 hours, 65%), while Valencia had only 5·7 hours (6%). At Westminster the total duration of sunshine was 39·7 hours (41%).

The mean temperature of the sea water round the coasts varied from 49°·9 at Seafield to 40°·2 at Cromarty.

The week ended April 29th, was warm but cloudy and unsettled, with thunderstorms and hail. The temperature was above the average in all districts, the greatest excess being in England E., where it was 4°·6 higher than usual. The highest maximum, however, was 2° lower than that of the previous week, being 67° (at Cirencester) on the 23rd, as against 69° (at Cambridge) on the 22nd. The lowest readings were 28° at Balmoral and 30° at Nairn, but at no other stations in the United Kingdom did the air temperature fall below the freezing point. On the ground the temperature fell to 23° at Crathes, and to 25° at Balmoral.

Rainfall was in excess in all parts. At several stations rain was measured on every day. At Donaghadee, on the 29th, there was a heavy thunderstorm with rain and hail, the total precipitation for the day being 1·12 inches.

Sunshine was everywhere deficient, and in some places less than half the usual amount was recorded. Torquay reported the largest aggregate, 48·5 hours (49%). At Westminster the total was 35·3 hours (35%).

The mean temperature of the sea water ranged from 40°·7 at Cromarty to 50°·8 at Seafield.

The week ended May 6th was unsettled at first but the weather improved later.

Temperature was low in most places, although the defect was nowhere very great. The highest reading reported was 66° at Alnwick Castle and at Raunds. Frost was experienced in several places, the lowest readings being 28° at West Linton, and 29° at Fort Augustus. The grass thermometer went down to 23° at Crathes, and to 24° at Burnley.

Rainfall was again in excess, except in England N.E. and E., where it was slightly in defect, and in the Midlands, where it was almost normal. In Scotland and in Ireland the rainfall was very heavy, and at Fort William the total for the week was as much as 3·27 inches, and at Killarney 2·34 inches.

Sunshine was above the average in England E. and S.E., and in the Midlands, though below it elsewhere, except in Scotland N., where, in spite of the fact that the rainfall was nearly twice as much as usual, the sunshine was 5 hours (5%) in excess of the normal. Brighton reported the longest duration of sunshine, 58·4 hours (57%); at Westminster, the amount was 46·5 hours (45%).

The temperature of the sea water varied from 43° at Pennan Bay and Burnmouth to 54° at Seafield.

The week ended May 13th was fine at first, but became changeable and thundery. Temperature was high throughout, being in excess of the average in all districts. In Scotland W. it was 6°·2 above the normal. Maxima above 70° were recorded in all parts, the highest being 76° at Colmonell and Greenwich. No frost was experienced, the lowest of the minima being 33°, which was reported from Geldeston Bawtrey and Marlborough. The lowest temperatures on the grass were 27° at Kew and at Rauceby, and 28° at Greenwich, Tunbridge Wells and Wisley.

Rainfall varied a good deal in different parts of the country. It was a little above the average in Scotland, and in Ireland N., but was below elsewhere, and in some places very greatly below. In the Midlands it was only one-third, and in the English Channel, less than one-seventh of the usual amount. Some heavy falls were however experienced, especially during the thunderstorm on the 13th, when the rain collected at York and at Rothamsted measured 1·2 inches, at Killarney 1·4 inches, and at Newton Rigg and Burnley 1·7 inches.

Sunshine was generally above the average. England S.E. was the sunniest district, with 68 hours (65%), or 21 hours above the normal. Of the individual stations, Felixstowe reported the largest aggregate 89·7 hours (85%), and Hastings the next largest, 82·7 hours (79%). At Harrogate the total duration was only 32·1 hours (30%). At Westminster the total was 52·6 hours (50%).

The temperature of the sea water was higher on all coasts than during the corresponding week of 1910. The individual readings varied from 44° at Burnmouth, to 60° at Seafield.

A balloon carrying a Meteorograph was liberated at Manchester at 5.50 p.m. on March 1st and was found at Little Downham, near Littleport, Cambridgeshire, having travelled one hundred and twenty-four miles in a south-easterly direction the instrumental record showed that the balloon had reached an altitude of 19·1 kilometres or sixty-two thousand feet. The lowest temperature recorded was 214°·5 (absolute scale) at a height of thirty-three thousand feet. The temperature then increased to 224°·5 at thirty-nine thousand feet, but fell again to 218°·0 at the maximum height.

MICROSCOPY.

By A. W. Sheppard, F.R.M.S.,

with the assistance of the following microscopists:—

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

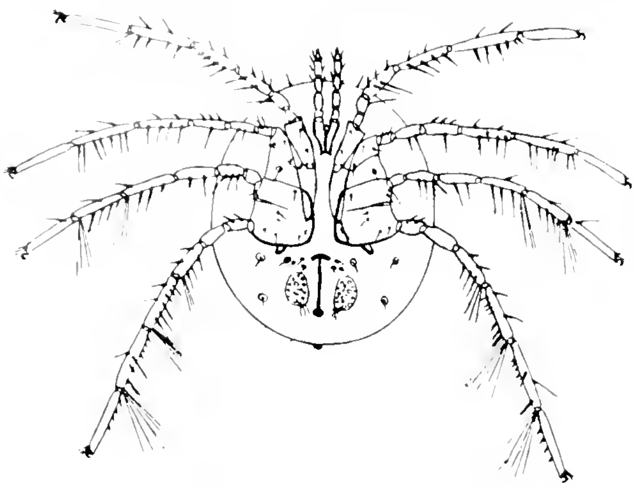


Figure 1.

Neumania triangularis, Female, ventral surface.

NOTE ON A WATER-MITE NEW TO BRITAIN (*NEUMANIA TRIANGULARIS* PIERSIG).—In 1908 both sexes of the above mite were taken from a fresh-water pool in the locality of Stourbridge, Worcestershire.

The female is 1·42 millimetres long, of a pale yellow colour. Epimeral plates are finely granulated, the fourth pair having a well-marked hook-shaped process at their lower extremity. The genital plates are green in colour, with thirty to thirty-five acetabula on each. Above each plate are three small hair pores arranged somewhat like the apices of a triangle in outline, together with a prominent gland. Legs are yellowish-green in colour and all supplied with strong spines or swimming hairs, the second and fourth pairs having in addition a number of feathered or serrated hairs presenting a pretty effect under dark ground illumination.

The male is smaller than the female, 1·12 millimetres long, of a light almost transparent yellow colour. The Malpighian vessel is very distinct. Genital plates are circular in outline, of a pale green colour, with about twenty-five acetabula on each half and several fine hairs at top and bottom. Two prominent glands on each side of median line, one towards margin of body. Several species of this genus are described by Mr. C. D. Soar in *Science Gossip*, Vol. VII, p. 19 under the generic name *Cochleophorus*.

G. P. Deeley.

ON THE IDENTITY OF *HABROTROCHA BIDENS* (GOSSE).—If the recognition of this handsome and graceful Bdelloid depended solely upon the original description ("Catalogue of Rotifera found in Britain," P. H. Gosse, *Ann. and Mag. Nat. Hist.*, 1851), it could only be regarded as hopeless, for the few characters then stated have proved to be common to many distinct forms. Fortunately, however, Gosse found opportunity in "The Rotifera" (Hudson and Gosse, 1886), to provide a fuller description accompanied by figures which, if wanting in detail, give a fair idea of the general style of an animal which seems to be somewhat of a rarity. In about twenty years' experience I have only met with it on two occasions, viz.: in ground moss kindly collected for me by Mr. D. J. Scourfield near Bury St. Edmunds, and from roof moss which I obtained from an accessible roof-gutter near Mundesley.

But before finding, in 1908, the particular form which I am confident is that seen by Gosse, I had repeatedly compared with his description other two-toothed blind Philodinidae, always with unsatisfactory result. That others may avoid the like tedious proceeding, it may be useful to point out the more distinctive details supplied by Gosse, and to give some additional characteristics which will further establish a very interesting species.

The corona and the body outline of my specimens were generally in agreement with Gosse's figures, and they also possessed the wild manners, the small two-toothed rami, and (occasionally) the angular lateral prominence which he described. But the most unusual detail, and, therefore, the best for purposes of identification, was the constantly recurring display of the central toe, short and acute, between the spurs, as shown by Gosse in his figure of the imperfectly retracted position, a pose of the toe and spurs characteristic also of *Habrotrocha tripus* (Murray), but elsewhere unknown among blind three-toed Philodinidae. Gosse describes the foot as having a small stiff point behind and two soft

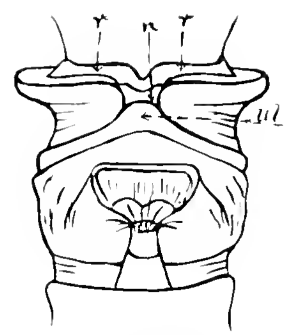


Figure 1.

Head with corona (dorsal view).

Figure 2.

Extremity of foot (ventral view).

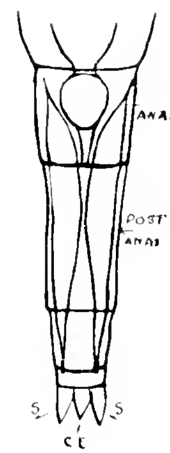


Figure 3.

Anal segment and foot (dorsal view).

cylindrical lateral protrusible toes, truncate at the extremities. I do not seem to have seen the truncate ends of the lateral toes, but the central toe was frequently visible as a small stiff point behind.

Gosse's description of the stomach is also noteworthy. In one of his specimens it appeared to be composed of a number of spherical cells, but in others was of a minutely granular texture. These varying appearances of the stomach are quite usual with several species of the "pellet-making" Philodinidae and depend upon the quantity of digestive fluid between the two membranes of the stomach wall. When the fluid is scanty the food-pellets within the stomach cavity are plainly visible, and have the appearance of spherical cells. When the fluid is abundant, its finely-granular consistence is sufficiently opaque to completely hide the actual contents of the stomach. I believe, therefore, that Gosse's description of the stomach indicates that his species was a pellet-maker and in this respect also my specimens agreed with his. *Habrotrocha* *bidens* is, in fact, the largest pellet-making species yet found, my examples attaining a length of 400 μ, when apparently fully grown. But apart from its great size, it may be recognised by the slenderness of the anal segment, and by the length of the foot, the post-anal segment being about twice as long as its average width, and also by a peculiar ridge-like structure crossing the trochal discs. When feeding the foot was generally extended, sometimes showing the central toe (*c.t.* Figures 2 and 3), sometimes not. The rather short spurs (*s.s.*) were held nearly parallel to the body axis. The lateral toes (*l.t.*) were invaginated as usual.

A diagrammatic view of the head with corona displayed is given in Figure 1, the cilia of both principal and secondary wreaths, which are quite normal, being omitted for greater clearness. The moderately wide trochal discs are supported on two strong pedicels. Near the centre of each disc the trochal seta-pencil rises from a small prominence from which a low ridge (*r. r.*) continues to and over the inner margin of the disc, the ridge from either disc dipping to meet that from the other. As these ridges arise at the nerve centre of the discs, I surmise that they protect nerve branches passing towards the median line. I have not seen them so well developed in any other Bdelloid and rarely even rudimentary. Between their junction and the moderately high upper lip (*u.l.*) is visible a fleshy nexus (*n.*) connecting the pedicels and extending nearly up to the level of the discs.

In all my specimens, the food-pellets were of unusually small size. The characteristic wildness of the animal is greatly modified if it be kept for a week or so in a small trough or cell. Examples thus confined produced eggs of oval form, but proportionally longer than customary among Bdelloids. The embryo developed very rapidly, and the young rotifer emerged in about six days, about half the usual period.

DAVID BRYCE.

ON FLUID MOUNTING.—There is no question that with very many classes of objects fluid mounting is the best, as the preparation is shown without pressure or distortion, and the natural arrangement of the parts gives a true idea of its real nature. Many of us, however, bar fluid slides altogether owing to their usual habit of leaking after a short period, and it is to obviate this fault that the present note is given. The first essential of a cemented joint is usually as close a joint as possible with a minimum quantity of the adhesive. This, as is ordinarily tried with marine glue, gives a perfectly sound joint of the ring to the slide, but owing to the unequal expansion and contraction with temperature changes of the fluid mountant as compared with the glass, the rigid setting sooner or later gives way and the slide is ruined. What is really required is a cement sufficiently hard to be adhesive, rigid enough to bear handling, yet elastic to stand the trifling differences of volume required with temperature variation. Hence a sufficient quantity of an elastic cement must be used to accommodate by its own variability the necessary changes. Such a cement can be made as follows:—A penny tube of cycle rubber solution, which is rubber in naphtha, is emptied into a four-ounce bottle and double its volume of old gold size added, shaking till thoroughly mixed. This must now be placed on a water bath or anywhere to be heated not beyond one hundred and fifty degrees in order to drive off the naphtha and any volatile constituent of the gold size. Whilst this is being done, prepare a thick solution of shellac in absolute alcohol (not methylated spirit) and add, when the other solution is naphtha-free, twice its volume of shellac solution as thick as treacle. Stir whilst hot and filter through fine muslin before cooling. It can be thinned as desired with absolute alcohol. The reason why methylated spirit cannot be used is that the denaturant which evaporates with the spirit may evaporate inwards and be condensed in the fluid mountant, and I have seen many slides spoiled by a milky fog caused by the condensed denaturant, which is not transparent when mixed with water any more than methylated spirit is. The quantity required is not large, so absolute alcohol is not prohibitive.

Use the mountant as thickly as it can be worked to flow and make a heavy ring on the slide. Of course, it is preferable to do a fair quantity at one time. This sets in about fifteen minutes and dries reasonably hard in a day. This ensures perfect contact of the cement to glass slip. To cement the rings I take a scraping of soap from the piece in use, and spread it on the turntable centre. A ring flatted on coarse emery cloth if metal, or coarse sandpaper if vulcanite, can be pressed on to the soap and adjusted centrally with sufficient firmness to be cemented all round, leaving a more level ring than can be otherwise obtained. The next day, or later, a thin ring of cement can be put on the slip and the ring adjusted in place. When hardened you will have perfect contact of cement and glass, with perfect contact of cement and ring, with an elastic layer of cement in between, which is capable of absorbing any small variation under the exercise of pressure. A ring fixed in this manner is likely to remain permanent if the further mounting operations are properly performed.

C. E. HEATH, F.R.M.S.

MICRO-FUNGUS FROM THE JAPAN-BRITISH EXHIBITION.—A friend who visited the Aino village in the Japan-British Exhibition last year at Shepherd's Bush, happened to pull out a straw from one of the native huts. He found it was rice straw and had been brought from Japan specially for the construction of the huts. Some minute dark spots on a leaf proved on examination under the microscope to be patches of a fungus. It is one of the Puccinias, a genus

FIGURE 1.

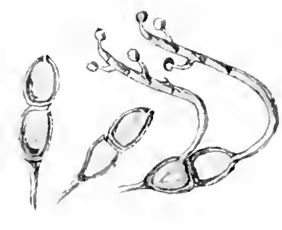


FIGURE 2.

of which there are very many species, growing on various plants and widely distributed. Dr. Cooke records no less than seventy-eight for Britain alone, "Microscopic Fungi" p.p. 202–212. The well-known "Mildew" on wheat is one of them, *P. graminis*, and the example found on the rice straw closely resembles it, though probably, as living on another host, it would be considered a separate species. The patches (sori) are found on both sides of the leaf in this case, and are made up of very numerous double spores, attached to stalks often of considerable length, Figure 1. The mature spore has a thick outer coat of a rich brown colour, and a thinner one within. At the apex an opening through the thick coat can be seen, and the lower spore has a similar opening—usually rather difficult to make out—on one side just below the cross wall, Figure 2. Through these openings, on germination taking place, a tube is protruded, the further end of which divides into three or four cells each bearing a very small spore on the end of a short branch, Figure 2. It is these extremely minute secondary spores which propagate the fungus. In many species they do not reproduce a Puccinia such as they arise from, but another form known as "cluster cups," an elegant little fungus well known to microscopists. This may be produced on the same or on a different species of host plant, with many variations in the details, for the life history in most cases is very complicated. Immense loss is caused to farmers and horticulturists, as the fungi weaken and even destroy the plants on which they grow.

J. B.

THE SCALES OF LEPIDOPTERA.—Some time ago I received from a correspondent in South Africa some curious pupae which he had found suspended by threads from one of the branches of a bush. They were sent in spirit which did not seem to have injuriously affected either their form or colour. On examination they were seen to be in different stages of development, the imago in one being apparently on the point of emergence. Upon carefully removing the enclosing membrane from this, I extracted a butterfly which ppeared to be perfectly mature, except that the wings were shorter than the body, as is usual when the insect first bursts from the pupa case. It had often been a matter of conjecture how it was that when the wings of a butterfly were fully expanded a few hours after emergence, the scales were all perfectly formed and covered the entire wing surface by overlapping at their lower edges like tiles when laid on the roof of a house. It did not seem possible that if the scales were fully formed and covered the wings in the same manner when only one third of their ultimate length, they could also cover the expanded wing so completely as we find to be the case in the mature insect. On setting the specimen referred to, and placing it under the microscope, the mystery was at once solved by finding that the scales were all there and in perfect condition, but instead of lying flat they were standing on end attached to the membrane of the wing in the usual manner, but so close together that the coloured pattern formed by them could be distinctly made out. In this position,—just as roofing tiles take up less room when standing close together on edge,—the scales then occupied a minimum amount of space, and it seemed clear that as the membrane expanded it would draw their stalks farther apart, and at the same time cause them to lie down, and in this way cover a greatly increased area.

R. T. Lewis, F.R.M.S.

THE ROYAL MICROSCOPICAL SOCIETY.—April 19th. H. G. Plimmer, Esq., F.R.S., President, in the chair. Mr. E. J. Spitta gave a demonstration of low-power photomicrography with special reference to colouring methods, in which he showed some fifty coloured slides which had been coloured by an artist friend by a completely new method.

Mr. Spitta also communicated a report on Grayson's Rulings presented by Mr. Conrad Beck to the Royal Microscopical Society, which embodied the results of many thousand observations.

Mr. E. J. Shepherd read a paper on "The Re-appearance of the Nucleolus in Mitosis," which formed an addendum to his previous paper, communicated in April, 1909, on "The Disappearance of the Nucleolus in Mitosis." In the present communication he said that with a view to ascertaining how and when the nucleolus makes its re-appearance, the diaster stage is the one which calls for most careful study and observation. At or about the time of the formation of the dispirem, and before the diasters have lost their characteristic shape, a looping in the chromatin is observed—the number of loops varying in each daughter nucleus. It is in these loops that the nucleoli will appear, but it must not be inferred that a nucleolus will appear in each loop, as there are frequently more loops than nucleoli. The latter make their appearance when the division of the cell is well marked, and when the interzonal fibres have generally disappeared. From the results of his research, he was of opinion that the nucleolus is a product of the chromatin injected into the loops by a process which can best be described as a "streaming in" process. A full account of the technique of the staining and methods adopted, and so on, which have led to the above conclusion, will be found in the *Journal of the Royal Microscopical Society*.

Mr. J. Murray communicated the second portion of a report from the Shackleton Antarctic Expedition of 1909, on the Canadian Rotifera. Forty-two species (all Bdelloids) were collected among mosses. They included five new species—*Callidina asperula*, *C. canadensis*, *Mniobia obtusicornis*, *M. montium*, *Habrotrocha maculata*. There were also a number of peculiar varieties of other species. *C. asperula* has since been found in Ireland by the Clare Island Survey. Twenty-seven Bdelloids were previously recorded for the United States. Six of these occurred in their collections, so that the number of Bdelloids now known in North America stands at sixty-three species, but a number of these are of doubtful value. Among the rarer Canadian species were *Philodina australis* (Australia and Canada), *Callidina speciosa* (British Guiana and Canada), *C. zickendrahti* (Russia and Canada).

A description of a new piece of apparatus for photomicrography, with the microscope in the inclined position by Señor Domingo de Oureta, was read by the Secretary.

QUEKETT MICROSCOPICAL CLUB.—April 25th, 1911. Professor E. A. Minchin, M.A., F.R.S., President, in the chair. Dr. A. C. Coles, of Bournemouth, sent a note describing the advantages of Parolein as a mounting medium. Its refractive index is 1·471, as against 1·530 for balsam in xylol. It is absolutely neutral, and, so far as is known at present, is entirely without action on any dyes. It is rather more trouble to use than a balsam, as, being a liquid, the preparations require to be ringed with some cement which is also neutral. (A detailed account of the methods employed by the author will be found in *The Lancet* for April 1st, 1911.) A number of bacterial preparations mounted in parolein were exhibited under microscopes lent by Messrs. H. F. Angus & Co.

The President exhibited and described: (1) Cysticercoid of the rat-tapeworm *Hymenolepis diminuta* from the body-cavity of the rat-flea, *Ceratophyllus fasciatus*, with head invaginated. (2) The same, with head extended. (3) Another species of cysticercoid, probably *H. murina*, also from the body-cavity of the rat-flea. (4) Ventral nervous system of *C. fasciatus*. (5) Salivary gland and duct of *C. fasciatus*. These preparations were displayed under microscopes, also kindly lent by Messrs. H. F. Angus & Co.

The Honorary Treasurer, Mr. F. J. Perks, read "Some Notes upon Seeds as Micro-Objects" contributed by Mr. N. E. Brown. It was recommended that the specimens be mounted in cells, dry, on clear glass slips, not on a dark ground, and fixed in position with seccotine or gum. For illuminating, a spot lens and concave mirror below the stage, together with a stand condenser to give top light, were used. Added beauty is obtained if coloured gelatine, say red, is placed below the spot-lens, and a green gelatine held over the stand-condenser. Some of the more beautiful varieties were then described, among which may be mentioned *Pterosperma andromedea*, *Paulowenia imperialis*, *Philydrum lanuginosum*, *Nemesia Strumosa*, *Elionurus elegans*, and *Sesamum capense*.

Mr. D. J. Scourfield, F.Z.S., F.R.M.S., made some remarks on "The Use of the Centrifuge in Pond-Life Work." He had recently been experimenting with a hand-driven form running at about seven thousand revolutions per minute. The tubes held only about one-and-a-half c.c. instead of the usual fifteen c.c. It was found that if plain water be taken from any pond in a tube without a net, and centrifuged, there are obtained numbers of very minute flagellates, very small heliozoa, diatoms and desmids, and a great variety of immature forms. The size of these organisms was of the order of the one-thousandth of an inch (25μ). There was a considerable field for work on what had been christened the "centrifuged plankton." He had observed quite a number of forms new to him, but could not yet say if they were really new. Certainly some of them had never been named.

ORNITHOLOGY.

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

JUDGMENTS ON THE ROOK.—Mr. Walter E. Collinge has recently been investigating the feeding habits of the rook, and gives his finding in his *First Report on Economic Biology* (Birmingham, Midland Educational Coy., 1911. Price 2/6 net.) He is strongly of opinion that we have too many rooks, as they are distinctly destructive to cereal and root crops, game, and so on, and that they should be systematically reduced in number and held in check. This verdict is supported by the results obtained from examination of the stomach contents of eight hundred and thirty rooks shot throughout the year 1908–9, in England and Wales, and (to continue using Mr. Collinge's own words) showing:—

(1) That 67·5 per cent. of the food of the rook consists of grain: if to this we add that of roots and fruits, the percentage is raised to 71 per cent.

(2) The animal food-content was only about 29 per cent., of which quite one-third must be reckoned against the rook.

(3) There is ample evidence to show that, with the present large numbers of rooks, a grain diet is preferred.
(4) So far as the evidence of this enquiry shows, the rook is not a particularly beneficial bird to the agriculturist, although its usefulness might be considerably increased were it fewer in numbers.

This is even more condemnatory of the rook than the figures which are given in the *Transactions of the Highland and Agricultural Society* for 1896, as the result of investigations made by Sir John Gilmour in Fifeshire. During one year, about thirty rooks were shot and examined each month—three hundred and fifty-five birds in all—and it was found that eighty-one per cent. of their food was cereal grain and husk, with insect and grub; also that grain and husk were at least as frequently met with as insects and grubs. It is stated that grain and husk is above everything the food of the rook, and that a general crusade throughout the country should be waged against rooks and rookeries.

On the other side Mr. Robert Newstead's opinion is that the rook is, on the whole, decidedly beneficial, though quite omnivorous and a great destroyer of grain. (*The Food of some British Birds*, 1908.)

The rook is scheduled, along with the starling and chaffinch, as the subject of the first enquiry by the Economic Ornithological Committee of the British Association as to the food of birds, and, from this, further reliable data and facts may be expected to be forthcoming ere long.

DECREASE IN THE CORN-CRAKE OR LAND-RAIL (*CREX PRATENSIS*).—In recent numbers of *The Zoologist*, correspondents have been giving instances of changes or fluctuations in the numbers and distribution of some of our commoner birds. To the present writer the most interesting case is that of the Corn-crake. Within the last few years he has had some opportunity of comparing, by field observations, the bird-life of the Home Counties with that of the West of Scotland, and, as regards the Corn-crake (a most familiar species in the last-named district), he has only once heard it in the course of many outings each season in Middlesex, Herts and Bucks. That was on 5th June, 1910, near Great Missenden, Bucks. This is so greatly at variance with the statements made in local bird-books, that some explanation or fresh examination seemed necessary. This has been forthcoming in some details from the various contributors to *The Zoologist*, who unite in agreeing that this bird, once abundant and common, must now be considered scarce over a wide area including Berks and the Thames Valley, Oxfordshire, Bedfordshire, Staffordshire, Surrey and Hants. It is, in one way, consolatory to the present writer to find Mr. O. V. Aplin, author of "The Birds of Oxfordshire," 1889, saying that he heard the Corn-crake at Bloxham, in 1910, but had not done so since 1904.

The scarcity is attributed to destruction of the birds and their nests by mowing-machines, by birds being killed by flying into telegraph and telephone wires, by unseasonable summers and by wetter meadows along the Thames and its tributaries. But the question may well be asked why the species holds its own in the West of Scotland, where such conditions are quite as prevalent as elsewhere in the country.

THE RED GROUSE ON THE CONTINENT.—This typical British species *Lagopus scoticus* seems now to have obtained a secure footing on the Hohe Venn, an elevated region of moorland situated along the Germano-Belgian frontier, South of Spa. The first introductions were made in 1893, but were unsuccessful. In August, 1894, fifty pairs were imported, and by the following autumn they had spread all over the locality named. In 1901, it was estimated that there were one thousand birds in the two "Kreise" of Malmedy and Montjoin. Professor W. Somerville, who gives this information in *The Ibis* (April, 1911, page 368), flushed a strong covey in a short walk over the moor in September last.

A NEW BRITISH BIRD.—Fair Isle has again yielded an addition to our avi-fauna, Mr. Wm. Eagle Clarke reporting in the current number of the *Annals of Scottish Natural History* (page 70) that an example of Blyth's Reed-Warbler (*Acrocephalus dumentorum*) was obtained there in September, 1910. This species resembles the Reed-Warbler, and Marsh-Warbler closely in colouration, and very careful comparison is required to distinguish these three forms. It is eastern in range and is not known to have occurred previously west of St. Petersburg.

WHITE STORK BREEDING IN THE "ZOO," LONDON.—A pair of White Storks (*Ciconia alba*), which were placed in the sea-gulls' aviary about a year ago, built a nest there on the ground, laid three eggs, and after twenty-eight days' incubation, hatched one egg on the 1st May. The young bird seemed doing well some days thereafter, and it is hoped may be successfully reared, as this is the first time this species has bred in the Zoo.

COLLECTING AND PROTECTING BIRDS OF PARADISE.—A great collector describes in the current number of *The Ibis* (April, 1911, pages 350–367) sixteen new species and sub-species of Birds of Paradise published since 1898, and also gives a complete revised list of all the known birds of this group. This makes a considerable addition to our knowledge, the information being given for high scientific purposes and for the advancement of knowledge. Trinomials are largely used, and such names occur as *Lycocorax pyrrhopterus pyrrhopterus* (Bp.).

A bird "collected," either scientifically or unscientifically, is accounted for in a final and effective method, although its remains may be treasured in a museum, and it is something of a coincidence that the same number of *The Ibis* (page 403) contains a plea for preserving Paradise-Birds "from the utter extinction which will certainly befall them unless some steps are taken to guard them from destruction." This remark is made in commending the action of Sir William Ingram, who has acquired the island of Little Tobago, West Indies, for the purpose of an experiment in acclimatizing Paradise-Birds. This is an uninhabited island, except for the keeper who has been placed upon it to look after the forty-eight living examples of *Paradisea apoda*, brought from the Aru Islands and set free on Little Tobago. We trust that the experiment will command success and shall look forward to hearing of satisfactory results.

THE BRITISH ORNITHOLOGISTS' UNION EXPEDITION TO THE SNOW MOUNTAINS OF NEW GUINEA.—The members of this expedition are now all returning home, and were to sail from Singapore on 5th May. Insurmountable difficulties have prevented complete success attending their efforts, but they attained the top of the first great mountain-range near the snows; and considerable collections of birds, mammals, and other objects, have been made, which are expected to yield valuable scientific results. A number of letters from the leader, Capt. Rawling, appear in *Country Life* (20th May, pages 719–23).

PHOTOGRAPHY.

By C. E. Kenneth Mees, D.Sc., F.C.S., F.R.P.S.

THE ROYAL PHOTOGRAPHIC SOCIETY'S EXHIBITION.—The Fifty-sixth Annual Exhibition of the Royal Photographic Society was opened on May 9th, at Prince's Skating Club, Knightsbridge, W.

The Exhibition of pictures was of considerable interest, the general collection being augmented by a special loan collection of photographs of His Majesty, King Edward VII, a number being lent by Her Majesty Queen Alexandra.

The Pictorial Section was generally considered to be a satisfactory and representative display, and an interesting new experiment was the Section for General Photography, in which the pictures were selected for their technical merit.

While some very fine work was shown in this Section, notably Dr. Thurstan Holland's photograph of the Bernese Oberland, one cannot help feeling that far more first-class echnical work is available than was shown, and that when the Section has become more familiar to Exhibitors much better results may be expected.

In Section 3, devoted to Colour-Photography, many transparencies of scientific interest were shown. Professor Waymouth Reid showed a splendid collection of Autochromes, including a very large and fine polarised light figure of the mineral Barytes. Other polarisation colour-slides were shown by Professor Pope, J. G. Bradbury and A. W. Harris.

There is no doubt that for the demonstration of polarised effects the Autochrome plate will prove most suitable, and should in the end win an important place for itself in the class teaching of Mineralogy.

Of Botanical work also there were many fine examples: the Alpine flowers of Mr. Somerville Hastings being conspicuous.

Dr. Drake Brockman showed a number of moths and butterflies, while Mr. Martin Duncan, Mr. J. I. Pigg and Mr. P. C. Dallinger, as well as Prof. Waymouth Reid, showed photomicrographs in colour.

As a whole the Colour Section must be considered excellent in quality, and thoroughly representative of the valuable work that can be done on screenplates.

Of Natural History Photography the present writer is scarcely competent to speak, but to an outsider the Section seemed a good one, and many interesting photographs were shown.

Technically, Mr. H. C. Knowles' photograph of the Great American Egret, reproduced in the Exhibition Catalogue, is excellent work, while the Yawning Jaguar of Mr. H. Irving, strikes a rather unusual note. Mr. C. J. King contributes a series of patient studies of Peregrine Falcons, and indeed the Section is unusually rich in series of photographs illustrating the life-history of birds and beasts, in which perhaps the chief scientific value of Natural History photography is to be found. An excellent example was the series of twelve prints illustrating the life-history of the Nightjar during the nesting period, by Mr. William Farren. Mr. Pike's photograph of the Gannet going down wind will appeal to most photographers and makes one inclined to suggest that it might be an improvement to this Section, even at the cost of enlarging the Catalogue, if fuller particulars of the way in which the photographs were taken were given.

Section 5, which is devoted to Scientific Photography and Reproduction Processes, was particularly strong this year, both the Photomicrographic and X-Ray sections being very representative. The Astronomical section, containing a large number of very high-class transparencies, is liable to be somewhat ignored by the general public. It would perhaps be better if astronomical workers were to prepare prints from their negatives for such an Exhibition, even though transparencies show more detail and better render gradation. Transparencies are very difficult to hang and light satisfactorily in an Exhibition, and are therefore liable to be separated from the rest of the scientific section, and to suffer in consequence.

The first eight frames of the Scientific Section were a collection of examples of new methods of process reproduction shown by the London County Council School of Photo-Engraving and Lithography; they comprised frames showing the new Rotary photogravure as applied to newspaper illustration, and also the improvements in relief methods which the introduction of intaglio processes has stimulated. There was also an excellent frame showing Rotary photogravure in colour, and another showing Photolithography in colour from half-tone transfers printed by the off-set process.

Immediately after these the photomicrographic section commenced with a splendid series of high-power photomicrographs of diatoms by Dr. T. W. Butcher, which have received a well-deserved medal. Conspicuous in this section also were the pathological photomicrographs of Mr. Richard Muir, and the bacteria and trypanosomes of Dr. Duncan J. Reid, an interesting frame, No. 633, by the latter giving full particulars of the photographic conditions under which a number of varying objects were taken. A careful study of this frame could not fail to be of use to any worker in this subject.

Mr. C. R. Darling showed a series of photographs of drop formation, the drops consisting of aniline oil suspended in water.

One of the best photographs, technically, in the whole Exhibition was Mr. H. N. Newton's photograph of a dissected human heart, No. 653, which showed the ventricles and valves with strengthening cords. A large number of photographs of osmotic growths was shown by Dr. Stephane Leduc, and others were contributed by Dr. J. Gray Duncanson.

The Radiographic Section vied with that dealing with Photomicrography in being fully representative and of the highest order. The medal was given to Dr. Thurstan Holland for his numerous photographs, and was no doubt awarded as much for the general excellent work which Dr. Holland has done in perfecting X-Ray technique as for the special photographs shown at this Exhibition. As Dr. Holland also received a medal for his photograph in Section 2, he is in the unusual position of receiving two medals in the same Exhibition.

Other excellent radiographs were shown by Dr. Robert Knox, whose technical skill closely approaches that of Dr. Holland's, and by Dr. G. H. Rodman; while two photographs of the highest class were sent by Dr. G. T. Haenisch.

The Astronomical Section of the Exhibition was mainly represented by the many transparencies shown by the Lowell Observatory and by Dr. Max Wolf of Heidelberg. Dr. Wolf showed a collection of no less than 50 lantern slides, while Lowell Observatory sent a series of photographs of Saturn and Jupiter, and of Comet *a* 1910 and of Halley's Comet, the spectrum of Halley's Comet being also shown.

In Spectroscopy, Professor Zeeman received a medal for his absorption lines of Sodium in a magnetic field, the resolution being very clearly shown. The definition which can be obtained in Spectroscopy under the best conditions was well shown by Mr. Stanley in his enlarged photographs of the iron and aluminium arc spectra.

Many other interesting photographs were shown, but one cannot help feeling that an Exhibition such as this might be made much more fully representative of the application of photography to science, if scientific workers generally would take more interest in it and endeavour to make use of the opportunity of laying their results before the general public.

PHYSICS.

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

OPTICAL PROPERTIES OF VAPOURS.—Professor R. W. Wood has recently delivered three lectures at the Royal Institution, on the optical properties of vapours. These lectures were illustrated by experiments, illustrating most beautifully the various phenomena referred to by the lecturer, who is a master of the art of designing experiments and whose ingenuity is unbounded.

His first lecture dealt with the absorption of light by vapours. Many substances have a definite colour in the gaseous state; nitrogen peroxide is brown, iodine vapour violet, chlorine green, nitrosodimethylaniline green—a few of many examples. If light, after passing through such gases, is analysed by a spectroscope, the spectrum will be crossed by dark lines and in some cases by dark bands. The light of these wave-lengths corresponding to the dark lines and bands has been absorbed by the vapour. In the same way the light from the photosphere of the sun is absorbed by the layers of vapour round the sun constituting its atmosphere: dark lines then make their appearance in the sun's spectrum corresponding to the elements in the state of vapour in the sun. At the time of an eclipse, when the moon hides the sun's disc-like form, the spectrum of the corona is often found to contain bright lines in the neighbourhood of prominent absorption bands in the solar spectrum, those about the yellow sodium lines being peculiarly prominent. It was not easy to explain how the "reversing" layer, or the layer of gas responsible for the absorption of the light from the photosphere should be hot enough to emit light of its own. This particular bright line spectrum has been termed the "flash" spectrum. Before being able to give the true explanation of the flash spectrum, it is necessary to explain what is meant by dispersion.

If white light be passed through a glass prism, it is not only bent and deviated by an amount proportional to the "refractive index" of the glass, but it is also split up into a spectrum, the red light being less deviated than the violet; this is termed the "dispersion" of the light. Now light is refracted more by a dense glass prism than by a light crown glass prism of the same angle, but it does not necessarily follow that the dispersion is proportional to the "refractive" power (*i.e.*, to the refractive index) of the glass. It is this that makes it possible to construct achromatic prisms and lenses; the dispersion of one prism can be counteracted by that of a dense flint glass prism though the deviation or refraction of the beam of light is still obtained. Newton arrived at the conclusion that dispersion was proportional to refraction; this was erroneous. If the refractive indices be plotted against the wave-lengths of the light passed through various substances, it is not always found that the substances of high mean refractive index give great dispersive powers, or steep curves, when plotted as mentioned.

Kundt found in examining the absorption spectra and dispersion curves of many dyes, that such highly coloured substances which show strong absorption bands, give what has been termed "anomalous dispersion" in the neighbourhood of these bands. Instead of increasing as the wave-length decreases, the refractive index increases very rapidly on the red side of the absorption band and decreases towards the blue side of the band. "Normal" dispersion is merely a particular case of the general phenomena of dispersion; the band near which the dispersion is "anomalous" lying, for transparent colourless substances, in the ultra violet invisible region of the spectrum.

Returning now to the sun and considering its "flash" spectrum, it follows that the refractive index in the neighbourhood of an absorption band, due to some vapour or other, will increase very rapidly; it will be very small except close to the absorption band, hence light nearly corresponding in wave-length to the absorption band will alone be sorted out and bent sufficiently for it to reach the earth, when the moon has blocked out all direct light from the photosphere. This beautiful explanation is due to W. H. Julius, but Professor Wood has been able to reproduce the phenomenon experimentally, thus confirming the correctness of the theory.

It will be well first to describe Professor Wood's method of illustrating the anomalous dispersion of sodium vapour. A long glass tube with pieces of sodium strewn on the bottom is fitted with plate glass ends and exhausted. It is then heated by carefully adjusted Bunsen burners. The upper surface of the tube being cool, the density of the vapour decreases as its distance from the heated sodium. It then forms what is equivalent to a prism of sodium vapour. Light from an arc lamp passed through a slit and then through the sodium prism is absorbed by the vapour which, by the way, when dense, has a blue violet colour; particularly absorbed are those wave-lengths corresponding to the yellow "D" lines. There are also absorption bands in the green and red. Now, in the neighbourhood of the "D" absorption bands, the vapour will have an abnormally high refractive index for waves slightly longer than those which it absorbs and an abnormally low refractive index for waves slightly shorter than those which it absorbs. Thus yellow light passing through the sodium vapour prism will be very highly dispersed, the wave-lengths on either side of the absorption bands being most widely separated. If the light be now observed in a spectroscope with the refracting edges of the prisms at right angles to the edge of the sodium prism, the light in the neighbourhood of the "D" absorption lines will curve up on the one side of the band and down on the other side owing to the great dispersion of the sodium vapour for light of wave-lengths in this neighbourhood. Professor Wood was able to project the artificial "flash" spectrum of sodium on the screen. Light from an arc is projected through a narrow horizontal slit along the lower edge of a metal plate heated by a Bunsen fed with sodium which colours the flame yellow. The light on leaving the plate is almost completely screened off, passed through a prism and projected on the screen. The metal plate lowers the temperature of the flame and the sodium vapour no longer emits light in its neighbourhood. The light passing through this layer of sodium vapour is anomalously dispersed in the yellow region. The rays on either side of the absorption bands are refracted differently, the one ray being bent upwards and the other down. The screen being adjusted to cut off the direct light from the arc, the yellow light bent upwards suddenly "flashes" out on the screen. This then illustrates what is occurring in the sun's atmosphere.

The second lecture dealt with the emission of light by vapours. Vapours can be made to emit light by the passage of electricity through them when the electrons in the ions are greatly disturbed and set in vibration. The disturbance in this case is effected by many causes; it is better then to look for a less complicated method of setting the electrons in vibration in order to discover something about the structure of the atom. Those vapours which absorb light and hence have a definite colour can be made to emit light by heating them. Professor Wood showed how iodine dropped into a quartz bulb heated to a high temperature, is vaporised and glows—the vapour appearing "red-hot." White light passed obliquely through a steel tube in which sodium is vaporised causes the sodium to fluoresce or emit light of a green colour by stimulation. In the same way light passed through a bulb containing iodine vapour at a very low pressure causes the vapour to fluoresce with an olive green hue. The presence of a small quantity of helium changes this hue to a reddish tint, while other gases destroy the fluorescence in proportion partly to their molecular weight and partly to their electro-negative character; a very small quantity of chlorine destroys the fluorescence altogether. Mercury vapour will fluoresce at much higher pressure; Professor Wood illustrated this point by projecting light from a magnesium spark on a quartz bulb in which mercury was boiled; the mercury vapour, when all the air had been expelled from the flask, lit up with a blue colour. Iodine when heated emits light of the same wave-length as it absorbs; the electrons in the molecule are set in vibration by the process of heating the vapour and give out particular wave lengths of light, just in the same way as these waves are absorbed on passing through the vapour, their energy being absorbed by setting in motion those electrons which vibrate with the same period of vibration. White light passed through such a vapour, provided the pressure is not great enough to prevent the free vibration of the electrons by the collision of the molecules, will give rise to fluorescence. If instead of employing white light, light of a particular wave-length be employed, then this light will affect only certain electrons which vibrate with the same period, and these in turn being grouped with only a few other electrons in the molecule will set in vibration only a few other electrons possessing different periods of vibration; only a few lines then appear in the spectrum of the light from iodine vapour set resonating by the light from the mercury arc. Professor Wood has studied these resonance spectra most elaborately and amassed much interesting material from which to obtain a glimpse of the atomic structure.

The third lecture dealt with the effect of magnetism on the optical properties of vapour. Light from an arc lamp was passed through a well-evacuated tube containing sodium vapour placed across the poles of an electromagnet; the light before it entered the tube was polarised by a Nicol prism and only permitted to vibrate in one plane. On emerging from the tube, the light was passed through a second Nicol prism, so that the prism either permitted the polarized light to pass or, by setting it at right angles to the plane of vibration of the waves, it could prevent the light from reaching the screen. An ordinary glass prism refracted the emerging light on to a screen and formed a spectrum on the screen. The second Nicol was so arranged that it almost extinguished the spectrum. The magnetic field was switched on and immediately the sodium yellow lines could be easily seen on the screen. In this experiment the magnetic field rotates the plane of polarization round through a right angle or some multiple thereof, thus permitting the light to get through the second prism. The rotation is only produced where the refractive index of the vapour is very high, namely in the neighbourhood of the sodium flames. If the sodium vapour be very dense, the beam of yellow light will be twisted round and round many times. The light examined in the spectroscope is shown to consist of a number of light and dark spaces on each side of the "D" lines, each line representing a rotation of the beam through 180°. In some cases the direction of the rotation of the plane of polarization is opposite to that of other wave-lengths, which Professor Wood has shown by means of a most ingenious double quartz prism of right and left handed rotation. The rotation of the plane of polarization of the light in the neighbourhood of the absorption bands of iodine was shown; the little monochromatic elements in the spectrum are selected out and give a line spectrum. Professor Wood referred finally to the reflecting power of vapours which if the absorbing power is great should also be great. He has been successful in obtaining reflection from mercury vapour under high pressure in quartz vessels when illuminated by ultra-violet light.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A.

ARTIFICIAL PARTHENOGENESIS.—It is now reported that the eggs of frogs and toads may be got to develop without fertilisation. Bataillon takes a piece of a string of toad's spawn with as little jelly as possible, puts it in a dry dish, bathes it with a little blood, and makes minute punctures in the eggs. They segment "magnificently," and the frog's blood works as well as the toad's, and better than the spermatozoa of the frog! Dehorne has made a careful study of a frog larva parthenogenetically produced which lived for eight days. The cells of its body had, as theory would lead one to expect, only six chromosomes in their nuclei,—half the normal number.

A CURIOUS HABIT.—Erik Bergström calls attention to a puzzling piece of behaviour which he has noticed in reindeers at the time of antler-growth. With some difficulty they frequently bring the tip of the antler into contact with the hoof-gland, and the result is that the tip is smeared with the viscid secretion. But why?

RINGS ON FRESHWATER MUSSELS.—There is some peculiar satisfaction in observing the organic registration of growth-periods,—so familiar in the rings of wood on the sawn tree-stem. It is striking, too, to read back to a peculiar line where there seems to have been no summer wood formed, and to find, on consulting the meteorological calendar, that this corresponds to what was called "the black year," when there was no summer. So from the scales of a fish, or from its otoliths, or even from some of its bones, one may read its age with security, corroborating one index by another. According to Malloch one can tell from the salmon's scales whether it has spawned or not, and more besides. A case that has always interested us, because of the great variety in the succession, is that of the rings on freshwater mussels, but we are not aware of precise observations on the subject. In a recent paper Israel points out that two rings are sometimes laid down in one year.

FLIES AND ERGOT.—We have heard much in recent years of the part that flies play in disseminating disease-germs—typhus-bacilli, sleeping sickness Trypanosomes, and many others. It is interesting to notice that L. Mercier has found that a common summer fly, *Sciara thomae*, carries about the spores of *Claviceps* which causes ergot on rye-grass. The conidia of the *Claviceps* were abundant in the food-canal of the fly and did not seem to be affected. There were also others on the setae of the body. The flies frequent rye-grass, but experimental proof that they infect healthy plants with *Claviceps* has not yet been furnished.

SPIDERS AND MOSQUITOES. — N. Leon gives an account of the formidable numbers of Mosquitoes in Roumania along the shores of the Danube. Every here and there, in some tracts, one sees the canopied *al fresco* beds where the fishermen sleep, or try to sleep. Equally characteristic is the astonishing abundance of spiders' webs which sometimes cover the trees with a thick veil. These are of no slight importance in imposing some check on the multiplication of the mosquitoes. As things are, the plague is sometimes terrifying, but it would be much worse without the spiders.

HYDRACTINIA AND HERMIT CRAB.—Prof. Seitaro Goto, of Tokyo, describes two species of *Hydractinia* which occur in Japanese waters in association with a hermit crab (*Eupagurus constans*), and form shells of their own entirely composed of a chitinous framework. In most specimens there is apparently no basis of gastropod shell, as is the case in most other known species of *Hydractinia*. The skeleton of one of the species (*H. spiralis* sp. n.) is totally devoid of spines, and its substance is very thin and papery, while that of the other (*H. sodalis* Stimpson) is richly armed with large spines, which are conical when small, but irregular in shape and branching when large. The skeletons of this species are rather common and are sold in a dry state under the name "Igaguri-gai," or "Chestnut-burr shell."

SPECIFICITY.—The late Mr. George Sim, of Aberdeen, author of "The Vertebrate Fauna of Dee," was wont to say that he could identify any British fish from a square inch of its skin. In other words, the scales of each species have distinctive peculiarities. They show specificity. And the more we know of the members of well-defined species the more we become convinced of the unity of the organism. Distinctiveness penetrates into every hole and corner. A striking illustration has recently been given by W. J. Loginoff, who shows that the ciliated cells lining the windpipe of horse, ox, sheep, and so on, are so distinctive in each case that it is not very difficult to tell from a preparation what animal it came from.

By Wilfred Mark Webb, F.L.S.

THE FAIRY SHRIMP.—It is interesting to record that Mr. B. J. Hunter has recently found examples of the Fairy Shrimp in ponds near Pewsey in Wiltshire. Commenting on the fact mentioned by Mr. Pyman ("Knowledge," Volume XXXIII, page 251) that the styles projecting from the telson of the female were usually broken, Mr. Hunter says that he noticed "a small animal that seemed to have a bivalve shell, which propelled itself rapidly through the water by means of its feet, attached itself to these styles and ate them, the shrimp appearing not to notice it until it had reached quite a distance when, by means of a powerful jerk, it was thrown off."

FLEAS AND PLAGUE.—In "Knowledge," Volume XXXIV, page 12, Mr. Grew, in dealing with the question as to whether there was much likelihood of fleas carrying plague in Europe, gave the generally accepted opinion that the European rat flea, *Ceratophyllus fasciatus*, will not feed on man except when starving. Quite recently a number of experiments have been made at the Lister Institute of Preventive Medicine by Dr. Harriette Chick and Dr. C. J. Martin, which have been published in *The Journal of Hygiene* for April 8th, and Dr. Chick has kindly sent us a reprint from which we learn that *Ceratophyllus fasciatus*, when hungry, will attach itself to man with great readiness. A hundred and sixty-one experiments were made, of which we describe one. A rat was removed from a flea-breeding cage, and four days later the hand and arm of a number of persons were placed in the cage at different times during the day for two minutes. In one instance as many as eighteen fleas jumped upon the arm, many of which could be felt at once to bite vigorously.

REVIEWS.

ASTRONOMY.

The Night-Skies of a Year.—By J. H. Elgie. 260 pages. 113 illustrations. $8\frac{3}{4}$-in. × $5\frac{1}{2}$-in.

(Leeds: Chorley & Pickersgill. Price 6/- net.)

The author adopts the course of noting down in a simple manner what he saw when viewing the sky at night, free from clouds, several times each month; it thus assumes the nature of a diary or journal, and is divided into the twelve months.

It is solely intended for those who are content to learn the positions and something of the stars in their courses; therefore, for a non-telescopic observer. The author adopts this journal form as the best way to meet the requirements of that large class of intending observers who are said to find the usual star-maps and books too full and bewildering in the number of stars dealt with. He prefers to give in the text diagrams of portions of the constellations and usually limits himself to the first, second, and third magnitude stars; in this way the most prominent and well-known configurations are represented.

Throughout the book the author, who has evidently a poetic fancy, has enlivened his bare bones of astronomical observations with historical facts, with opinions of various writers, and with frequent dives among the poets, from Chaucer's time. Though we are not enamoured with poetic effusions, being accustomed to the more solid branch of astronomy dealing with observations of facts and with figures, to those who like poetry and poetic imagination the book should at once appeal; they should not fail to obtain a copy and verify for themselves all that is stated therein, and, in learning the stars, they may contemplate upon them as suits the human mind.

The table of contents gives in detail the subjects referred to each month and a list of diagrams is similarly given. A full index of eighteen pages is at the end of the book, which is well printed in type of good size.

F. A. B.

Remarkable Eclipses.—By W. T. Lynn. (Eleventh edition). 58 pages. 1 plate. $6\frac{1}{2}$-in. × $4\frac{1}{4}$-in.

Remarkable Comets.—By W. T. Lynn. (Fifteenth edition). 48 pages. 2 plates.

(S. Bagster & Sons. Price 6d. each, limp cloth.)

There is always a freshness in the successive editions of these valuable, useful, and popular little books; not mere reprints of former editions. For beginners in Astronomy they serve both as introductions to the subject and as historical accounts. The one referring to the eclipses is quite a marvel of compactness, embracing a period of eclipses for three thousand years (B.C. 1063 to A.D. 1999), and every page is crammed with interesting scientific and historical facts. The first two pages, explaining the nature of an eclipse, might, with advantage, be extended to three or even four, and a diagram inserted. Tables of contents are given at the end. The little book relating to comets meets with our approval in a similar manner. It, however, mainly deals with the more prominent comets of the past three hundred years; the ancient records are less precise and cannot be verified so well as eclipses by ante-dated calculations. Two useful books by a trusted author. The title of these little books might be, with advantage, printed on the back; an unlabelled book on a bookshelf is a nuisance.

F. A. B.

The Stars from Year to Year.—Edited by Mrs. H. P. Hawkins. Fourth edition. 11 pages. 13 maps. (Price 1/-).

The Star Almanac for 1911.—Same editor. Second edition. Large illustrated sheet. (Price 6d.)

The Star Calendar for 1911.—Same editor. Card planisphere. (Price 1/-.)

(Simpkin, Marshall, Hamilton, Kent & Co., and others.)

These three publications are of considerable utility to all sky-watchers at night. There is an abundance of information for all enthusiastic beginners in Astronomy, and the star maps will certainly serve them when their knowledge has emerged beyond that of a novice. These books may well be within most country households—and the stars are observed far too little by those living away from towns, with [illegible]htly lit and dusty atmosphere—whether the squire's, the parson's, the schoolmaster's, or governess's. If they were in the hands of school-teachers and those with the educational care of children, much simple astronomy might be imparted to those entrusted to them.

The prices at which these publications are offered, bring them within the reach of all; the typographical reproduction is excellent.

F. A. B.

CHEMISTRY.

The Simple Carbohydrates and Glucosides.—By E. Frankland Armstrong, D.Sc., Ph. D. 112 pages. $10\frac{3}{4}$-in. × 6-in.

(Longmans, Green & Co. Price 3/6 net.)

Even in physiological chemistry the process of specialisation has proceeded so far that no worker may hope to keep fully in touch with more than one or two branches of his subject. It was, therefore, a happy idea of the editors of this series of small handbooks upon biochemistry to issue concise monographs dealing with separate classes of physiological compounds, so arranged that they would be useful for purposes of reference, and capable of being brought up-to-date from time to time, without the necessity of issuing a new edition of the whole series. Various companions of this book, dealing with proteins, fats, enzymes and so on, have already been noticed in these columns, and the present monograph, which is devoted to the simple sugars and glucosides, follows the same general plan. Dextrose (glucose) is taken as the type of these sugars, since, as the author points out, it is probably the first sugar formed synthetically by the plant by way of formaldehyde from the carbon dioxide in the air, and is also the form in which a large proportion of the carbohydrates in the food of animals is absorbed into the system. The chapter discussing the relationship between the chemical configuration of the sugar molecule and its biochemical properties is particularly interesting. As in the case of the other monographs of the series there is an excellent bibliography and a good index, and every chemist who is interested directly or indirectly in the subject of the sugars will find this book of the greatest use.

C. A. M.

Elementary Chemical Theory.—By J. M. Wadmore, M.A. (Oxon). 275 pages. 16 illustrations. $7\frac{1}{2}$-in. × 5-in.

(Methuen & Co. Price 3/6.)

If we were asked to recommend a guide to the elements of chemical theory suitable for students at an early period of their work, we could suggest nothing better than this book. It is clearly and simply written, and the author's experience as a teacher of beginners has enabled him to anticipate and answer the chief difficulties that will arise. It deals at sufficient length with most of the subjects usually found in the larger works upon the theory of Chemistry, and has an excellent chapter upon radio-activity and its bearing upon the possible constitution of the elements. Perhaps, in a future edition, it may be found possible to devote more attention to the "phase rule," and the principles of thermo-chemistry.

Although the author anticipates inevitable criticism upon his use of the hydrogen standard for the atomic weights, and gives good reasons for its retention, we still think that an early adoption of the oxygen standard would be the better course. For since the use of H = 1 has been discarded in the annual tables of International Atomic Weights, all scientific work is now based upon the standard of O = 16. Hence to accustom students to the use of values which in practice they will have to unlearn, seems a greater evil than the difficulty of making the fact clear that the value 16 is only an arbitrary standard, and the possibility that some students may acquire for a time the notion that atomic weights are necessarily whole numbers. By the way, why was a table of atomic weights of 1905 chosen for the appendix? The current table contains several more elements and gives values differing in many respects from those in a table that has been out of date for five years.

C. A. M.

A Concise History of Chemistry. By T. P. Hilditch, B.Sc., A.I.C. 263 pages. 16 illustrations. 7¾-in. × 5-in.

(Methuen & Co. Price 2/6.)

It is no easy task to survey, within the limits of one small volume, the entire history of chemistry, from the days of alchemy to the present time, and in this case the difficulty was increased by the fact that the book was also designed to meet the requirements of certain examinations in the subject of historical chemistry. A book upon these lines runs the risk of being little more than a skeleton of facts, names and dates. The author, however, has escaped this pitfall, and has given us a most readable outline without sacrificing the necessary compression, and has enabled us to follow easily the development of the main theories of modern chemistry. There is also an excellent account of the history of the different elements and their chief compounds, and the book concludes with biographical notes of many of the great chemists, tables summarising the sequence of discoveries and theories, and a good name and subject index.

The chief fault in the book is the complete omission of any reference to many important branches of the science, such as biological chemistry, and the scanty treatment of other subjects. For instance, in the section dealing with technical chemistry the subject of oils and fats is mentioned, but there is no reference to any worker of later date than Chevreul; while in the account of the progress of experimental methods there is no mention of the now classical iodine absorption method of von Hubl.

The selection of the names included in the biographical notes appears somewhat capricious. Thus the names of Odling and of Newlands are omitted, while the names of many whose contributions to chemistry have been of much less weight are included. Doubtless these omissions will be remedied in the next edition.

C. A. M.

An Introduction to Chemical Theory.—Second edition. By A. Scott, D.Sc., F.R.S. 272 pages. 8¼-in. × 5½-in.

(Adam and Charles Black. Price 5/- net.)

Slowly, out of a confused mass of painfully accumulated detail, there has been evolved a philosophy of chemistry which has shown that there was a certain law and order connecting the apparently isolated facts. Several large works upon the subject have appeared from the pens of such masters as Mendeléef and Ostwald, and the present handbook, which has deservedly reached its second edition, forms an excellent introduction to these. It takes a brief survey over the whole ground upon which the theory of chemistry has been raised, and is so fully and clearly written as to be easily followed by any student who has acquired some knowledge of the facts of the science. Among the subjects treated at considerable length in the different chapters are the determination of atomic weights, classification of the elements, carbon compounds, the principles of thermal chemistry, and solution and electrolysis, and these are illustrated by numerical examples wherever necessary.

The author's aim has been to deal only with points concerning which there is little or no dispute, and as far as possible to exclude speculative matter; but we venture to think that there has been a somewhat too rigid adherence to this rule in a book, one of the objects of which should be to stimulate the imagination of the reader. Thus the subject of radio-activity is practically ignored, although it is in this direction that most progress in the immediate future may be expected. In the few remarks upon radium (page 70) some doubt is implied as to whether that substance is really an element; but since this view is opposed to the now generally accepted opinion—an opinion based upon the properties of radium and its salts, its position in the periodic system, and its characteristic spectrum—it would have been of interest to have learned the reasons for this doubt.

The book is clearly printed in large type, and has a good index, but its use as a handbook would have been enormously increased by references to the original papers and by the addition of a classified bibliography.

C. A. M.

MATHEMATICS.

A First Book of Geometry.—By J. V. H. Coates, B.Sc. 142 pages. 127 illustrations. 7-in. × 4¾-in.

(Macmillan & Co. Price 1/6.)

This book seems to have been compiled in compliance with the recommendations recently issued by the Board of Education, on the teaching of Elementary Geometry. Naturally there is nothing new except in the arrangement of the subject matter, and in some pleasing pictures of a small boy in knickerbockers engaged in "field work."

W. D. E.

Elements of Analytical Geometry.—By G. A. Gibson, M.A., LL.D., and P. Pinkerton, M.A., D.Sc. 475 pages. 149 illustrations. 7½-in. × 5-in.

(Macmillan & Co. Price 7/6.)

This book contains a great deal of matter not usually included in elementary treatises on Cartesian Geometry. Much space is allotted to the plotting of curves, and not only curves of the second degree, but some of what are usually classed as Higher Plane Curves are discussed as fully as elementary methods permit. Geometrical treatment after the manner of Euclid is freely adopted, so that the chapters on Conic Sections are a combination of analytical and geometrical methods. There was no real justification for the separation of the two in older books, and this one seems to include all the essential parts of what we used to learn as Geometrical Conics. We hoped to have found the notation of the Calculus introduced somewhere in the book. Surely it must be possible to combine the elements of Differential Calculus with the elements of Analytical Geometry in a way that is less tedious and yet not unsound. Here the authors, instead of making the beginner's yoke lighter, have added to it, and the beginnings of the Calculus seem further off than ever. But a student who has worked through this book will be thoroughly prepared for it when at length it does come.

W. D. E.

TECHNOLOGY.

Journal of the Municipal School of Technology, Manchester. Vol. III, 1910. Edited by J. Barnes, M.A., B.Sc. 392 pages. 130 illustrations. 9¾-in. × 7¼-in.

(The Education Committee.)

This journal forms a record of original investigations undertaken by members of the Teaching Staff and Students of the School in the Session 1909. In most cases the papers have been reprinted from the journals and publications of learned societies.

Although the application of science to industry is the object of the instruction given in the school, the researches contributed by the various departments are not entirely technological; theoretical investigations have not been shirked, but indeed form quite a large part of some of the papers.

Mechanical Engineering is represented by three important investigations:—Professor J. T. Nicholson's masterly research of "Heat Transmission in Steam Boilers," a further paper on the same lines by Mr. H. P. Jordan, and an exhaustive account of some experimental work on "Twist Drills." Well-illustrated dissertations on "Single-Phase Traction," "Vagabond Currents," "Flash-Over Voltages," and some notes on the "Elimination of Sparking" are contributed by the staff and students of the Electrical Engineering Department.

An important contribution to the subject of Ventilation is made by Professor J. Radcliffe.

A number of new methods in Volumetric Analysis are described, also a modification of the Beckmann apparatus by Dr. Knecht. The dyeing industry receives a large share of attention, especially in its application to cotton fabrics, while even the colouring matter in mummy cloths has been investigated!

Weaving, of which we should [illegible] expected to hear much, has only one short paper devoted to [illegible] This, a twelve page monograph on "The Effect of Tw[illegible] on Yarns," consists mainly of a detailed description of t[illegible] plates depicting "single" and "double" yarns in vario[illegible]es of twist.

The report to the Government on the H[illegible] Loom Industry in Bombay is also included in the volume.

The journal is printed in the Printing Crafts [illegible]rtment of the School, on which it reflects some credit.

P. K.

CORRESPONDENCE.

HALLEY'S COMET.

To the Editors of "KNOWLEDGE."

SIRS,—I shall be glad if any one of your readers or contributors of astronomical articles will please explain to me, through "KNOWLEDGE," why the tail of Halley's Comet was shown divided into one on the east before dawn, another on the west after dusk, instead of one on the north and another on the south, when our globe entered into the tail of the comet in the morning of the 19th May, 1910. Is the cause of the division of the tail the magnetic repulsion of the earth?

I should also like to know whether the tail of Halley's Comet actually touched the atmosphere of the earth or not?

R. G. CHANDRA.

THE ETERNAL RETURN.

To the Editors of "KNOWLEDGE."

SIRS,—I should like to say a few words on the above subject. I have dealt with the matter from the theological point of view in two letters which have recently appeared in the *New Age* criticising some articles on "Theology" by "M.B. Oxon."

First, it is necessary to realise that one's knowledge of the "external world" and the phenomena which occur there is primarily obtained by sensations, these sensations necessarily depending upon the nature of the corresponding sense organs. Most of us *think* principally in visual impressions (retinal images); and since the shape of these images depends upon the structure of the eye, it is open to question to what extent the relation of the images in the mind is a true representation of the "external" phenomena.

Space, time, force, motion are so intimately associated with "consciousness" that there is a good deal of reason for asking whether they really exist apart from consciousness. I often wish scientific people felt more than they appear to do, that whatever line of investigation into the underlying processes of nature is taken, the rock-bottom arrived at is the consciousness of the investigator. One may reduce the whole cosmos, including humanity, to motion and force—but these are *effects in consciousness.*

It is very gratifying to see the notion of space of more than three dimensions entertained by Professor Pickering. If only the conception were more readily entertained by astronomers, physicists and biologists, many astounding results might follow.

The possibility that the bodies of the solar system are something more than spheres, as a sphere or cylinder is something more than a circle—the possibility that organisms (including man) are something more than three-dimensional entities—opens up a province of speculation which might not be devoid of practical results. However, since dimension depends upon consciousness, one has to be careful in talking of dimensions of which the human mind is not "consciously" conscious.

J. JOHN ELLIOTT.

COSMIC CHANGES.

To the Editors of "KNOWLEDGE."

SIRS,—In the recent work of Dr. Alfred Russel Wallace, "The World of Life," the following statement occurs ". . . . there have been cosmic changes due to the varying eccentricity of the earth's orbit and the precession of the equinoxes, leading to alternations of hot, short summers with long, cold winters, and the reverse; culminating at very distant intervals in warm and equable climates over the whole land surface of the globe; at other shorter and rarer periods in more or less severe "ice ages," like that in which the whole north temperate zone was plunged during the Pleistocene period. . . ."

Can any of your readers give a proof of the cosmic changes due to varying eccentricity and precession of the equinoxes?

"ANXIOUS."

IS SPACE INFINITE?

To the Editors of "KNOWLEDGE."

SIRS,—Surely it is easier to conceive of infinity than of finity? In considering this question one must assume that one has the power of illimitable flight; one must deal with the question on a practical basis. Your correspondent talks about curved space. Now, however slight is the curve, some sort of limit is suggested of which we are on one side. What is on the other? Either absolutely nothing, *i.e.*, infinity or something, in which case we should have to start afresh. To my mind the very fact of talking of finity, tacitly admits infinity. Directly one talks about a boundary, the "other side" must always be considered.

It is also interesting to speculate about time, such as we know it. Suppose that all our systems by which we measure time were taken away, and that man lived on the surface of a dark earth, let us suppose, absolutely the only sphere in existence,—would time still be considered to exist? It would exist, and yet it is strange to think upon.

C.H.E.R.

SCIENTIFIC NOTES.

To the Editors of "KNOWLEDGE."

SIRS,—In reading a paper by William R. Renwick on "Insects Destructive to Books" reprinted from *The American Journal of Pharmacy*, I came across the following which is well worth attention:—"Too little attention has been given to the manuscript notes of scientific workers, often only a line or two of their observations upon the small forms of life. The average scientific man, thinking it too trivial to notice, often passes over the very observation which is the key to the puzzle that he has been spending years in trying to solve."

It cannot be emphasized too strongly that real advance in knowledge, in any branch of science, is only to be made by the worker who pays attention to the minute details, and who regards nothing as too trifling to be worthy of record.

FRANK C. DENNETT.

WILLIAM HERSCHEL: HIS TELESCOPES AND WORK.

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

WILLIAM HERSCHEL completed his first telescope in March, 1774, and made his last observation in June, 1821. What a period of activity those forty-seven years included! His sister Carolina assisted him in his observations, while his brother Alexander helped him in constructing telescopes.

When Herschel came upon the scene and recognised the requirements of practical astronomy the heavens had not been explored. Nebulae and double stars existed in myriads but only in a few special instances had they been suitably recorded. He resolved to search the firmament, to reap the harvest of wonders it presented, and to properly arrange and classify them for the advantage of ages to come. So he swept the sky year after year with a skill unmatched, an energy indomitable, and a success beyond anticipation. He was a star indeed risen amid the dawn of a new astronomy. He sounded the depths of space and brought to light great numbers of interesting objects never previously discerned by human eyes. When his work was done the heavens had given up many of its secrets.

He had advanced our knowledge, in a marvellously comprehensive manner, of the great expanse around us, and posterity will honour his name as that of a great pioneer in the field of methodical observation.

Yet he was not backed up by any national institution, endowment, or observatory. He was a comparatively poor man, but with a genius within him which conceived a noble work, and mechanical abilities which enabled him to fashion with his own hands the telescopes he required. True his Sovereign encouraged and pecuniarily assisted him after he had gained renown. But without any help from George III. his great career was assured—Herschel would have been Herschel still!

The quality of Herschel's telescopes has been sometimes discussed, and the subject is interesting, though differences of opinion must necessarily exist. We can hardly think that telescopes made more than a century ago could equal the best appliances of our own day. We must have learnt something, and approached a little nearer perfection during the last hundred years. Old mirrors carefully tested alongside Calver's and With's best work might be expected to suffer in the comparison; at any rate that seems to be the reasonable inference.

But we may depend upon it that Herschel's mirrors were as good as they could be made in his day, and that they were very excellent in certain cases is sufficiently evident from his own allusions, and from the high powers he occasionally utilized so successfully.

It may in some degree elucidate the question if a few quotations are made from Herschel's writings. And in giving this evidence relatively to his telescopes I should like to mention that my intention is merely to mention facts on both sides of the case, and give no expression of opinion. At this distance of time it would be in bad taste, and certainly unjust, to disparage the instruments with which such splendid results were achieved. No doubt Herschel's powers were such that he could have made discoveries with relatively inferior instruments, but we have his word for it that his telescopes were of far different character from that.

On April 12th, 1805, he speaks of viewing "Saturn with a power of five hundred and seventy on a seven-feet mirror of six and three-tenths inches aperture and extraordinary distinctness."

Referring to the seventh satellite of Saturn, he says he "saw it very well in the twenty-feet reflector, to which the exquisite figure of the speculum not a little contributes."—August 28th, 1789.

On October 24th, 1791, with a "seven-feet reflector, having a new machine-polished, most excellent speculum, I see that the division in the ring of Saturn and the open space between the ring and body are equally dark."

An impression has prevailed that the forty-feet telescope rather disappointed expectation, and that its defining powers were certainly not on a par with its light-grasping capacity: at any rate Herschel generally used the twenty-feet and seven-feet instruments. Burnham's opinion is that some of the instruments utilized by the old observers of double stars could not compare favourably with modern refractors, and particularly with telescopes made by the Clarks. "Even when the earlier observers had powerful instruments in point of light-gathering power, as in the case of the Herschels, there can be no doubt that they were far inferior in definition."

In the *Phil. Trans.* for 1795 he gives us an idea of the number of instruments made, and says:—"When I resided at Bath I had long been acquainted with the theory of optics and mechanics, and wanted only that experience which is so necessary in the practical part of these sciences. This I acquired by degrees at that place . . . My way of doing these instruments at that time, when the direct method of giving the figure of any of the conic sections to specula was still unknown to me, was to have many mirrors of each sort cast and to finish them all as well as I could; then to select by trial the best of them, which I preserved; the rest I put by to be repolished. In this manner I made not less than two hundred seven-feet, one hundred and fifty ten-feet, and about eighty twenty-feet mirrors, not to mention those of the Gregorian form."

High magnifying powers involve a severe test of the performance of telescopes. In proof of the quality of his mirrors we may quote him as saying "In beautiful nights when the outsides of our telescopes are dripping with moisture discharged from the atmosphere there are now and then favourable hours in which it is hardly possible to put a limit to magnifying power."

But these superlative hours were all too few, alas, for he mentions he "had recourse to his journals to find how many favourable hours we may annually hope for in this climate. It is to be noticed that the nights must be very clear, the moon absent, no twilight, no haziness, no violent wind, and no sudden change of temperature, and it appears that a year which will afford ninety or at most one hundred hours is to be called a very productive one."

Herschel's favourite working instrument seems to have been a seven-feet of six and three-tenths inches aperture. Speaking of observations of Saturn he mentions that "all that magnifying can do may be done as well with the seven-feet as with any larger instrument."

The great forty-feet telescope was not used very frequently by Herschel, as its manipulation occupied valuable time and required assistance. It has been stated that this large instrument was discarded in consequence of its bad performance and cumbersomeness, but this is scarcely justified, Herschel himself states "A forty-feet telescope should only be used for examining objects that other instruments will not reach." "The opportunities of using the forty-feet are rendered very scarce." On August 28th, 1789, he says "Having brought the forty-feet to the parallel of Saturn, I discovered a sixth satellite of that planet, and also saw the spots upon Saturn better than I had ever seen them before, so that I may date the finishing of the forty-feet telescope from that time."

This is great praise for the big instrument, but Dr. Dick in describing the details of its construction and work, as published in the *Phil. Trans.*, says: "It was not to be expected that a speculum of such large dimensions could have a perfect figure imparted to its surface nor that the curve, whatever it might be, would remain identically the same in changes of temperature; therefore we are not surprised when we are told that the magnifying powers used with this telescope seldom exceeded two hundred; the quantity of light collected by so large a surface being the principal aim of the maker." *The Practical Astronomer*, Page 304.

No doubt Herschel's object was chiefly to get as much light as possible out of his instruments, as he was constantly searching for faint nebulae, minute satellites and so on. Thus we often find him adopting contrivances, and using expedients to obtain the maximum "penetrating power."

Possessing optical and mechanical skill only matched by unwearying energy, Herschel must have succeeded in producing some thoroughly good instr[illegible] though it should never be forgotten that his splendid o[illegible]ational work more indicates the measure of the man tha[illegible] particular kind or quality of his glasses.

We, at the present day, cannot fairly [illegible] to the degree of perfection he attained, but it certa[illegible]st have been considerable. Critics may possibly find fault [illegible] few details recorded in his papers, in the volumes of the *[illegible]l. Trans.*, such as the supposed discovery of the ring around U[illegible]anus, but when we consider the enormous amount of work he accomplished, sometimes in indifferent air, or amid trying circumstances, he must have been more than mortal could he have invariably avoided mistakes.

Herschel's papers number sixty-nine, and they are practically inaccessible to the general astronomical public, in the volumes of the *Phil. Trans.* Will these important memoirs ever be reprinted in book form?

Every year brings us some new astronomical works, but they are neither so welcome nor so valuable as a volume of Herschel's writings would prove. And this has been a desideratum for more than a century! Had Herschel's collected papers been available for convenient reference what immense trouble would have been avoided, and how many misunderstandings prevented! Some descendant of the illustrious astronomer should present the scientific world with a handy volume of his results described in his own language.

SOLAR DISTURBANCES DURING APRIL, 1911.

By FRANK C. DENNETT.

There has been a continuance of the somewhat increased activity upon the solar disc. On three days, April 18th, 19th and 20th, no disturbance, bright or dark was visible; and upon the 16th and 17th only bright, or faculic disturbances were seen. At noon on April 1st the longitude of the central meridian was 188° 56′.

No. 12 on the March list continued upon the disc until April 6th, and therefore re-appears upon the present chart.

No 13.—Near the eastern limb, on the 1st, there appeared a moderate spot, but when farther on the disc it was seen to consist of three spotlets and three pores in slightly divergent lines. The middle, largest spot had the inner edge of its penumbra fringed brightly. The members decreased from the 6th until the 8th when only penumbraless pores were visible having a faculic lip. The length of the group was 44,000 miles. The region was faculic until the limb was reached.

No. 14.—A spotlet, only seen upon the 2nd.

No. 15.—A pore, only visible upon the 4th, approximately in the position shown.

No. 16.—A solitary spot, 10,000 miles in diameter, crossed the disc between the 3rd and 15th. The inner edge of its penumbra was fringed bright upon the 8th, 10th and 12th, whilst the umbra was crossed by a bridge upon 12th and 13th.

No. 17.—A spot, 14,000 miles in diameter, visible from April 22nd until May 3rd. The penumbra brightened inwards upon the 24th, 26th, 27th, 30th, and May 1st, and the umbra was crossed by a bridge on the 24th, and from the 27th until the 30th. On the 28th and 29th the southern half of the umbra appeared to be less dark than the northern.

No. 17*a*. A fine spot 15,000 miles across, visible from April 22nd until May 5th. The brightening inwards of the penumbra was noted on the same days as No. 17, and also on the 26th. The umbra was crossed by a bridge which became very narrow. A faculic chain, convex northward, joined Nos. 17 and 17*a*, in which evanescent pores appeared on the 28th and 29th.

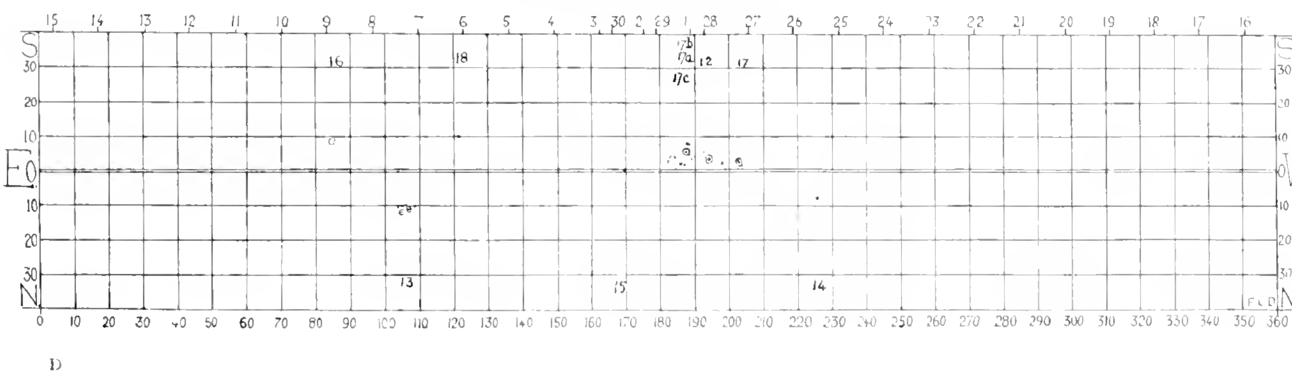
No. 17*b*.—A spotlet seen from the 22nd until May 2nd. There was a bright inner fringe to the penumbra on the 24th. On the 27th the umbra became elongated and on the 28th and 29th broken. Pores showed round it on the 27th, 28th, 29th, and on May 1st.

No. 17*c*.—Two spotlets upon the 24th, one remaining until the 26th.

No 18.—A small group of pores only seen upon the 30th.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and F. C. Dennett.

DAY OF APRIL.



NOTICES.

LEWIS'S CIRCULATING SCIENTIFIC LIBRARY.—We have received from Mr. H. K. Lewis, of Gower Street, London, a supplementary catalogue, covering works added to the library during the years 1908 and 1909. The catalogue is published at sixpence, and contains a classified index of subjects with the authors who have written upon them, as well as an alphabetical list of titles. We have on previous occasions called the attention of our readers to the completeness of this library, and the inducements it offers to students of science. Mr. Lewis has asked us to mention that his premises will in future be closed at 6.30 p.m., instead of 7 p.m., during the months of June, July and August.

A NEW DISCOVERY.—Smoked glasses, it has been shown, only cut off a part of the ultra-violet rays, which are those which have an irritating effect on the eyes of many people; they also are harmful as they make the retina more and more sensitive to light. A new glass which has been called "Spectros" has been introduced by Messrs. W. Watson & Sons, of High Holborn, which cuts off the ultra-violet rays and yet allows all the remainder to pass freely. It has a pale green tint but it is the chemical constituents upon which its peculiar properties depend, and eye-glasses made from it have not the disfiguring effect of the ordinary smoked ones.

ILLUMINATION.—A very interesting exhibition is now open at the offices of the Westminster Electric Supply Corporation, Limited, in Ecclestone Place, Belgravia. One part of it deals with various systems of electric lighting and the effects which can be produced by them in rooms, while the other shows how electricity can be pressed into domestic service.

Our illustration shows one of the demonstration rooms. Beginning on the extreme left we find that the first ceiling light illustrates the method of downward reflecting by means of an opaque reflector. The second shows one in which there is a white silk shade beneath the lamp to diffuse the light below and produce upward reflection. The fourth, with the bell-shaped shade, illustrates a method of concentrating all the light and reflecting it downwards. The fifth shows upward reflection and slight downward diffusion by means of an opal shade. The seventh gives diffused light by means of holophane glass. The effects of lighting by means of metal filament lamps hidden behind the cornice are also well seen. The candle lamps are used for reflecting from the walls, and the brackets below them are intended for downward lighting.

Demonstration Room at the Westminster Electric Supply Corporation.

On the other side of the exhibition we have an elaborate display of the apparatus which is being perfected in connection with cooking by electricity, and an experienced cook is in charge to demonstrate its use. Amongst the exhibits are ranges, ovens, grills, breakfast cookers, kettles and apparatus for giving continuous hot water supply at very small cost. There are also methods of introducing warm fresh air, for keeping towel rails sufficiently hot to air the towels, and motors for working sewing machines and floor polishers as well as soldering irons, hair driers, and curling tongs which are themselves heated by the current as they are used.

Knowledge.

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

A Monthly Record of Science.

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

JULY, 1911.

PLANT HAIRS.

By K. E. STYAN.

(Continued from Page 166.)

III.—BRANCHED AND STINGING HAIRS.

(a) THE term "compound" is applied to branched hairs, their distinctive feature being that they give ornamented with numerous lateral branches, which are long and very slender, giving the appearance of a person holding up many arms. Again, in the Deadly

FIGURE 1.
Hair from the leaf of Garden *Ribes*.

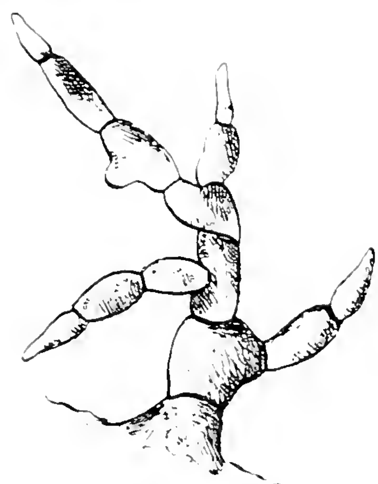


FIGURE 2.
Hair from the corolla tube of Deadly Nightshade.

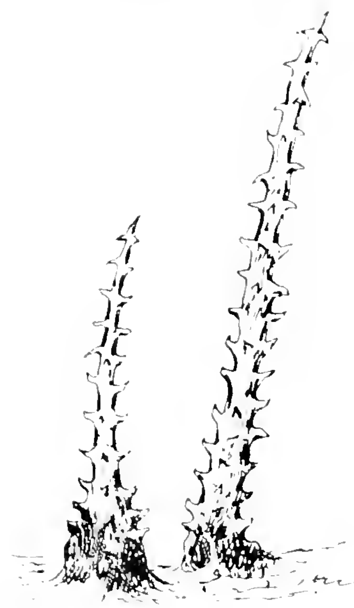


FIGURE 3.
Hair from the leaf of the Chili Nettle (*Loasa*).

off lateral branches from the main pedicel instead of from the tip, as do *forked* hairs.

Among the branched hairs are all kinds of most extraordinary-looking structures, and many of very great loveliness.

If we examine a hair from the leaf-sheath of garden *Ribes* (see Figure 1) we find that the main pedicel is more or less thick all its length, and distinctly swollen at the base, glandular-tipped, and

Nightshade (see Figure 2), a most strange form of branched hair may be found, consisting of a number of thick, clumsy-looking cells, fitting into each other at all sorts of awkward angles, which create an impression of a hand with fingers pointed out and down, or of some species of thickly-formed coral from a foreign sea. Every part of this plant—the stem, leaf-surfaces, veins, flower stems, calyx and corolla surfaces, corolla tube, stamens and stigma—

show these marvellous little hairs, and they are indeed "things" worth looking at very carefully. Figure 3 depicts two hairs from the leaf of the Chili Nettle. On this plant two distinct forms of hairs are found: (1) these branched ones and (2) others of quite different form, that sting. No one can deny that the branched hairs are very formidable looking structures, with their barbs, or tiny, sharp-pointed branches springing out at all angles from the surface of the chief pedicel, which is swollen at the base. A hair like this reminds one rather of the teeth of the sword-fish. Figure 4, illustrating a hair from the leaf of the wild Mouse-ear Hawkweed, shows another branched hair, somewhat similar to that of the Chili Nettle (*Loasa*), but different in that its apex divides off into two wee branches, and its lateral ones are thicker and less tooth-like.

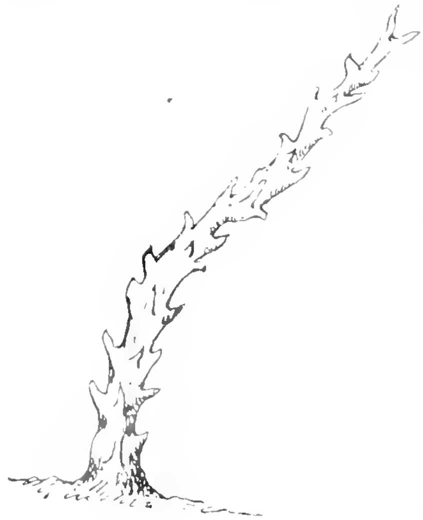


FIGURE 4.
Hair from leaf of Mouse-ear Hawkweed.

Perhaps *Stinging* Hairs should be included amongst the glandular, since they secrete a peculiar acrid burning fluid, but they are so interesting that this fact seems to warrant their being considered by themselves.

Two species of stinging plants have been chosen by way of illustration (1) the Chili Nettle (see Figure 6), (2) the Common Stinging Nettle (see Figure 5).

Our own Stinging Nettle (*Urtica*) receives its name from the burning property it possesses, "*Urtica*" being derived from "*uro*" I burn. An individual hair of this plant shows a very enlarged bulbous base composed of a large number of elastic cells, a long pedicel, and an oval, slightly enlarged, sharp-pointed "cap" at the tip. The cells at the hair-base contain the gland that secretes the acrid fluid. By means of a duct that runs up the pedicel, this fluid is conducted to the tip of the hair, and, if the point of the delicate cap be broken or pressed against unwarily, the sharp point pierces the flesh and the secreted fluid is injected. If, however, the hair be damaged *below* the cap, no uncomfortable feeling is experienced because the stinging fluid does not then become injected into one's skin.

Our own English species of Stinging Nettles are unpleasant enough to handle roughly, but some of the foreign species, especially *Urtica baccifera* and *U. Balerica* are most formidable plants. In some of the East Indian species they are truly dangerous for, after the first pricking sensation has passed away, it is often followed by that of hot irons being rubbed on the flesh, and the pain increases to such an extent that, after hours and sometimes days, the patient is seized with symptoms like those following influenza and lock-jaw, whilst sometimes death results—especially when the stinging has been caused by one species of nettle from Java. Our own species never prove in any way dangerous, merely discomforting at the time and sometimes for several hours afterwards. Another plant—*Malpighia urens*—has dangerous stinging appendages, and they are met with also in some species of *Rhus*.

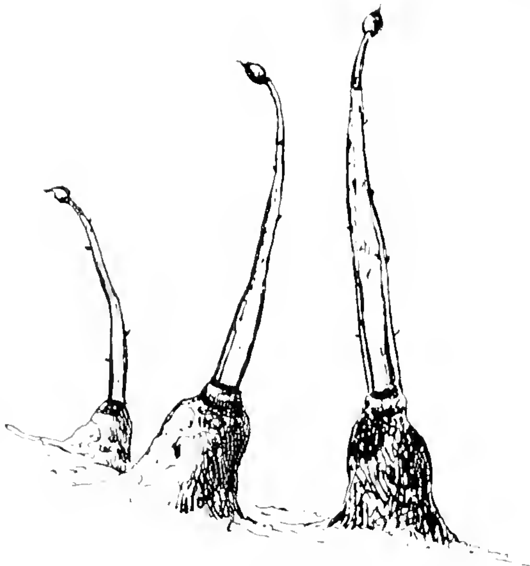


FIGURE 5.
Stinging hair from the leaf of Wild Nettle.

An individual hair of the Chili Nettle (*Loasa*) is bulbous at the base and there secretes its acrid fluid which runs up the pedicel duct to the hair tip. In this case, however, unlike our own nettle, the tip is not swollen into a distinct "cap" but is very sharp-pointed, like a curved needle. These hairs grow in thick masses, along with those that are branched, on the leaves and stems of the plant. In both cases the hairs are probably defensive.

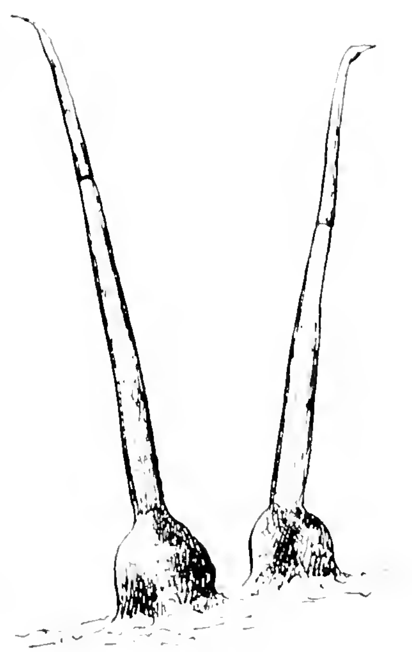


FIGURE 6.
Stinging hair from the leaf of the Chili Nettle.

THE GOLDSCHMIDT REACTION.

By H. STANLEY REDGROVE, B.Sc. (LOND.), F.C.S.

1. SCIENTIFIC ASPECTS OF THE GOLDSCHMIDT REACTION.

IT was in 1898 that Dr. Hans Goldschmidt announced that he had succeeded in reducing the oxides of many metals very conveniently by the aid of aluminium[1]. That aluminium should prove a most powerful reducing agent, readily reacting with the oxides of other metals with the production of much heat, is a result that might very well be expected from the fact that aluminium has a greater heat of combustion, and therefore possesses a greater affinity for oxygen than the majority of other metals. But like certain other substances which, capable of reacting exothermically (*i.e.*, with the evolution of heat) with one another, will not do so until a certain amount of energy has been supplied to them from without, aluminium and metallic oxides will react with one another only at high temperatures. Earlier attempts, however, to bring about the reduction of metallic oxides by aluminium, by heating mixtures of these ingredients, proved very unsatisfactory: for either no reaction took place, not sufficient heat to start it being supplied, or else it occurred with explosive violence. Dr. Goldschmidt overcame the difficulty by an ingenious device. He found that intimate mixtures of metallic oxides and powdered or granulated aluminium, if heated strongly at one point, react with the production of intense heat, the temperature produced being far greater than that required to initiate the reaction. Consequently the reaction spreads throughout the whole mass, as a matter of fact doing so very rapidly, the time of reaction, which is about half to one minute in the case of iron oxide and aluminium, not appreciably depending upon the quantity of material employed.

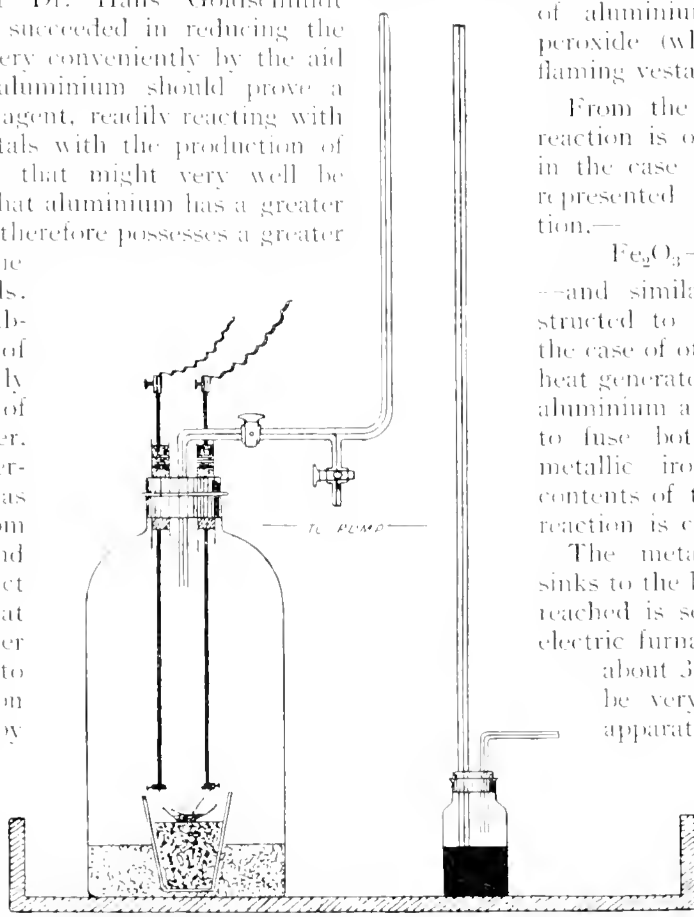


FIGURE 1.
Apparatus employed by Weston and Ellis for carrying out "thermitic" reactions *in vacuo*.

The external heating necessary to start the reaction may in some cases be supplied by means of a strip of burning magnesium; or better, a fuse composed of aluminium powder and barium peroxide (which can be ignited by a flaming vesta) may be employed.

From the chemical standpoint the reaction is one of the simplest, thus, in the case of *iron* oxide it may be represented by the following equation,—

$$Fe_2O_3 + 2Al = Al_2O_3 + 2Fe.$$

—and similar equations can be constructed to represent the reactions in the case of other metallic oxides. The heat generated in the reaction between aluminium and iron oxide is sufficient to fuse both the alumina and the metallic iron produced, the whole contents of the crucible in which the reaction is carried out becoming fluid. The metal, owing to its density, sinks to the bottom. The temperature reached is second only to that of the electric furnace, being estimated to be about 3,000°C. The reaction can be very readily carried out, no apparatus beyond a crucible of highly refractory material being required. Care, however, should be taken to protect the crucible in case it should be cracked by the heat of the reaction, and its molten contents run out.

That substances apparently so inert as aluminium and iron oxide should be capable, once interaction between them has been started, of producing sufficient heat, not only to continue their own combustion, but to liquefy iron and even more difficultly fusible metals, may seem an extraordinary fact. But it is quite analogous to the behaviour of a rock nicely balanced at the top of a hill. Leave it alone, and what could seem more destitute of energy: give it but a gentle push and who shall stay its course?

By using other oxides in place of iron oxide

[1] H. Goldschmidt: "Ueber ein neues Verfahren zur Darstellung von Metallen und Legirungen mittelst Aluminiums" *Annalen der Chemie*, (1898), Vol. 301., pp. 19 *et seq.*, and H. Goldschmidt and C. Vautin: "Aluminium as a Heating and Reducing Agent" *Journal of the Society of Chemical Industry*, (1898), Vol. 17, pp. 543, 649.

Goldschmidt was able to prepare many other metals in a fused condition). Moreover, providing that the oxide was present in slight excess of the amount chemically equivalent to the quantity of aluminium employed, the corresponding metal was obtained in a state of exceptional purity, free from carbon. By using mixtures of oxides, alloys of desired composition were similarly obtained. It seems, indeed, that practically all metallic oxides will react in this manner with aluminium. In some cases, e.g., titanium and vanadium, in which pure metals are not obtained, the product is sufficiently pure for the preparation of the chlorides. Even calcium oxide (lime) is not entirely proof against the activity of aluminium, though the reaction between these two bodies can only be brought about when they are heated together in a furnace, and is then by no means complete. It seems, therefore, to differ from the reactions between aluminium and other metallic oxides in being endothermic (*i.e.*, heat-absorbing), and it may be concluded that calcium has a greater heat of combustion than aluminium (measured, of course, with respect to the same quantity of oxygen).[*] Magnesia, however, is quite unattackable by this most active element. With alumina itself, aluminium yields a blackish-grey product, probably containing a sub-oxide.

Aluminium reacts in a similar manner with the sulphides of the metals. Thus, with galena (lead sulphide) the products are lead and aluminium sulphide, as shown by the following equation,—

$$3PbS + 2Al = Al_2S_3 + 3Pb.$$

This reaction may be employed for the preparation of aluminium sulphide (which cannot be obtained in the wet way, since it is decomposed by water, giving aluminium hydroxide and sulphuretted hydrogen) which is obtained pure if the aluminum is present in slight excess.[†] This excess of aluminium also serves to free the lead from any metallic impurities, for whilst aluminium will not alloy with lead, it readily alloys with many other metals. If aluminium were cheaper, the method might be used commercially for the extraction of traces of the precious metals from lead ores.

Aluminium will also react with certain non-metallic oxides (*e.g.* boron trioxide and silica). In the former case the product of the reaction contains aluminium boride and aluminium nitride (the nitrogen coming from the air) as well as alumina and free boron.[‡] In the latter case impure silicon is obtained as a crystalline substance containing aluminium. Aluminium will also react with charcoal: in this reaction the air seems to play an important part, the product containing aluminium oxide and nitride, as well as aluminium carbide (Al_4C_3) together with unchanged aluminium and carbon.[§]

Since Goldschmidt's discovery, many other reactions, similar to those between aluminium and metallic oxides, in which substances other than aluminium are employed, have been described. Dr. F. M. Perkin, for example, has succeeded in bringing about the reduction of metallic oxides and certain other substances (*e.g.*, galena and borax) by means of metallic calcium. Dr. Goldschmidt has also carried out experiments with this metal: he finds that it reacts with oxides in a most violent manner, but a regulus of metal is not formed owing to the limited fusibility of the calcium oxide produced. He finds, also, that, whilst silicon alone yields unsatisfactory results, a mixture of calcium and silicon reacts with metallic oxides in a satisfactory manner, giving a fusible slag of calcium silicate.[¶]

Another substance, behaving in a similar manner, is calcium hydride (CaH_2). Dr. F. M. Perkin finds that a mixture of this substance and cupric oxide (in the proportion of two molecules of the oxide to one of the hydride) can be readily ignited; volumes of steam are evolved and copper is produced, but the temperature is insufficient to melt the whole of the copper. A mixture of antimony sulphide and calcium hydride is also very easy to ignite. As the reaction proceeds, the mixture swells up in a manner similar to that in which mercury thiocyanate ("Pharaoh's serpents") behaves when heated.[**]

Messrs. F. E. Weston and H. R. Ellis have carried out a series of experiments on "thermitic reactions" (as these reactions are called) *in vacuo*. Their final form of apparatus is shown in Figure 1. They found considerable difficulty in igniting the mixtures experimented upon, but this was probably due to the difficulty of producing a sufficiently high temperature *in vacuo*. They succeeded, however, in obtaining reaction *in vacuo* between magnesium and sodium peroxide and between aluminium and sodium peroxide by ignition with a platinum wire electrically

[*] F. E. Weston and H. R. Ellis: "The Heats of Combustion of Aluminium, Calcium and Magnesium." *Transactions of the Faraday Society*, (1908), Vol. IV., pp. 130 *et seq.*

[†] In this reaction the mixture may be heated in a crucible furnace with the cover off: but the aluminium should not be too finely powdered, as otherwise the heat generated may be sufficient to volatilize the lead, giving rise to an explosion.

[‡] F. E. Weston and H. R. Ellis: "Note on the Action of Aluminium Powder on Silica and Boric Anhydride." *Transactions of the Faraday Society*, (1907), Vol. III., pp. 170 *et seq.*

[§] F. E. Weston and H. R. Ellis: "The Interaction of Aluminium Powder and Carbon." *Transactions of the Faraday Society*, (1908), Vol. IV., pp. 60 *et seq.*

F. M. Perkin: "Reduction of Oxides, Sulphides, &c., by Metallic Calcium." *Transactions of the Faraday Society* (1907), Vol. III., pp. 115 *et seq.*

[¶] English Patents, 788, Jan. 11th, 1906.

[**] F. M. Perkin and L. Pratt: "Reducing Action of Metallic Calcium and Calcium Hydride upon Metallic Oxides, Sulphides and Halogen Salts." *Transactions of the Faraday Society* (1907), Vol. III., pp. 179 *et seq.*

heated; and by the use of the latter mixture as a fuse they succeeded in obtaining reaction *in vacuo* between aluminium and iron oxide. In air, one drop

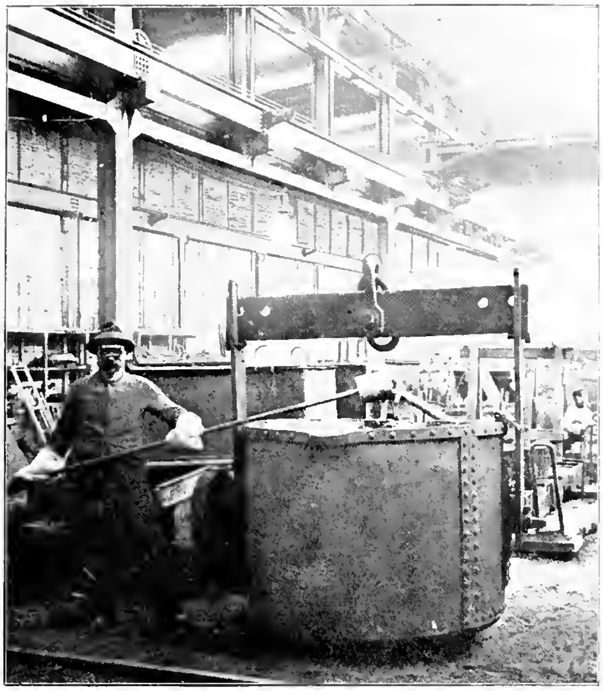


Figure 2.
Titanium "thermit" in foundry work.
(Heating "thermit" tin over the ladle before insertion.)

of water added to a mixture of aluminium and sodium peroxide causes it to react: but *in vacuo* they found it to cause merely a slight effervescence.*

II.—Technological Aspects of the Goldschmidt Reaction.†

The technological importance of Goldschmidt's reaction can hardly be over-estimated. The whole subject is as yet in its infancy, but already it may be said to constitute a new branch of technology, to which the name of "Alumino-thermics" has been given.

In the first place, the reaction serves for the preparation of a number of pure metals and alloys of considerable value in the iron and steel and allied industries. Of the former of these we may mention chromium (98–99% pure), manganese (96%), and molybdenum (98–99%). Chromium is used in the manufacture of high-speed tool steel, as well as armour plate; manganese is also used in the manufacture of very hard steel. Amongst the alloys we may mention chromium-manganese, manganese-titanium, ferro-titanium, ferro-vanadium and ferro-boron.

"Thermit"‡ containing a small amount of titanium oxide is used in foundry work. The mixture, placed in a tin fastened to an iron rod (see Figure 2), is plunged into the molten iron as soon as it is run from the furnace into the ladle, and held at the bottom until the reaction is over. The slag rises to the top and can be removed. It is found that this treatment tends to prevent blowholes and to give clean, dense castings, the effect of the titanium being to increase the fluidity of the metal and produce a finer grain; moreover, the sulphur content is decreased.

In the slag from the reaction of chromium "thermit," minute rubies are found, ruby being nothing but crystallised alumina coloured with chromium; but they are too small to be of any commercial value. A use, however, for the slag has been found. Dr. Buchner has discovered that, owing to its comparative freedom from metallic impurities and absolutely anhydrous condition, it is preferable to natural corundum (which it resembles) in the manufacture of pottery, for which purpose it is mixed with clay and burned, and is especially useful for making chemical apparatus which may be subjected to great changes in temperature without fracturing.

Figure 3.
Alumino-thermic repair to the stern frame of the s.s. "Sevilla" after twelve months.

* F. E. Weston and H. R. Ellis: "Thermic Reactions in Vacuo," *Transactions of the Faraday Society*, (1910), Vol. VI.

† The writer's heartiest thanks are due to "Thermit, Limited" for their kindness in supplying him with full information concerning the technological applications of Goldschmidt's Reaction, for opportunity to examine their apparatus and methods, and for the loan of the blocks of several illustrations in the present article.

‡ "Thermit" is the registered name given to a mixture of aluminium and iron oxide.

"Thermit" is also employed technologically as a heating agent. As Dr. Goldschmidt has pointed out,* in "thermit" we have a new sort of fire differing in certain respects from all other fires. In the first place, in the combustion of "thermit" neither is air consumed nor is any gas evolved, as in the case of the combustion of such substances as wood, coal, coal-gas or petrol. The second difference is in the heat density. The actual amount of heat obtainable from a given weight of "thermit" is really much less than that obtainable by the combustion of the same weight of anthracite: but in the former case the whole of this heat is, so to speak, obtained at once, the reaction between large quantities of iron oxide and aluminium, as we have already indicated, occupying a very short period of time: indeed, by the combustion of "thermit" a heat density is produced unattainable otherwise. It is these peculiarities in its behaviour which determine the applicability of the "thermit" fire. Where a continuous heating effect rather than density of heat is the essential desideratum, "thermit" would be useless: thus it is not suitable as a source of heat for locomotive purposes or for cooking generally. But where great density of heat is required, "thermit" is preferable to other forms of fire, because by its aid one can so readily produce an enormous temperature at a moment's notice.

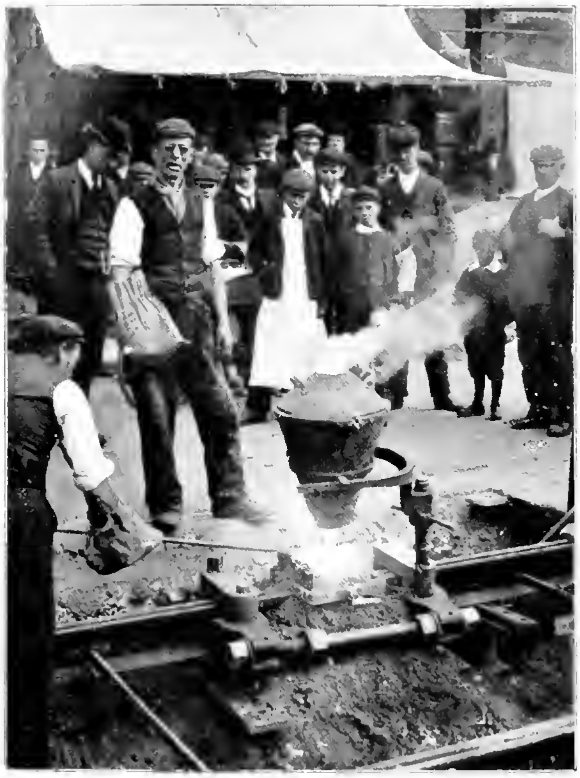


FIGURE 4.
Alumino-thermic welding of tram rails.

One of its chief applications as a heating agent purely is in the butt-welding of iron pipes. The ends of the pipes to be welded together are surrounded by a suitable mould, into which the products of the "thermit" reaction are poured. Welding temperature being reached, the ends of the pipes are pressed together by means of screws arranged in position beforehand. Of course, if the liquid iron produced in the reaction were allowed to come into contact with the pipes, they would be burnt through, but it is found, as a matter of fact, that the highly-refractory alumina slag, which issues from the crucible first on pouring out its contents after the reaction, solidifies on the surfaces of the pipes, thus forming a protective coating which is impenetrable by the molten metal.

In a method of welding which has been chiefly applied in the welding of tram lines, not only is the heat derived from the "thermit" re-action utilised to heat the lines to welding point, but the liquid steel produced is employed to form a bulb of metal holding the two lines together, thereby strengthening the joint. An illustration of the method in use is shown in Figure 4. The "thermit" is ignited in a crucible with a hole in the bottom fitted with a device for tapping. The moulds around the rails are constructed in such a manner that the "thermit" steel, which first issues from the crucible when it is tapped after the re-action is over, runs to the bottom, forming a metal bulb over the joint to about

FIGURE 5.
Alumino-thermic welding of "third" rails (Paris, Metropolitan Railway).

* H. Goldschmidt: "Alumino-Thermics," *Transactions of the American Electrochemical Society* (1904), Vol. VI, Part II, pp. 85 *et seq.*

half way up the rail or more. The metal, of course, must not be allowed to come in contact with the top of the rail. The molten alumina, which flows out of the crucible after the liquid metal, completely covers the top of the joint, and welding temperature being reached, the rails are pressed together by screws placed in position beforehand.*

It is interesting to know that tests carried out on rails thus welded have proved very satisfactory. The following are given by the Manchester Corporation Tramways (November 29th, 1906).

Bending Tests.

	Span.	Loads Elastic Limit.	Bending Moment.
Solid Rail	10 Feet ...	28,200 ...	70,500
Fishplate Jointed Rail ...	10 ,, ...	10,000 ...	25,000
Thermit Jointed Rail ...	10 ,, ...	25,000 ...	62,500
Solid Rail	5 ,, ...	74,000 ...	92,500
Thermit Jointed Rail ...	6 ,, ...	42,000 ...	63,000

Hardness Tests†.

Load on Die in Tons.	Welded Rail. Length of Indentation Produced. Away from Joint.	Close to Joint.
0·25...	0·26 Inch	0·26 Inch
0·50...	0·32 ,,	0·32 ,,
0·75...	0·37 ,,	0·36 ,,

It is clear from the hardness test that the subjection of the welded edges of the rails to the high temperature of the "thermit" reaction products has no injurious effect upon the hardness of the rail.

A somewhat similar method to the above is employed in welding third rails of electric railways (see Figure 5).

The liquid steel produced by the "thermit" reaction may be employed in all sorts of repairs to iron and steel articles: and not only is it applicable to small articles but to work on the largest scale. Indeed, by the ignition of a couple of hundredweights of "thermit" one may produce in a few moments a hundredweight of super-heated mild steel, a quantity producible in so short a period of time by no other means. In repair work it is often found advantageous to add a certain proportion of steel punchings to the "thermit": this reduces the quantity required and renders the reaction less violent. As an illustration of the applicability of "thermit" to marine repairs we reproduce a photograph (Figure 3) of a repair to a fracture (20-in. by 8-in.) in the stern frame of s. s. "Sevilla" of the Hamburg-American Line, taken after twelve months use.

[We are indebted to Messrs. Thermit, Limited, for the loan of Figures 2 to 5.—Eds.]

* English Patents, No. 10,859, May 25th, 1901. (Dr. Hans Goldschmidt: "A new and improved process for welding metals.")

† These tests were made by measuring the lengths of indentations made by a hardened steel die with a curved edge struck to a radius of one inch, and having a cutting edge whose angle was 50°.

UNIQUE AMERICAN STEAM MOTOR CAR.

By FRANK C. PERKINS.

During the past decade the steam motor car has been developed to a high state of perfection in Europe, and has entered the field of urban and inter-urban service with the gasoline motor car, in competition with electrically operated motor cars. In the United States, however, little has been done in this line until recently.

The accompanying illustration shows a new and unique car as utilized for passenger service, provided with a baggage compartment and seats for thirty-eight passengers.

Although this steam motor car was not designed for freight service, its capacity for hauling trailers or freight cars in an emergency has been demonstrated by hauling a train of freight cars, weighing fifty-two thousand pounds.

The car has a total length of thirty-seven feet three inches with a width of nine feet two inches, and it weighs complete, without passengers, sixty-six thousand pounds. There is included in this weight, six thousand six hundred pounds for water and oil, the latter being utilized as a fuel instead of coal. It is maintained that this American steam motor car is capable of developing a speed of forty miles per hour on a level track and is designed for hauling not more than two trail cars or two express or freight cars under normal conditions, although in emergency longer trains can be handled.

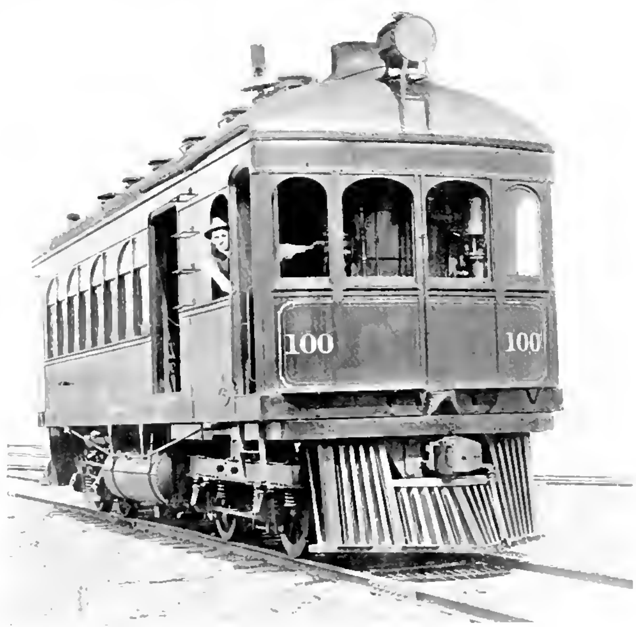


Figure 1.

An Unique American Steam Motor Car.

It may be stated that the engines are hung to the motor trunk but the car body carries the water tube boiler which supplies steam to the driving cylinders at a pressure of 200 pounds per square inch.

The engines develop one hundred and twenty-five horse-power and are capable of driving the car at a speed of forty miles per hour, with two hundred pounds steam pressure and on a level track. It is maintained that the use of crude oil for making steam is most convenient in operation and cleanly, there being no dust nor dirt as when coal is used and the combustion in the fire box is complete.

While the primary object aimed at, it is said, in the development of this design was to provide a self-contained steam motor car for passenger service, still considerable freight and express may be handled when necessary, and a number of trailers may be hauled during heavy passenger service on extra occasions when required.

FIGURE 1.
Gold Medal of the Royal Astronomical Society of London.

THE POLITICAL IMPORTANCE OF ASTRONOMY AS A PEACE PROMOTER.

By IRENE E. TOYE WARNER.

Member of the British Astronomical Association and of the Société Astronomique de France.

THERE have been numerous conferences recently to consider how best to promote international arbitration and peace.

The study of geography and history on a wider scale has been suggested, but the vast and *living* power of astronomy in this matter has, as far as I can learn, been practically overlooked. It is to this subject, therefore, that I wish to draw special attention in this article.

Astronomy is pre-eminently a living thing, ever growing, changing, and advancing — requiring united and universal study. More and more as time goes on we find a tendency towards coöperation amongst astronomers throughout the whole world. Racial and party differences are at least buried, if not wholly forgotten, in the study of a science which deals with other worlds and universes, and draws our thoughts from all that is earthly, to consider that which is heavenly.

FIGURE 2.
Bronze Comet Medal of the United States of America.

From its very nature, and the conditions necessary for its favourable study, it is peculiarly fitted to play a most potent part in the promotion of universal peace. Religion and commerce are generally acknowledged to be the two greatest civilizers of the world, but experience has shown that, in the present state of the world's evolution, neither has quite succeeded in banishing war.

I do not for a moment claim that where they have failed, astronomy would succeed, but I maintain that the latter must become a great bond of union between those very nations at present divided by both religion and commercial interests. This is largely due to the fact that astronomy can never become a means of money-making or an object of greed. No one will ever be able to claim the stars as an exclusive possession. On the other hand there is no tendency towards socialism, for does not "one star differ from another star in glory"? and do not all the planets obey their ruler, the Sun?

Should not all who "consider the heavens" learn that in them is universal peace as a result of universal law and order?

There is nothing that binds races or nationalities together, promotes comprehension, and fosters friendly rivalry, like having a common object of interest which appeals only to the highest emotions without exciting the baser passions of mankind—and such, undoubtedly, is astronomy.

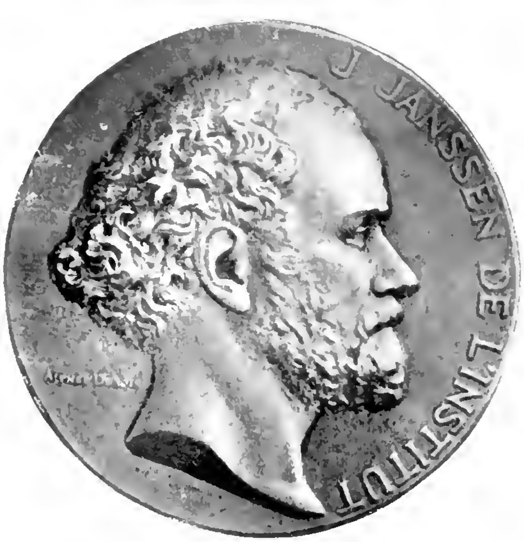


Figure 3.
Janssen Medal of the Société Astronomique de France.

Figure 4.
One of the Medals of the Société Astronomique de France.

I do not think it is generally known that all astronomical honours and rewards are distributed according to merit, irrespective of nationality. For example, the Gold Medal of the Royal Astronomical Society is given to astronomers of *all* nations and creeds, and tongues, so long as their merit is established by the work they have done. And in thus honouring the individual we honour the nation to which he belongs, and promote a kindly feeling between the winner and donor of the gift.

Other nations win our medals and rewards, and we, in our turn, receive theirs, the only qualification necessary being sterling worth.

Then, in the matter of *work*, hearty and effective coöperation is no longer a dream but a reality, amongst the students of the heavenly science, for it is an actual *fact* that in the pursuit of astronomical research and observation, all nations, peoples, and languages are united.

Figure 5.
The Valz Medal of Paris.

Eclipse expeditions are ever a means of fostering amity between astronomers of different nationalities, particularly when the eclipse happens to be visible from some desert island where the various members of the party are thrown much together!

There is an International Congress on the "Map of the Sky," held at Paris. This congress is composed of seventy leading astronomers, representing twenty-two countries, scattered all over the globe. These "peace-promoters" meet to report the progress made in the preparation of an enormous photographic atlas of the heavens, which was begun in 1887 and will not be finished for another ten years. On this map over forty million stars will be marked, and when complete it will represent the combined work of astronomers of nations otherwise divided by race, creed, and commercial interests.

Comets are ever a means of promoting peace amongst widely separated nationalities. A good example is furnished by the "hairy star" discovered by Mr. Morehouse, of America. This comet in its course passed almost from the North to the South Pole, and exhibited many variations in form and brilliancy. It was seen and photographed by astronomers at nearly all the observatories in the world and thus a complete record of the history of this beautiful object was obtained by the *united* efforts of the students of the heavenly science.

Figure 6.
Commemorative Medal of the Société Astronomique de France.

In its journey past this "little sun-lighted wanderer in the depths of the Infinite"—as one of our greatest living poets terms the Earth:—it saw many sad sights. Fierce rivalry and doctrinal quarrelling amongst the various sects, each crying "I am of Paul! . . . I of Apollos! . . . I of Cephas!" and only a small minority who actually "live" Christ. To quote the same sweet singer (Mr. S. R. Lysaght)

"We are faithless of life, and in *creeds* our unfaith do we hide; the world that our faith should unite with our creeds we divide."

It saw political war, each party fighting for power and proclaiming an immediate Utopia if they gain it; and the universal struggle, and keen competition of commerce; yet quiet, and apart from all the turmoil of life, it found a devoted band of astronomers whom no differences of creed, nationality or interest could deter from coöperation in studying its gauzy, fairy-like self!

Surely, then, if we teach the nations even the elementary truths of this great science and give them a common and united interest in the starry realms, we lift their thoughts heavenward and appeal to those higher emotions in the human soul, which ever make for *peace*. Let all, then, who love science unite in striving to teach its many lessons to the inhabitants of Earth, so that in the fulness of time those that are "afar off" may draw near in unity, peace and concord.

SPRING AND SUMMER SHOOTING STARS.

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

I observed seventy-eight meteors in May, during watches extending over twenty-two-and-a-half hours in the aggregate.

Very fortunately, this year one of the meteors was seen by Mr. Fiammetta Wilson, at Reigate, and by myself at Bristol, on May 24th. Details are given at the end of this note, and I also give the real path of a bright long meteor, recorded by the same observers from the radiant at 350° + 37 on May 29th. This shower is a remarkable one from the exceptional swiftness of its meteors in September. The radiant being a long way from the earth's apex in that month, we should expect only slow flights from it, but I have recorded them as *very swift.*

May meteors are very rarely abundant, but I found them unduly plentiful on the 24th this year. Clouds veiled the stars in the early evening, but a west wind cleared the sky at about 10.15 p.m., and the stars afterwards shone with a splendour not often equalled at this time of the year. I saw eighteen shooting stars in one-and-a-quarter hours.

July may be regarded as the advent of the meteoric observer's prolific season. This month always exhibits a great increase in the frequency of meteoric phenomena. At the middle of the month the earth may be said to emerge from the region of scarcity which she has been traversing since the middle of December to enter a space far more richly occupied with these tiny planetoids which illumine our skies in the form of shooting stars. The first fortnight of July usually gives few meteors, but Perseids actively during the last week. An observer may sometimes count twenty or twenty-five meteors per hour and more than three times the number ordinarily visible in the spring months of the year.

It is to be hoped that, as the heavens will now for some time present such an abundance of meteors, many observers will specially watch for them and record details of all the brighter objects. It is important this work should be performed for the purpose of securing duplicate observations, of the same objects, at two stations. Without these data it is often difficult to ascribe the correct radiant points and the real paths cannot be determined.

Real Paths of Two Meteors Observed at Reigate and Bristol.

Date ...	May 24	May 29
G.M.T.	$10^h\ 38^m$	$10^h\ 42^m$
Radiant	243 + 34	350 + 37
Mag. of Meteor	3 − 2	3 − 1
Height at First	72 Miles	74 Miles
Height at End	53 ,,	57 ,,
Length of Flight	20 ,,	91 ,,
Velocity per Second	35 ,,	30 ,,
Position over—		
Beginning	6 Miles N. of Southampton	E. of Northampton
Ending	4 Miles N.E. of Netley	Salisbury
Name of Meteor	ξ Coronid	ι Andromedid

AN ANTEDILUVIAN ZOÖLOGICAL GARDEN.

By DR. ALFRED GRADENWITZ.

THOUGH no human fancy could imagine the infinite variety of forms embodied in the representatives of the animal and vegetable kingdoms—either of which is known to number hundreds of thousands of different species—an even superficial glance at the fossil remains of extinct organisms shows that Nature in the course of bygone ages has brought forth many startling forms to which no analogy is to be found in our present vegetation or fauna.

FIGURE 1. *Stegosaurus* assailed by *Ceratosaurus*.

Carl Hagenbeck, the founder of the famous animal park at Stellingen, near Hamburg, where even the most savage beasts are kept in a state of apparent freedom, has installed in his Garden of Eden a series of wonderfully life-like representations of the most striking monsters that inhabited our earth in prehistoric times, thus creating what may be called an Antediluvian Zoölogical Garden. These weird giants, who millions of years ago ruled this world of ours, can be seen in surroundings corresponding to their very modes of life, thus producing a perfect illustration of what the earth looked like in their days. In fact, an hour spent in that strangest of all sceneries brings us back as in a dream to a world which the science of palaeontology allows us to reconstitute in its very details.

In that long-distant past the struggle for life among the animal dwellers on earth must have been much more acute than even now. A perpetual war was waged between those monsters, startling alike by their form and enormous size. The manifold natural weapons which Nature had lavished upon them proved no sufficient protection in the course of time, the more so as the changing climatic conditions sealed their final doom to extinction. Apart from such features as are entailed by the peculiar conditions of their antediluvian world, these animals certainly have much in common with existing species, their remote descendants, and strikingly illustrate the slow evolution from one class to another, with many intermediate stages between reptile and bird, fish and mammal, and so on.

These antediluvian cement models, made in artistic perfection by the well-known animal sculptor, Mr. J. Pallenberg, have been arranged in an impressive group

FIGURE 2. *Allosaurus* feeding on the remains of a *Brontosaurus*.

round the shores of a beautiful little lake encompassed by abundant vegetation. Most of them are seen standing by the water's edge amidst the shrubs and trees, while huge crocodiles and weird creatures emerge from the lake itself. Scenes of battle between these monsters of bygone ages lend additional realism to their appearance.

Every care was taken to investigate most conscientiously all the bone finds and fossil imprints housed in the foremost museums of the world, especially the American Museum of Natural History. Each model was submitted to the leading authorities in the science of palaeontology who, wherever necessary, suggested such alterations as might produce a perfect agreement with scientific data.

A fascinating scene of battle offers itself to the observer's eye as he reaches the bridge crossing the lake (see Figure 1). A monster called *Ceratosaurus* which could be described as a crocodile with huge kangaroo-like hind-legs and tail, is seen assailing another beast of the reptile class, the *Stegosaurus* which, though protected by a double row of plates or spines up to a yard in length down the centre of its back, and by spikes upon its tail, is likely to have been too clumsy in the long run to resist the attacks of its more agile, though considerably smaller, enemy.


Figure 3. *Iguanodon.*

A short way off is seen an even much larger giant, called *Brontosaurus* (see Figure 2) who has already succumbed in the struggle for life.

An *Allosaurus*, likewise a huge lizard of the same family of monsters, is gluttonously devouring the remains of his luckless herbivorous fellow, who apparently was quite unfitted for any serious struggle. The triumphant dinosaur with its huge head and large pointed teeth — as evidenced by the circumstances under which its remains have been found — was one of the rulers of those times, and thanks to its enormous fore-claws, so well adapted for lacerating, its powerful long hind-legs, so admirably suited for jumping, was excellently fitted to play a domineering part. The dinosaurs, generally speaking, constituted a family of land-dwelling

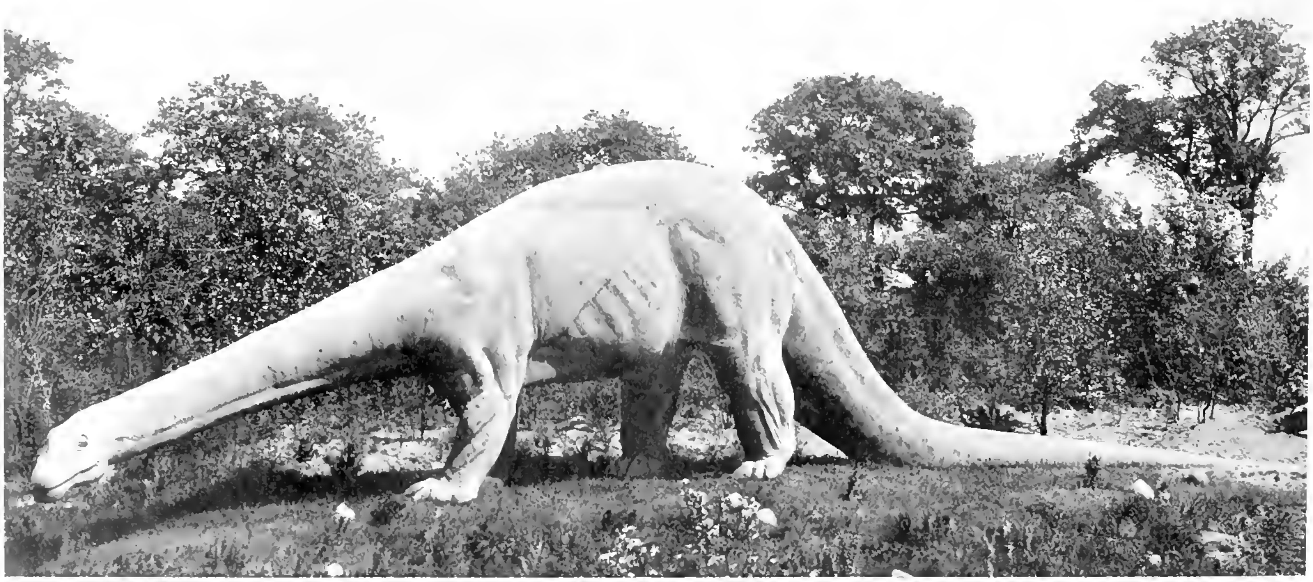


Figure 4. *Diplodocus carnegiei.*

reptiles with an astounding abundance of forms which are the more remarkable as the structure of their skeletons gives evidence of a continuous transition to the bird class of animals.

One of the largest among these monsters, beside which the surrounding trees look small indeed, is a giant *Iguanodon* (see Figure 3), the head of which towers some twenty-five feet above the ground. This weird creature habitually walked on its bird-like hind legs as proved by the enormous foot-prints up to thirty inches in length and forty-five feet apart which have been found in the weald of Sussex. The erect position and bird-like gait of this beast was assisted by the extreme bulk of its tail: the neck was relatively long, the arms short and the first and fifth fingers stood out nearly at a right angle to the three middle fingers. However, the head was surprisingly small and this limited provision of brain obviously failed to protect the *Iguanodon* in its struggle for life.

Another dinosaur species, the *Diplodocus* (see Figure 4) bears a certain resemblance to the former, but is of even huger dimensions. This animal lived in Wyoming, Montana, Colorado, New Mexico and the Dakotas, which countries then possessed a tropical climate and included extensive lakes of salt water, the sedimentary remains of which form the "bad lands" of our day. The *Diplodocus*, sixty-six feet in length, at the Stellingen Park, has been reconstituted from the most complete and not from the largest bone finds of its kind. This mammoth lizard possessed a tail even longer than the *Iguanodon*, while the hind-legs were not much longer than the fore-legs, thus enabling the beast to use all four limbs for walking about. The enormous length of the neck and remarkable smallness of the head are equally striking.

Figure 5. Rhinoceros Saurians.

Between the place where the *Iguanodon* stands, and that reserved for its fellow, the *Diplodocus*, visitors can watch a charming idyll of ten million years ago (see Figure 5). A family of "rhinoceros Saurians" (*Triceratops*) has come to the lake, and the father lustily disports himself in the water from which only his head and shoulders are seen to emerge, while the mother with her little one still lingers at the water's edge. Apart from the thick lizard tail, characterising them as reptiles, these strange animals strikingly remind us in general appearance of the rhinoceros of our day. The *Triceratops* had three horns, a beak like a bird of prey, and a broad-toothed frill surrounding its neck.

An even more ancient group of fossil lizards comprises the *Plesiosaurus* (see Figure 6), which could be

FIGURE 6. *Plesiosaurus.*

described as an enormous seal with long, thickened tail, remarkably long neck and a tiny head. It was a marine reptile with limbs reminiscent of whale fins, with five toes and no claws. A somewhat related family comprises the fish-like Ichthyosauria which among the reptiles of their age occupied a similar position to the whales among present-day mammals. Their neck was short and stumpy, their snout remarkably large, the tail lengthy and vigorous, and the limbs as short as whale fins. Such an *Ichthyosaurus* is seen (see Figure 5), in the lake to emerge from the water with the swift and elegant motion of a first-class swimmer, allowing the head, the front half of the back and the rear fin to be seen.

Like these whale-shaped reptiles, the fossil flying lizards or Pterosauria have left no representative among the reptiles of our day. In fact, the only analogy in our present-day fauna could be found with the bat family of the mammal class. However, while the flying membrane of bats extends between the second, third, fourth and fifth fingers and the body, that of the Pterosauria reached from the strikingly developed last (fourth) finger to the body. The first three fingers were short and fitted with claws. A number of these strange beasts are seen in the Stellingen Park, squatted at the water's edge, crawling on the rocky shore, or resting on its stone slabs. These bird-lizards comprise a few *Acrosaurus* with their broad snouts and some *Rhamphorhynchus* with long rat-like tails. On a mighty rock towards which the *Diplodocus* is taking its course there are represented two giant flying dragons in a lazy creeping position and with striking life-likeness (see Figure 7). These Pteranodons, as they are called in science, were huge, short-tailed flying lizards endowed with a long marabou beak and a narrow crest of nearly equal length at the back of their head.

Simultaneously with the now extinct animal families, there lived many other species which are more or less closely related to the reptiles of the present day. Some specimens of these are the big and small crested lizards (*Dimetrodon* and *Naosaurus*) represented in Figure 9. While resembling in their outward appearance an alligator endowed with an especially large and broad snout, they were characterised by a high crest with rigid spikes running alongside their back.

Two real crocodiles from the Cretaceous and Jurassic formations, which are mainly distinguished from present-day representatives of the same family by their clumsy build, are shown half hidden in the water (see Figure 9). On the turf are seen creeping two huge turtles characterised by a cartilaginous formation on the tail and head, and especially by two large horn-like excrescences near the ear.

In addition to antediluvian reptiles, there are

FIGURE 7. Flying Dragon (*Pteranodon*).

found some fossil animals belonging to other classes. Quite a number of primitive birds (*Archaeopteryx*) (see Figure 8), which are still closely related to the reptile class, are seen roosting here and there on the rocks and at the water's edge. The birds are characterised by a long tail, consisting of vertebrae, to which the large steering feathers are fastened in a row on either side. The wing comprises three well-developed fingers, while some real bevelled teeth are still found at the edges of the jaws. Remains and imprints of *Archaeopteryx* have been unearthed at Solenhof, Germany, in the lithographic slate of the Jura formation. From the middle of the lake is seen to emerge the mighty head of a batrachian, called *Mastodonsaurus*, which was a member of a family common to the coal and trias formations. While the largest amphibia of our day hardly reach one-and-a-half meters length, these antediluvian ancestors of theirs comprised some species, whose skull alone measured one-and-a-half meters in length. Another amphibian is the *Pareiosaurus*, about two meters in length, seen half-hidden in the shrub, which can be described as a giant toad endowed with a short, blunt tail, and a head relatively narrower and less flattened than that of present-day toads, the skin showing striking remains of bony armour plates.

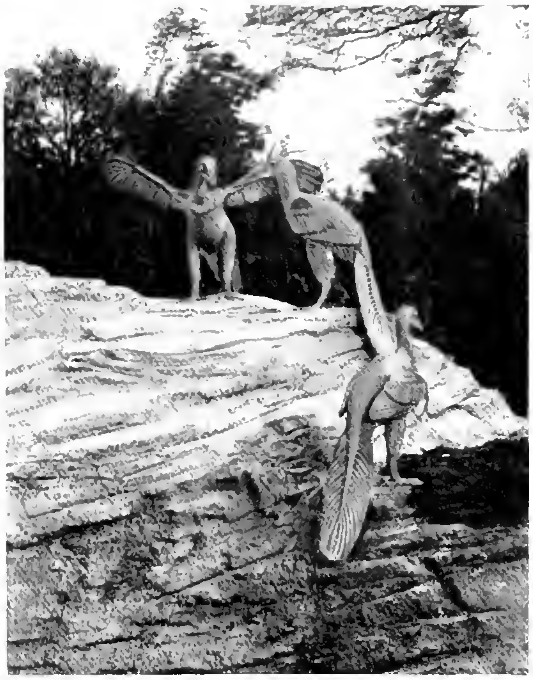


FIGURE 8. Primitive Birds.

Even a fossil insect, viz., a giant dragon-fly of upwards of 2 feet wing expanse, is represented at the Stellingen Park (see Figure 9).

Elaborate plans have been made for extending this antediluvian "Zoo" by the addition of a number of new specimens belonging to all the known extinct animal families.


FIGURE 9. A collection of Antediluvian Reptiles.

RADIO-ACTIVE RECOIL.

By WALTER MAKOWER, M.A., D.Sc.

It is well known that when a shot is fired from a cannon, the latter attempts to move backwards and is said to recoil. Furthermore, if the cannon is free to move, then its velocity is such as to make the momentum of the cannon equal to that of the shot which causes it to recoil. The momentum of a body is a quantity which may be taken as giving a measure of the quantity of motion in a system and is measured by the product of the mass and velocity of the body considered.

The question whether the ordinary laws of dynamics apply to the case of atoms as well as to that of molecular masses has frequently been discussed, but till recently it has been beyond the possibility of direct experiment to test the point. By the recent discoveries in radio-activity the motion of streams of atoms, and in some cases of single atoms, can be observed and studied and the possibility has thus been afforded of investigating the dynamics of atoms in motion. It is now generally accepted that radio-active processes are the manifestations of changes in the constitution of the atoms concerned, and are of a more subtle nature than chemical changes, in which atoms of various kinds react on each other without affecting the internal structure of the atoms themselves. Thus to take as an example the case of the best known radio-active substance—radium, discovered by Mme Curie. It is now certain that this element, which is similar to barium in its chemical behaviour, is slowly but constantly ejecting positively charged atoms known as α particles which have been shown by Rutherford and others to be nothing other than charged atoms of helium. This can be proved by collecting the α particles, which can be detected in many ways and then subjecting them to spectroscopic analysis. The remainder of the atom from which the helium has been expelled constitutes a new element also displaying radio-active properties, which happens to be a gas, and is called the *emanation*—a name which has persisted since the time of its discovery, when its nature was not yet fully understood. The emanation, whose chemical and physical properties are entirely distinct from those of the radium which produced it, in turn gives off α particles, and disintegrates into a new product which has been called radium A. The only essential difference between this change and that undergone by the radium exists in the difference in the speed of the disintegration. Whereas radium takes thousands of years to change into the emanation and helium, the emanation is much more unstable, and disappears in the course of a few weeks. A similar process occurs with radium A, which in turn gives rise to a series of successive radio-active products, known as radium B, radium C, and so on. It should here be mentioned that all radio-active processes are not exactly of the nature just described; for in some cases the disintegration is associated merely with the expulsion of an electron—that minute negatively charged particle first detected by J. J. Thomson. It will, however, be sufficient for present purposes to confine attention to those transformations in which the radio-active change is associated with the expulsion of an α particle, which we have seen is a charged atom of helium.

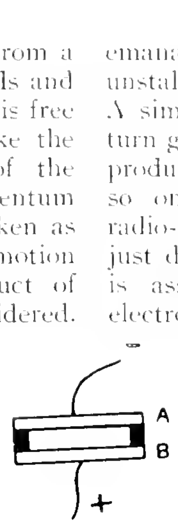


Figure 1.

The change of radium A into radium B, mentioned above, presents a particularly convenient case for studying the phenomena of atomic recoil; for radium A has a very short "life," and quickly disappears with the production of radium B, an α particle being ejected during the process. The details of the method of obtaining pure radium A from the emanation need not be considered here; suffice it to say that if a plate is exposed to the emanation for a short time, as the kathode in an electric field, it becomes coated with a strongly-active film of radium A. If the plate is removed from the emanation and left for some minutes, most of the radium A will have turned into radium B in position and after about a quarter of an hour practically no atoms of radium A will be left. It is to be noticed that the radium B formed remains on the plate. The thing is different when the experiment is carried out *in vacuo*, for according to the laws of probability half of the number of α particles ejected will be shot out from the radium A atoms away from the plate and half towards it. Thus in half the disintegrations of the radium A when an α particle is shot into the plate, the residual atoms of radium B possess momentum in directions away from the plate and will be detached unless there is some force preventing them from leaving. When the experiment is performed under ordinary conditions at atmospheric pressure, the atoms of radium B are prevented from travelling more than a fraction of a millimeter before colliding with molecules of air by which they are stopped; they then mostly diffuse back to the plate from which they came. On the other hand, *in vacuo* there is nothing to stop the motion of the atoms of radium B, and they continue on their course until they

Figure 2.

encounter some obstacle such as a second plate which may be placed at any convenient distance to catch them. The plate receiving the recoil may subsequently be removed and actually found to be coated with a deposit of radium B by testing in the usual manner with an electroscope.

The same thing may be accomplished in a somewhat different way, as was first shown by Hahn, by working at atmospheric pressure with an electric field as shown in the accompanying diagram (Figure 1).

The positively charged plate A, coated with radium A, is placed below the plate B which is negatively charged and insulated from the plate A. After a suitable exposure the plate B is removed and found to be coated with radium B.

Whichever mode of experimenting is adopted, it will be seen that the method of recoil affords a convenient means of separating a radio-active product from the parent substance from which it is formed, and this is perhaps the most important practical use to which these phenomena have been put. Indeed the method has already rendered great service in this direction, and its application has resulted in the discovery of new radio-active products.

To take two examples of particular interest which were first investigated by Hahn. It is well known that thorium possesses radio-active properties similar to those of radium, and gives rise to a number of disintegration products. In particular, at one stage of the transformations a gaseous emanation is formed, which was known to produce successively three radio-active substances—thorium A, thorium B, and thorium C. It was, however, unknown what became of the last of these products after disintegration. By using the method of recoil, it was shown that a previously undiscovered product was formed which was called thorium D. A similar case is that of radium C, which produces a series of slowly-decaying radio-active products. By exposing a plate to the recoil of radium C, a new substance has been isolated, which has been called radium C_2 to distinguish it from radium C, from which it is produced. The nature of the recoil has quite recently been studied by Fajans, and it would seem that, from the results so far obtained, an entirely new type of radio-active process is involved: but it is, perhaps, somewhat early to speak with absolute certainty on the matter as yet.

To turn again to the question of the dynamics of the atom, which we have seen can be studied in the case of radio-active recoil, and which has been subjected to experimental test by Russ, Evans, and the author. It has been mentioned that when the radio-active atom breaks up with the expulsion of an α particle, the residual atom recoils in such a way that its momentum is the same as that of the α particle. Now a charged particle in motion has been shown to act in many ways as an electric current, and will therefore be acted on by a magnetic field, just as is the case with a wire carrying an electric current. Moreover, if the particle is caused to move through a strong electric field applied at right angles to the direction in which it is travelling, it will be deflected from its course. This has been shown to be the case with α particles, and the same should be the case with a "recoil-stream" if this should prove to be charged.

Now the magnetic deflection depends upon the momentum of the particles, and therefore the deflection of the α particle and recoiling atom in a magnetic field of given strength should be the same if they carry the same charges. On the other hand, the electric deflection of the recoiling atoms should be greater than for the α rays, since this deflection can be shown to depend on the *energy* of the particles. These matters have been put to the test of experiment in the case of the recoil of radium B from radium A, and the magnetic and electric deflections observed show that the recoil-stream carries with it an electric charge. It is, however, remarkable that the deflections are such as to indicate that the charge on the α rays and recoil-stream is of the same sign—namely, positive. This fact gives rise to some interesting considerations as to what happens with the negative charge when the atom of radium A breaks up, but the point has not yet been definitely settled.

The magnetic deflection of the recoil-stream can be observed in different ways, of which perhaps the most interesting is to allow a narrow stream of radium B particles to pass *in vacuo* through a magnetic field and fall upon a brass surface. After some minutes the field is reversed and the brass subsequently removed and placed in contact with a photographic plate. The radio-active matter on the brass, photographs itself, giving two bands as shown in Figure 2, the distance between the bands representing twice the deflection suffered by the stream in passing through the field. An examination of the photograph shows that the deflection is only half that experienced by the α particles under similar conditions. From the law of momentum it may be inferred that the charge carried by the recoiling atom is half that on an α particle, or the atomic charge of electricity, since the α particle is known to be associated with twice that charge. The electric deflection of the recoil-stream has been measured in a somewhat similar manner, though not yet with the same accuracy. But though the precise manner of obtaining this information cannot be entered into, the results suffice to make certain important deductions regarding the mass of the atom of radium B—or, in other words, of its atomic weight. The result of the calculation is to show that the atomic weight of radium B is in the neighbourhood of two hundred, a result which had already been predicted from radio-active theory as follows:—The atomic weight of radium has been measured by several investigators, and found to be two hundred and twenty-six. Now radium gives rise to the emanation with the loss of one atom of helium, whose atomic weight is four. Thus the emanation should have an atomic weight of two hundred and twenty-two, and since this in turn produces radium A and radium B successively, with the loss of an α particle in each case, the atomic weight of radium B should be two hundred and fourteen. The method of recoil thus gives an important confirmation of this theoretical deduction.

An account has been given of some new branches in radio-activity which have already been opened to investigation by the method of recoil. It seems not unlikely that many hitherto unsolved problems may receive explanation when attacked by this recently-discovered method.

ON DRAWING ELLIPSES.

By W. B. GIBBS, F.R.A.S.

IN the number of the *Journal of the British Astronomical Association*, for May, 1910, Mr. Hardcastle has given an interesting account of a method of forming the boundaries of an elliptic area by folding down segments of a paper circle according to the following rules:—

The paper circle is to be about six inches in diameter, the centre S is to be marked and also some other point H, which it is convenient to choose about two inches from the centre. On the circumference a number of points are to be marked. I myself find about thirty are desirable. K (Figure 1), will serve as an example of one of these points. The paper is then to be folded so as to bring K to H, and the crease is to be marked clearly. Then the paper is to be opened and the next point on the circumference is to be brought to H, and this new crease to be pressed clearly, and so on for the whole number of points. Then it will be found that a neat smooth area is left forming an ellipse about S and H, each crease being a tangent to the curve.

Now I find that this elliptical area can be made much more distinct, if, when the segments are folded down, they be shaded on the outer side with a lead pencil and then this shading well rubbed with the finger. Figure 2 shows an example of a shaded segment. When all the segments have been so treated and the paper is turned up, there will be seen on the lower side a clear elliptic area as shown in Figure 3, the tangent crease lines being also very plain.

Mr. Hardcastle's paper is well worth reading in its entirety. He gives a geometrical proof that the area is bounded by an elliptic curve, and also shows that it is not only interesting geometrically but that it can be used for dynamical purposes.

It is easily seen that ellipses of any degree of eccentricity can be drawn in this way, for from the properties of the ellipse $AS = A^1H = A^1K$ therefore AA is always equal to SK, or the major axis of the ellipse is equal to the radius we have chosen for our paper circle, while the minor axis continually decreases as H approaches K, vanishing absolutely when H coincides with K, the ellipse then becoming a straight line; but if H approaches S then the minor axis gradually increases, and ultimately, when H coincides with S, becomes equal to the major axis, and the ellipse becomes a circle whose radius is equal to one-half the radius of the original paper circle.

If the radius of the original be 3 inches

Then $AS = \frac{1}{2}$-inch

and the minor axis $= 1\frac{1}{2}$-inches

from formulae given in all treatises on conic sections.

In order to draw elliptic orbits by this method, I subjoin the accompanying table giving the eccentricities of the orbits which correspond to those values of SH which lie between two and three inches, proceeding by thirty-seconds of inches. This will be available for all comets which move in closed orbits. Taking, for example, Encke's comet, the eccentricity of which is ·8476, we see at once we must take SH between $2\frac{17}{32}$ inches and $2\frac{9}{16}$ inches, because ·8476 lies between ·84375 and ·8541, the nearest numbers given in the table.

In Figure 4 I give a representation of this orbit.

Distance between H and S in fractions of an inch and corresponding decimals.		Eccentricity or e.
2	2	·666
$2\frac{1}{32}$	2·03125	·67708
$2\frac{1}{16}$	2·0625	·6875
$2\frac{3}{32}$	2·09375	·69791
$2\frac{1}{8}$	2·125	·708
$2\frac{5}{32}$	2·15625	·71875
$2\frac{3}{16}$	2·1875	·7291
$2\frac{7}{32}$	2·21875	·73958
$2\frac{1}{4}$	2·25	·75
$2\frac{9}{32}$	2·28125	·76041
$2\frac{5}{16}$	2·3125	·7708
$2\frac{11}{32}$	2·34375	·78125
$2\frac{3}{8}$	2·375	·791
$2\frac{13}{32}$	2·40625	·80208
$2\frac{7}{16}$	2·4375	·8125
$2\frac{15}{32}$	2·46875	·8229
$2\frac{1}{2}$	2·5	·833
$2\frac{17}{32}$	2·53125	·84375
$2\frac{9}{16}$	2·5625	·8541
$2\frac{19}{32}$	2·59375	·8646
$2\frac{5}{8}$	2·625	·875
$2\frac{21}{32}$	2·65625	·8854
$2\frac{11}{16}$	2·6875	·8958
$2\frac{23}{32}$	2·71875	·90625
$2\frac{3}{4}$	2·75	·9166
$2\frac{25}{32}$	2·78125	·9271
$2\frac{13}{16}$	2·8125	·9375
$2\frac{27}{32}$	2·84375	·9479
$2\frac{7}{8}$	2·875	·9583
$2\frac{29}{32}$	2·90625	·96875
$2\frac{15}{16}$	2·9375	·9791
$2\frac{31}{32}$	2·96875	·9896
3	3	1·

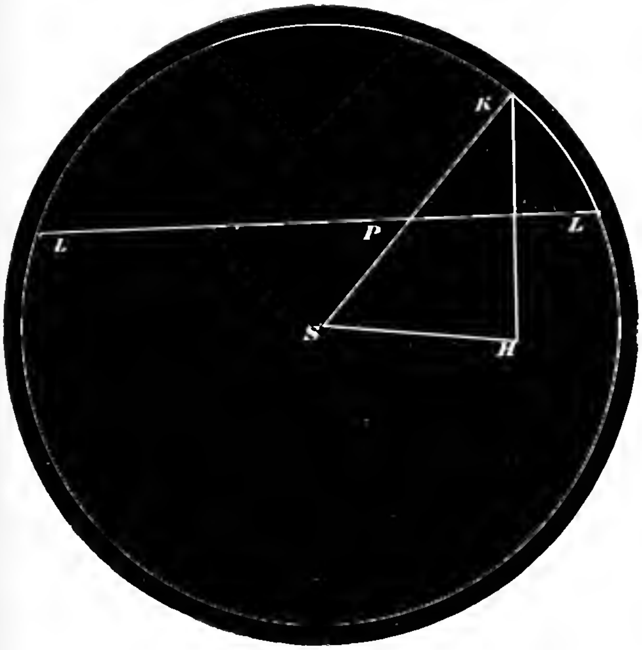


Figure 1.

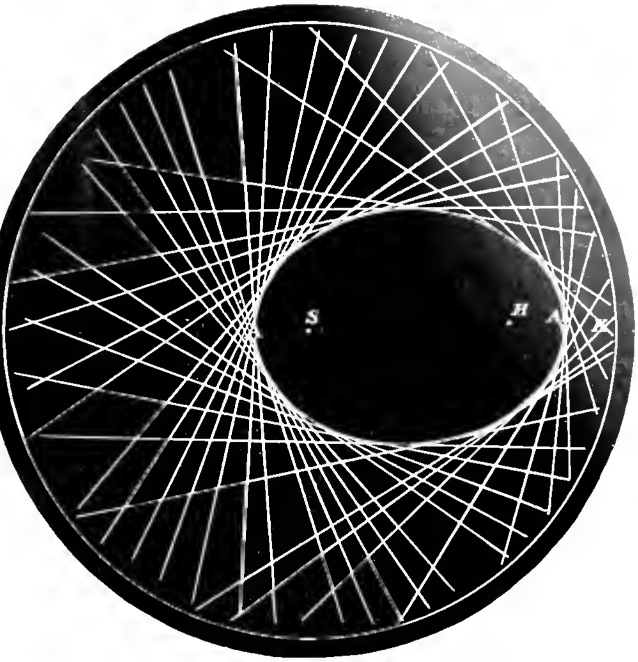


Figure 3.

Figure 2.

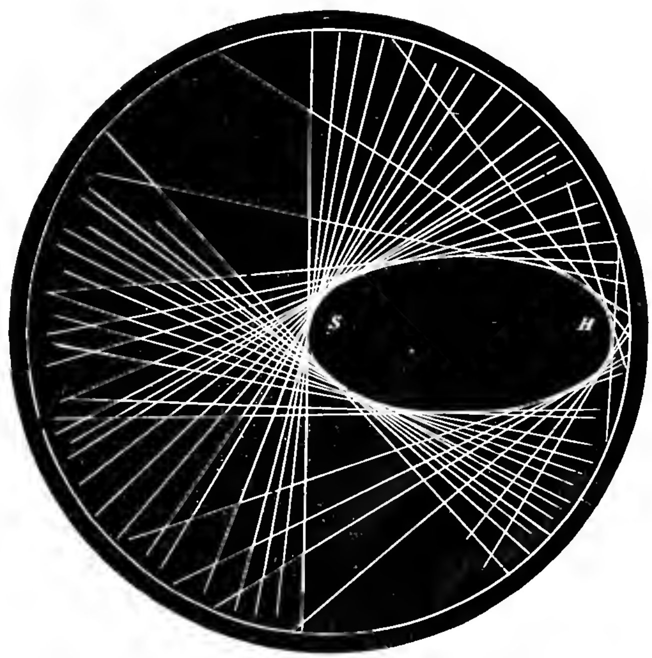


Figure 4.

ON LOADED TELEPHONE CABLES.

By Dr. J. A. FLEMING, F.R.S.

Professor of Electrical Engineering in University College, London.

When the telephone was first invented and began to be used, more than thirty years ago, anticipations were indulged that it would be possible to transmit the songs of an operatic prima donna or the speeches of a public orator by submarine cable between Europe and America. But a very little experience showed that severe limitations existed to the transmission of telephonic speech through a cable. The reason for this is the electrostatic capacity of the cable. A copper wire surrounded by gutta-percha or indiarubber, and buried in the sea or soil, forms a virtual Leyden jar of large capacity. The electrical capacity of an ordinary Leyden jar, such as is used in wireless telegraphy, may be about one-five-hundredth of a microfarad. The capacity of one mile of submarine cable may be one-third of a microfarad, or nearly one hundred and seventy times as much. Hence even twenty or thirty miles of submarine cable has a very considerable capacity; and the capacity of an Atlantic cable is about eight hundred microfarads, or about the same as the capacity of the whole earth considered as a sphere free in space. The effect of this capacity is that if we attempt to send an electric current through the cable it has (so to speak) to be filled up with electricity before any current begins to flow out at the distant end. Moreover, if we make sudden changes in the strength of the current at the sending end, these changes are not reproduced instantly at the other end, or in the same degree. The mathematical theory shows that the speed with which these current changes travel along the cable depends upon their frequency. Also, the degree to which the amplitude of these changes decreases, or *attenuates*, depends upon their frequency, and upon the constants or structure of the cable. Current changes of high frequency attenuate more rapidly and travel faster than those of low frequency.

Now when an articulate word is spoken to the diaphragm of a telephone transmitter, the rapid changes of air pressure which constitute sound, compress the diaphragm and produce corresponding changes of resistance in the carbon granules of the microphone. These again cause variations of like nature in the electric current entering the cable. These current variations are a more or less complete copy of the air pressure changes. If the cable could transmit these current changes unaltered to the telephone receiver at the other end, speech would be perfectly reproduced. The wave-form, or mode of current variation, which corresponds to articulate speech, is very complicated, but it may be resolved into the sum of a number of vibrations of different frequency and amplitude. The effect of the electrical capacity of the cable, as already mentioned, is to cause an attenuation, or weakening, in the amplitude of the current vibrations as they are transmitted along the cable, and this attenuation affects the higher or shrill notes more than the lower or deep notes. Also the higher notes travel faster than the lower ones. It will easily be seen that the result of this inequality is that the wave-form of the current is *distorted* by transmission. The different constituent notes or harmonic vibrations arrive at the far end of the cable unequally degraded, or attenuated, and shifted in phase relatively with each other, the high vibrations having outrun the lower ones.

If this distortion has not proceeded beyond a certain limit, the ear of the listener is able to guess, from the sound heard, the meaning of the word, just as in the case of bad or ordinary handwriting we are able to guess from the general shape of the written word what it means although the individual letters are badly formed or distorted. If, however, the distortion has proceeded beyond a certain point, then the ear is unable to attach a meaning to the sound heard. Apart, therefore, from any imperfection in the actual telephonic instruments, or in the speech or hearing of the two communicants, we have a limit to the telephonic transmission of speech, imposed by the distortional qualities of the cable itself. Accordingly, it was soon found that the limiting distance of speech through an ordinary submarine telegraph cable might be taken as twenty miles or so, depending on the size of the core. In the case of land, or overhead, lines, this limiting distance is very much larger. The capacity of an overhead line per mile is not a one-hundredth or one two-hundredth of that of a submarine cable, and therefore telephonic speech is possible through several hundred miles of ordinary overhead wire.

The question of the improvement of telephony by underground and underwater cables soon began to be discussed, and foremost amongst those whose writings assisted in laying the true scientific foundation was Mr. Oliver Heaviside. He showed that the true antidote to the capacity effects of the cable was to add to it inductance. This term may be defined, for the ordinary reader, as follows:—A coil of wire, especially a coil of many turns, possesses a property in virtue of which a current started in the wire tends to run on, and also the starting of a current takes time. Inductance, electrically speaking, corresponds to inertia in the case of ordinary matter. Generally speaking, we may say that the presence of inductance hinders rapid changes of currents in a line, just as inertia in machinery hinders very rapid changes of speed in moving parts. For this reason non-mathematical electricians of the old school had arrived at the idea that inductance in a telephone line should be reduced as much as possible. On the contrary, Mr. Heaviside showed that what most telephone lines required was not less, but more, inductance, to make them less distortional. In short, inductance is capable of neutralizing capacity in cables. The reason for this is that capacity in cables acts as if it were a sort of vacuum, into which electricity tries to rush just as air rushes into a gaseous vacuum. On the other hand, inductance opposes the movement of electricity and hence inductance in series with capacity can be made,

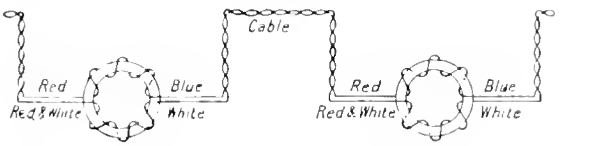


FIGURE 1.

Mode of inserting the loading coils in the two sides of a telephone cable.

by suitable adjustments, to neutralize each other. The suggestion was therefore made as far back as 1887 that to effect an improvement in the qualities of the line it was necessary to add inductance to it. All problems in engineering are, however, ultimately questions of cost and detail, and until it had been practically shown that this addition of inductance was both economical and advantageous, telephonic engineers were hardly justified in embarking on expensive constructions. In 1899 and 1900, however, Professor Pupin, in the United States, published the results of some remarkable investigations on this subject. He showed that if coils of wire (called loading coils, see Figure 1) having high inductance were inserted in the run of a telephone cable at equal distances, and so close that nine or ten of the coils were covered by or included in one wave of the current, the result was as if the inductance were smoothly distributed over the cable and also that provided the inductance were large enough, a considerable improvement in the speech-transmitting qualities resulted. The phrase, wave of current, needs a little explanation. The characteristic of a wave motion of any kind, whether in air or water, is that some change is periodically made in the medium, which is repeated successively at contiguous points. If we have a long cable, at one end of which some kind of periodic or alternating electromotive force is applied, then the changes in potential are not reproduced instantly at all points in this cable, but are propagated from point to point in it with a certain velocity. The more rapid these changes the faster they travel, up to a limiting value which is equal to that of light. At certain points in the cable, separated by distances called one wave-length, changes of potential of similar type take place at the same time: that is to say, the potential becomes zero or a maximum at the same instant. It is found that the mean value of the frequency involved in ordinary speech is nearly eight hundred. That is, the mean pitch of the aërial vibrations has this value.

Corresponding to this frequency in a telephonic cable the wave-length may be ten to twenty miles or so. Now a telephonic or telegraphic cable has four specific qualities. Its conductor has a certain resistance per mile reckoned in ohms, and also a certain inductance measured in units called a henry. Also it has a certain capacity per mile, and a certain leakage per mile.

Mr. Heaviside first showed that to make a cable distortionless in the sense that waves of all frequencies would travel along it at the same rate, it is necessary that the product of the resistance and of the capacity per mile shall be equal to the product of the inductance and leakage per mile.

In all ordinary cables the capacity is too great to fulfil this condition, and hence we have to increase the inductance to approximate to the distortionless condition.

Pupin showed that we can add this inductance in lumps, so to speak, provided we insert these lumps of inductance at such intervals that there are nine or ten coils per wave-length at a frequency of eight hundred. A telephone cable so constructed, with inductance coils inserted in it every mile or so, is called a *loaded cable*, and loaded cables have of late years played an important part in improving telephonic communication. After the publication of Pupin's researches attempts were made to put them to practical test in long overhead telephone lines, both in the United States and in Germany. The results were very encouraging, and the attention of telephonic engineers was closely directed to the

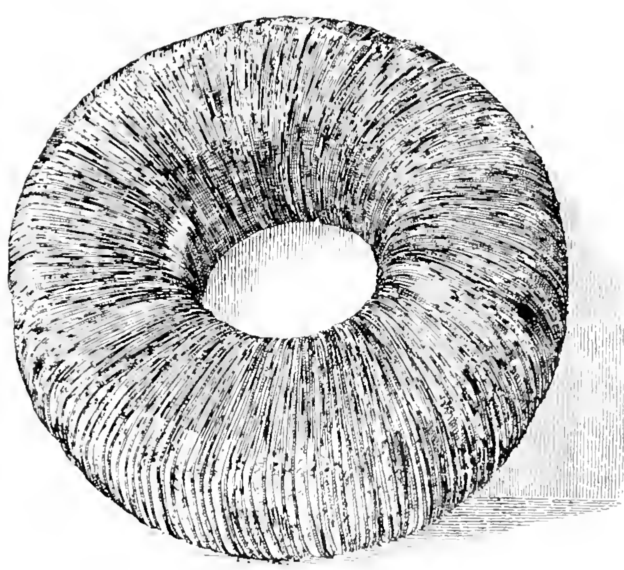


FIGURE 2.

A loading coil for loaded telephone cables as used by the National Telephone Company.

subject. It is a comparatively easy matter to insert such inductance coils in an overhead line, because they can be attached to the telegraph posts, a coil being inserted in the line circuit every mile or so.

The coils used consist of iron rings built up of fine iron wire which are wound over with many turns of silk-covered copper wire like a transformer (see Figure 2). These loading coils are enclosed in iron cases and fixed on the posts. It is easy to construct such a coil to have an inductance of about 0·1 henry, and a resistance of only ten to fifteen ohms.

Loading coils can also be easily inserted in the run of underground telephone cables, and such loaded circuits have been much employed of late years by the National Telephone Company (see Figure 3). A more interesting and recent application is in the case of submarine telephone cables. So inferior is even a length of twenty miles or so of submarine cable to an equal or even much greater length of aërial line in the transmission of telephonic speech, that the great obstacle in conducting telephonic communication with Ireland or the Continent has always been the interposition of the twenty to eighty miles of submarine cable necessary to cross the English or Irish Channel. The problem of loading a submarine cable was, however, one of peculiar difficulty. In any case the laying of an unloaded submarine cable involves engineering difficulties of a considerable kind. Even when the advantages of inserting the loading coils had been well ascertained, cable engineers were rather reluctant to embark on the enterprise of laying a submarine cable having heavy protuberances in it every mile or so. Hence as a first step attempts were made at continuous loading. The inductance of a cable can be increased by winding over it many layers of fine iron wire separated, however, from the copper by an insulation. The effect of this is to increase the magnetic field surrounding the conductor when a current flows through it. Such a continuously loaded cable will be thicker and heavier than an ordinary unloaded cable, but the risks in laying it are not thereby seriously increased. Several continuously-loaded telephone cables were laid in Denmark. There are however, difficulties in the way of foretelling the actual performance of such a class of cable, which do not exist in the case of cables loaded in the Pupin manner. The first cable of this last type laid under water was that put down a few years ago in Lake Constance. The length of this cable is nine miles and it consists of a paper-insulated lead-covered cable, having loading coils inserted in it at intervals. The performance of this cable was such as to encourage further developments, and a year or so back, when the authorities of the British Postal Telegraph service

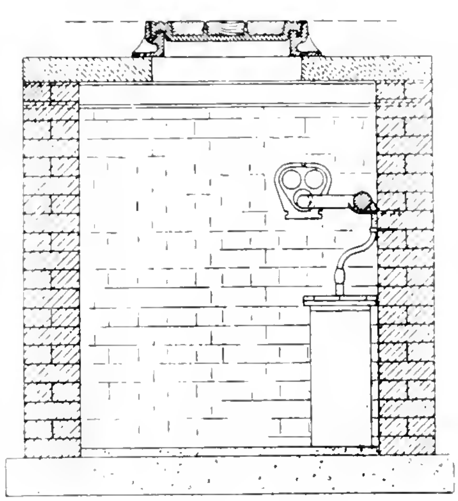


Figure 3.

A brick pit for containing the loading coils inserted in telephonic cables.

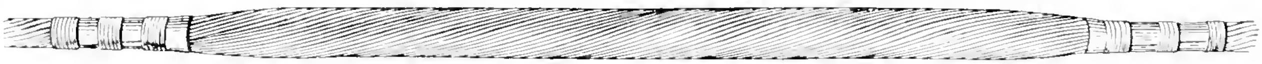


Figure 4.—Section of cable containing loading coils, complete with sheathing wires.

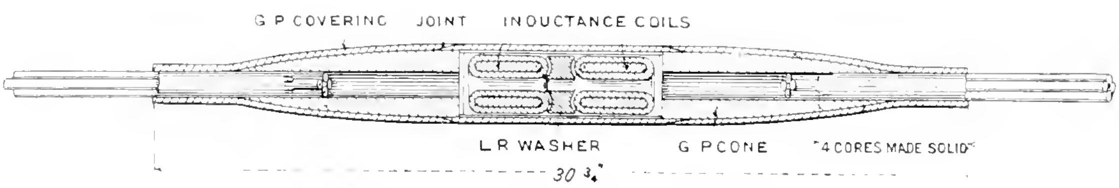


Figure 5.—Arrangement of coils in cable.

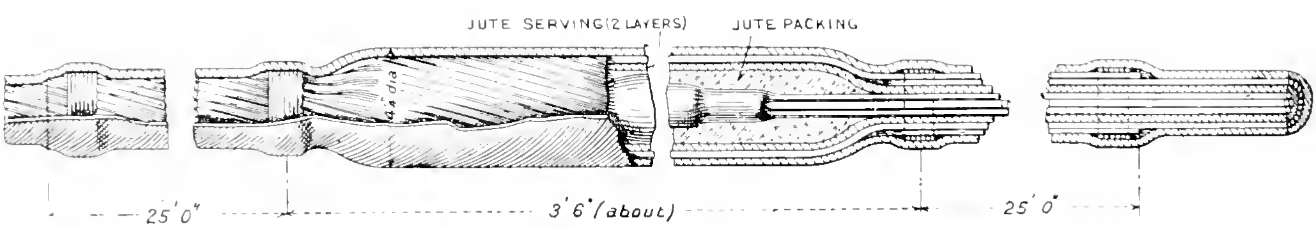


Figure 6.—Method of sheathing over coils.

began to consider the laying of a new telephone cable across the English Channel, the question of a loaded cable was seriously considered. After many experiments and measurements, a type of Pupin-loaded cable was evolved which was made and laid for the Post Office by Messrs. Siemens Brothers, in 1910. This Anglo-French loaded telephone cable was described to the Institution of Electrical Engineers recently in a paper by Major O'Meara, C.M.G., the Engineer-in-Chief of the British Postal Telegraph Department.

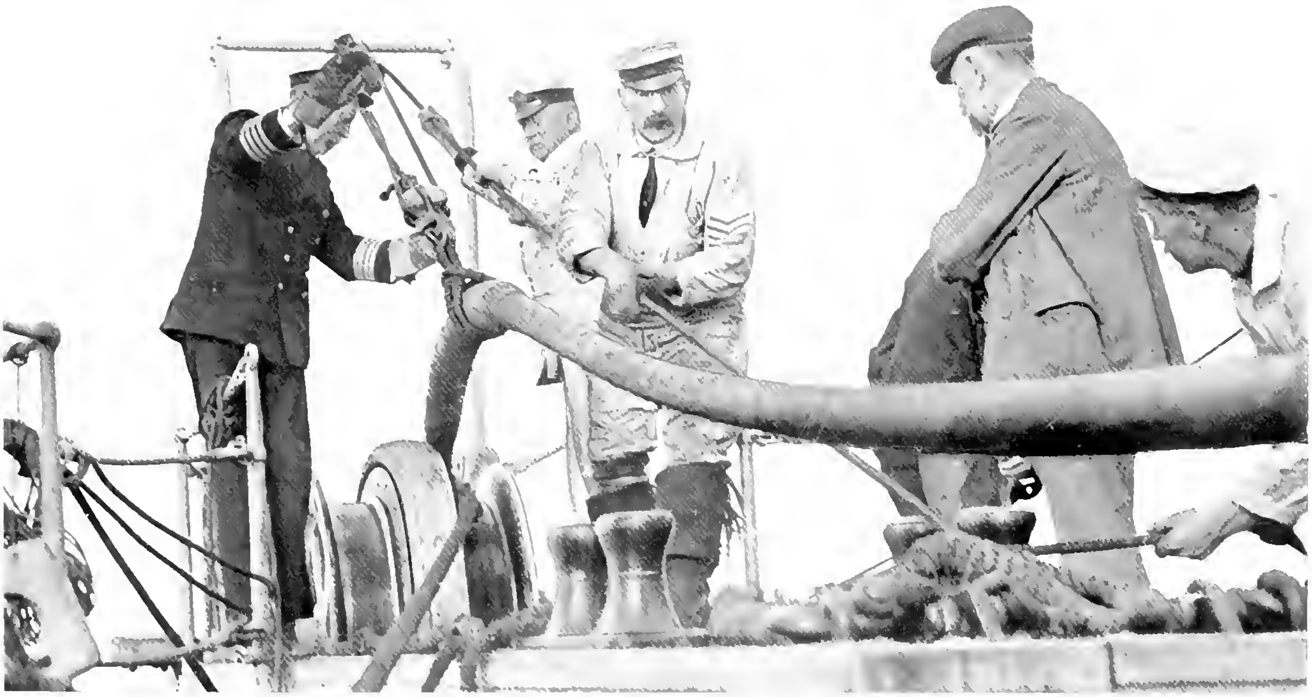


FIGURE 7.

Passing over the sheave a loading coil in the Anglo-French telephone (1910) cable laid across the English Channel.

The cable contains four-stranded copper conductors insulated with gutta percha in the usual way, and every nautical mile, coils are inserted which consist of silk-covered wire wound over an iron core so as to form an inductance coil which is inserted in the run of the cable (see Figure 5). The gutta percha insulation and the steel wire armouring are, of course, continued over the coil, and the result is to produce an enlargement or protuberance on the cable every mile.

The cable was laid with great skill by the manufacturers at the bottom of the English Channel between Abbots Cliff, near Dover, and Cape Grisnez, in France.

The cable was laid by the cable ship "Faraday" by the experienced operators of Messrs. Siemens Brothers, and under the inspection of officials representing the British and French Telegraph Services, between May 15th and May 18th, 1910. Some special precautions had to be taken in handling the thickened-up portions of the cable containing the loading coils (see Figure 7). The operations were, however, successfully carried out, and London and Paris are now connected by a new telephone cable of superior type containing two complete circuits. The attenuation constant of the new cable or ratio in which the current is enfeebled in passing along the cable was found to be close to the predicted value, and the speaking qualities of the cable also fully realised expectations. By the employment of extra thick conductors in the land lines at each end, and when the added distances do not exceed seventeen hundred miles, Major O'Meara states in his paper that well maintained conversations by telephone could be conducted between London and Astrakhan on the Caspian Sea. This important achievement has been watched with great interest by practical telephone engineers on both sides of the Atlantic. The great improvement in the distances over which it is possible to speak telephonically through cables when loaded in the Pupin manner is a great testimony to the value of correct scientific theory in guiding practice. The old rule-of-thumb methods are abolished, telephonic engineers are everywhere engaged in studying the improved methods of predicting the effect upon the speaking qualities which of certain constructions in telephonic cables have been based upon the researches of Heaviside and Pupin, and chiefly reduced to simplicity by the work of Dr. Kennelly, of Harvard University, U.S.A.

The writer of this article delivered last year to a large class of practical telephone engineers a course of Post-Graduate Lectures on this subject on behalf of the University of London, and these Lectures have just been published by Messrs. Constable & Co., in a book entitled "The Propagation of Electric Currents in Telephone and Telegraph Cables" in which a full discussion of the scientific questions involved in loaded telephone cables is given.

CORRESPONDENCE.

THE FOURTH DIMENSION.

To the Editors of "KNOWLEDGE."

SIRS,—I much appreciate the article of Mr. Annison on the Fourth Dimension: I regard it as peculiarly fortunate that I happened to refer to the subject in my letter on The Eternal Return. Just recently I devoted a fair amount of thought to the subject of meta-space, approaching it from the geometrical side. The principal difficulty is, I think, that of determining what analogies are justifiable. For instance, it may be argued: A line can revolve about a point in two-dimensional space (2 D. space), and a plane can revolve about a line in 3 D. space; therefore, a volume can revolve about a plane in 4 D. space. This seems straightforward, but actually we need to examine more closely the meaning of the word "revolve." Suppose we say that "to revolve round" means "to move continuously at constant normal distance from." Then we must be careful when talking about a body revolving about a line. A body moving in a circle should not be said to move at constant normal distance from a straight line, but from a curved line—any other coplanar, concentric circle, in fact.

Thus, instead of expecting a Euclidean plane to be a fulcrum and axis in 4 D. space, we should regard a sphere and "meta-cylinder" as such.

Now, of course, it is possible to obtain rotation "about a sphere" in 3 D. space, except that, practically, it is difficult to devise suitable mechanism. However, my own incomplete geometrical investigations have shown that, even in 3 D. space, very curious projected motions arise from a point revolving "spherically." For instance, suppose we have a ball revolving about an axis (using common parlance), and that this axis is revolving about a line bisecting it at right angles, the two component angular velocities being the same; then differently situated points move in differently shaped loci "in space." Each "pole" for instance, has the following locus.

Front elevation. A figure of eight.

Plan.—Two coincident circles, of diameter equal to *half* that of sphere.

Side elevation.—Two coincident half-sine-curves.

This may seem irrelevant to the subject of the fourth dimension, but actually it is not. When one realises the vast number of 3 D. motions which, either by projection or section, are similar in 2 D. space, one realises the magnitude of the task of trying to identify 4 D. figures and motions by their 3 D. manifestations.

I hope this letter is not unduly long, but I should just like to say this: As I hinted in the last sentence of my former letter, we must not lose sight of psychological considerations in these matters. However, I think that something profitable might arise from cogitation along the following lines. Instead of utilising the analogy of 2 D. beings who "sense" 3 D. objects by their sections in a 2 D. world, we should rather deal with 3 D. beings whose "introspectible consciousness" (forgive the term!) is limited to two dimensions whilst they actually live and move in three. The analogy must not be pushed too far, but think of *men*, who, whilst living and acting (to a limited extent) in a 3 D. world, sense objects (including one another) by means of shadows cast on a wall; also remember how easy it is for visual space and "loco-motor" space to be dissociated, as, for instance, when shaving or arranging one's hair, one thinks of the visual operation as occurring "in the mirror." Unfortunately, there is a lack of written matter on the fourth dimension; although I may be allowed to mention Mr. C. H. Hinton's "Fourth Dimension" (Sonnenschein).

J. JOHN ELLIOTT.

THE SELENIUM PHOTOMETER.

To the Editors of "KNOWLEDGE."

SIRS,—I desire to make a few remarks with reference to your note on the application of the Selenium Photometer to the measurement of starlight.

First, let me protest against the use of the term *Selenium "cell"* to the selenium *resistances*, which are commonly employed in photo-electricity. In 1895 I used, at the Daramona Observatory, Westmeath, a selenium *cell*, properly so called, for comparing the lights of stars (see the *Proceedings of the Royal Society* Volumes LVIII and LIX). This cell contained a liquid; and in the cell the light of a star generated an electromotive force, the cell being thus quite distinct from the ordinary selenium *resistance*, in which increased conductivity is produced by light. In the *Proceedings of the Royal Society*, Volume LXXXI, 1908, I described a form of selenium resistance, called a *selenium bridge*, which is suitable for star measurement; and I also pointed out a fallacy involved in the usual employment of selenium for comparing two lights. I am afraid that no notice has been taken of this fallacy. In the last-named paper are given the results of exposing a selenium bridge to the infra-red, red, yellow, blue, and ultra-blue parts of the spectrum of one and the same source of light. The effects of red and blue are enormously different, the red producing much greater effect. Hence it will be seen that if we compare the light of Sirius or Vega with that of Aldebaran or Betelgeuse, we are not doing justice to the former stars if we merely allow the total light of the star to fall on the selenium, and measure it by the electrical effect produced. We should proceed quite differently. We should split up the various lights into their spectra, and compare two stars, colour by colour.

This, of course, requires large telescopes, of which this country possesses none available; but in America the thing could be done properly.

I send you a copy of my 1908 paper, from which you will see how necessary it is to use spectra when comparing two stars, and how suitable the *selenium bridge* is to the purpose. The bridge is so narrow—as narrow as the thinnest flake of mica—that the light in any line of a spectrum can be measured.

Another thing of vital importance is to keep aqueous vapour from the surface of the bridge, or other form of selenium resistance; otherwise we get spurious conductivity. I rather think that this fact has not been attended to in America: but I have actually constructed an *electric hygrometer* depending on the presence of vapour on the bridge.

I have been hoping to use the selenium bridge here in the Radcliffe Observatory, for spectrum comparison of stars; but the telescope available is only one of small aperture, and other work has prevented observations.

GEORGE M. MINCHIN.

A NOTABLE RECORD.

CAPTURE OF A NEW SPECIES OF *MYMAR*.

By FRED ENOCK, F.E.S., F.L.S., F.R.M.S.

LAST July (1910), it was my pleasure to record in the pages of "KNOWLEDGE," the interesting fact that I bred that wonderful insect, *Mymar pulchellus*, the Battledore Wing Fly, on June 14th, when a male and female emerged from their host egg. During the past winter, I made collections of various stems of plants, in and upon which I found numbers of eggs, cunningly hidden away, in the pleated leaves of grasses, or embedded in the stems in such a manner that the utmost care is needed to detect them and preserve them from drying up or becoming mouldy. Great ingenuity is displayed by the parent in distributing them either singly or in groups of three or four, so that the minute operculum shall be just flush with the outer covering. Sometimes a single hole is made about a sixty-fourth of an inch in diameter, and through this minute opening, seven or eight eggs are laid in such a manner that the head end (a mere point), starts from this hole. It is such eggs that the *Mymaridae* search for with unwearying care, running up and down the stems, keeping up an incessant drumming with their clubbed antennae—the under-side near the tip being covered with most delicate sensory hairs—until, by their marvellous sense of touch or hearing, an egg of the right species of host—(not *any* other), is located. The tip of the ovipositor is then brought into position until it is at right angles with the stem, and the boring through the egg-shell commences, the tiny mechanic bringing its muscular power to bear upon the microscopic "broach" which gradually goes deeper and deeper and then with a bump goes right through, sometimes up to the base. The germ is transmitted, sealing the doom of the host's egg the fluids of which go to the nourishment of the ovivorous larva. I have repeatedly observed the oviposition of many of the *Mymaridae*.

FIGURE 1.
Mymar regalis, new species (enlarged).

The intense heat of June has brought out *Mymar pulchellus* in confinement four days earlier than in 1910. Of some species we have but single specimens and have yet to obtain more data before we can state the time of their appearance. One of these is Walker's genus *Limacis*—of which but five specimens are known. Mr. Waterhouse has taken a male and female: my nephew, Mr. John Enock a female, and I have one, a male. *Limacis* is, we find, one of the earliest to appear—in May. On June 3rd, I had a long day's sweeping for it at Burnham Beeches, but without success. I only captured a dozen very common species, and I confess to feeling a little disheartened: for five hours sweeping and examining the contents of one's net with a magnifier is very trying and fatiguing work. I had almost decided to pack up my kit, when I noticed a likely stretch of grass, which I swept. On examining the sweepings of grass seeds, and bits of sharp tipped rushes I was very pleased to see the familiar form of *Mymar* running and skipping about in its own peculiar manner—running along with its battledore wings arched over its back, then after a sudden pause—and a jump—somewhere, the search begins again, until at last a phial is placed over it, and safely corked. This was my thirteenth phial, and I wended my way to the motor-'bus

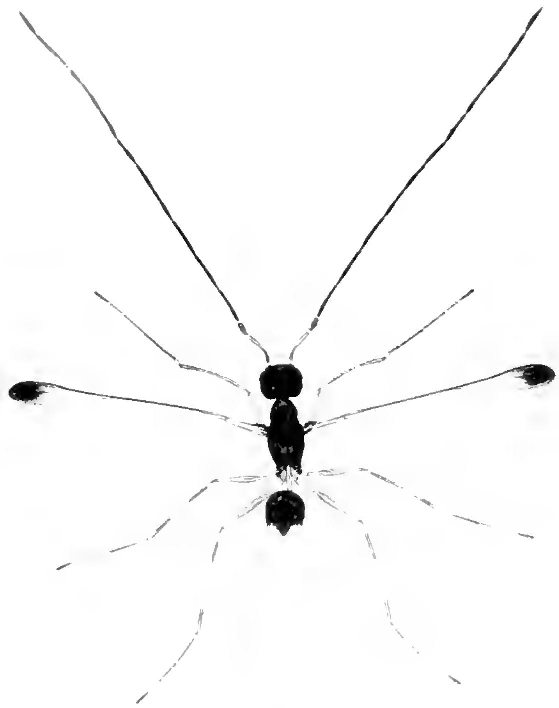


Figure 2.
Mymar pulchellus (male) enlarged 30 diameters.

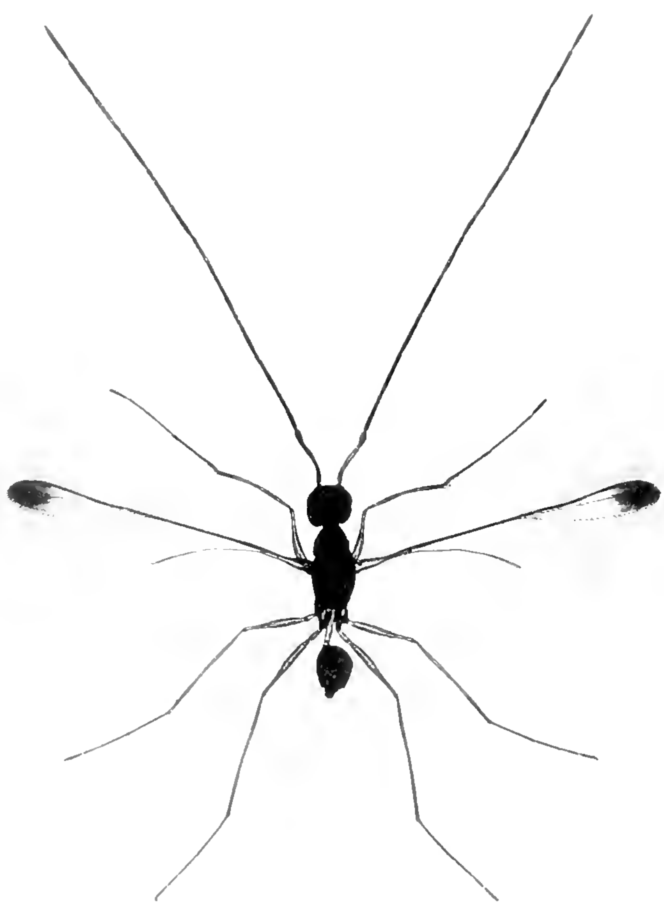


Figure 3.
Mymar regalis (male) new species, enlarged 30 diameters.

for Slough, little dreaming that in that phial No 13, was the most wonderful capture made for many years. On reaching home, I killed my twelve captures, then *Mymar*, and was proceeding to brush and clean it—its battledore wings were in a perfect tangle requiring care to undo—when I was much troubled by a minute piece of fluff or dust, which I could not remove, so placed the *Mymar* under the microscope, when I was astonished beyond description, for I looked for an ordinary *Mymar pulchellus* with its abnormally short under-wings, instead of which, the fluff I had tried to remove was an *elongated* posterior wing, with cilia of six hairs, and I realized that I had captured a brand new species of *Mymar*! As soon as I had mounted it in balsam I telegraphed to Mr. C. O. Waterhouse:—"Captured new species of *Mymar*, with battledore shaped under-wings." This brought us together, and we gloated over the distinguished visitor. I suggested that we should christen it *Mymar regalis*, in honour of His Most Gracious Majesty, King George V.

On Thursday, June 8th, Mr. C. O. Waterhouse and I had a day at Burnham, and after five hours sweeping in a broiling sun, I was fortunate in obtaining another male, so confirming the genuineness of the species, which not only differs from *pulchellus* in its posterior wings, but the cilia around the anterior pair are composed of some sixty long hairs against thirty-five in *pulchellus*. In other respects, the colour and markings are similar. Another long day in search of the unknown female was not by any means a successful one: in fact, this *Mymar* is but the one twenty-fifth of an inch in length, and searching for such a creature on a wide expanse of wood and common requires a large amount of patient labour.

SOLAR DISTURBANCES DURING MAY, 1911.

By FRANK C. DENNETT.

ON ten days during May, namely the 10th to 18th, inclusive, and the 24th, only faculic disturbances were visible on the disc, dark spots being seen on the remaining twenty-one. The longitude of the central meridian at noon on May 1st, was 152° 40'.

Nos. 17, 17*a* and 17*b*, continued upon the disc until May 3rd, 5th and 2nd respectively, and so appear again upon the accompanying chart.

No. 19. A pore amid a faculic disturbance within the eastern limb on the 2nd, and remaining until the 5th, the facula being still visible as it neared the western limb on the 14th.

No. 20.—Broke out as a pair of pores 22,000 miles apart, on the 4th. Next day the following one had increased to a spotlet, and on the 6th it had developed to an elongated ellipse, with a major axis 48,000 miles in length. It attained its maximum length of 74,000 miles on the 7th. The dwindling group reached the western limb on the 9th. Some of the members on the 6th appeared as slits in the photosphere.

No. 21.—On May 4th, a pore very similar to No. 19, appeared in a faculic disturbance a little north-east of that disturbance. Next day two pores were seen with others ranged behind them like the border of an ellipse, with a length of 48,000 miles. Much change took place in the appearance of the group, which was last seen as six pores outlining an oval area 26,000 miles in greatest diameter, on the 9th.

No. 22.—A pair of pores 19,000 miles apart, with tiny dots between them, only seen upon the 9th.

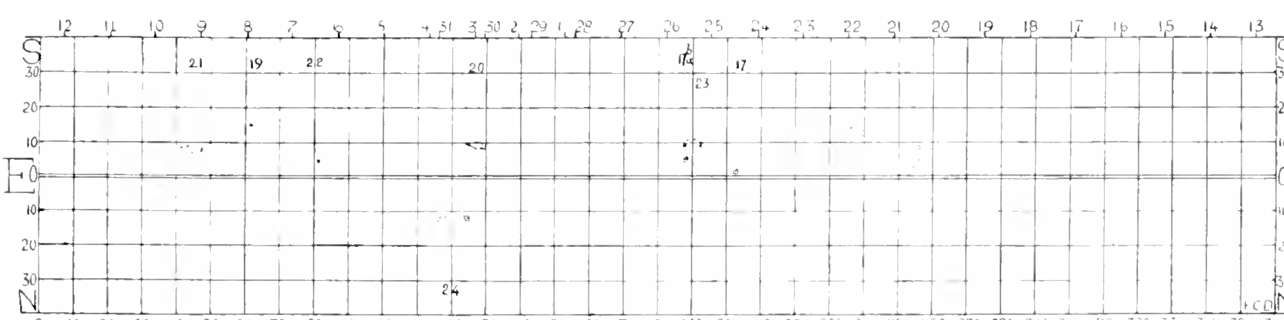
No. 23.—A spot seen on the 19th close within the eastern limb. On the 21st it appeared to have a bridge across the umbra, and also to be situated near the head of a considerable faculic disturbance. Only two close umbrae were visible amid faculae on the 22nd, but when last seen on the 23rd, there were three pores forming a triangle, the longest side being 33,000 miles. The area still showed faculic disturbance as it approached the western limb on May 31st.

No. 24.—Bright faculic ridges were visible on the morning of the 25th near the eastern limb, a little north, containing a tiny pore. Other pores showed later and a spot over 7,500 miles in diameter developed during the afternoon. The latter expanded until 14,000 miles across. The umbra was penetrated by a bright projection from the south, from the 28th until the 30th. The penumbra brightened at its inner border from May 30th until last seen on June 5th. It was followed from the 24th until the 31st, by a group of pores extending back 63,000 miles, and some were seen on the 1st and 3rd, close up to the large spot. During its visibility it had a forward motion on the Sun's surface amounting to fully 5° or 37,000 miles.

Bright faculic disturbances were visible within the eastern limb on the 16th, in the positions shown dotted on the chart, about longitudes 240° and 255°.

Our chart is constructed from the combined measures, drawings, and descriptions of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and F. C. Dennett, working respectively at Lisburn, Chorlton-cum-Hardy, Bath and Hackney.

DAY OF MAY, 1911.



THE FACE OF THE SKY FOR JULY.

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

THE SUN.—On the 1st the Sun rises at 3.48 and sets at 8.18; on the 31st he rises at 4.22 and sets at 7.50. On the 3rd at 6 a.m. the earth is at its greatest distance from the Sun, the solar parallax then reaching its minimum value of 8″·66.

Sun spots may occasionally be observed on the solar disc in spite of the declining solar activity; at the time of writing no spots were visible.

The positions of the Sun's axis, equator, and the heliographic longitude of the centre of the disc, are shown in the following table:—

Date.	Axis inclined from N. point.	Centre of Disc N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
June 30 ...	3° 25′W	2° 50′	78° 55′
July 5 ...	1° 8′W	3° 23′	12° 44′
" 10 ...	1° 0′E	3° 53′	300° 33′
" 15	3° 24′E	4° 23′	240° 23′
" 20	5° 37′E	4° 51′	174° 13′
" 25	7° 40′E	5° 17′	108° 5′
" 30	9° 52′E	5° 41′	41° 50′
Aug. 4	11° 52′E	6° 2′	335° 40′

THE MOON:—

Date.	Phases.	H. M.
July 3	☽ First Quarter	0 20 a.m.
" 11	○ Full Moon	0 53 p.m.
" 19	☾ Last Quarter	5 31 a.m.
" 25	● New Moon	8 12 p.m.
Aug. 1 ...	☽ First Quarter	11 20 p.m.
July 9 ...	Apogee ...	2 42 a.m.
" 24	Perigee ...	10 30 a.m.

OCCULTATIONS.—No occultations of naked eye stars are visible in this country during the present month or early August.

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
July 1	6 24	N 24° 21′
" 11	7 50	22° 37′
" 21 ...	9 14	17° 30′
" 31	10 14	11° 10′
Aug. 10	10 50	N 5° 8′

Mercury is in superior conjunction with the Sun on the 4th. After the 20th the planet sets about an hour after the Sun in the W.N.W., thus for all practical purposes he is unobservable, being in too bright a portion of the sky after Sunset.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
July 1	9 47	N 14° 52′
" 11	10 22	10° 40′
" 21	10 54	6° 30′
" 31	11 20	N 2° 18′
Aug. 10	11 39	S 1° 32′

Venus continues to be a conspicuous object in the evening sky looking W. immediately after Sunset. The planet is increasing in brilliancy, and reaches her "greatest brilliancy" on August 10th, whilst on July 7th she is at greatest easterly elongation of 45° 29′ from the Sun. At the beginning of July the planet sets about 10.30 p.m., and at the end of the month, about 9 p.m.

The planet is so bright that most persons are able to see it long before it is dark, and this is the best time for observing with a telescope. The planet may readily be seen, even in broad daylight if slight optical aid, such as a pair of opera glasses, be employed and directed to the correct position in the sky. With the help of nothing but a pair of opera glasses and a celestial globe, I was able to find the planet in the early afternoon, and after finding it with the glasses it was fairly easy to see the planet with the naked eye, when shielded from direct sunlight. During July, the planet is on the meridian about 3 p.m.; 3.13 on the 1st and 2.48 on the 31st, and as the brightness is increasing, it should be fairly easy to discern in the afternoon. As seen in the telescope, the planet appears like a half moon at the beginning of July, but the phase rapidly changes, so that at the end of the month the form is crescent, 0·3 of the disc being illuminated, the apparent diameter increasing from 22″ to 32″ in the same period. The Moon appears near the planet on the evening of the 28th.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
July 1 ...	1 18	N 6° 1′
" 11	1 44	8° 20′
" 21 ...	2 9	10° 47′
" 31	2 34	12° 53′
Aug. 10	2 58	N 14° 44′

Mars rises about ten minutes after midnight on the 1st and at 10.50 p.m. on the 31st. The planet is situated in Pisces and appears about half a degree S. of *o* Piscium on the 10th; he is rather an inconspicuous object, but as the opposition of November approaches, he will become more interesting. The planet is increasing in brightness, the apparent diameter on July 1st being 8″·0 and on August 1st, 9″·3.

The latitude of the centre of the disc is about −19°; thus the southern polar cap is visible, and it is approaching summer in the southern hemisphere of the planet, the summer solstice occurring on August 1st.

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
July 1	14 11	S 11° 58′
" 11	14 12	12° 3′
" 21	14 13	12° 13′
" 31	14 16	12° 29′
Aug. 10	14 19	S 12° 50′

Jupiter appears as a brilliant star looking S.S.W. at sunset. The planet sets at 0.42 a.m. on the 1st, and at 10.40 p.m. on the 31st.

For small telescopes this is the easiest and most interesting planet to observe, on account of his brightness, numerous moons, the markings on the disc and polar flattening. A telescope magnifying about fifty times shows the planet of the same apparent diameter as the moon seen with the naked eye; with this magnification and an aperture of two inches, the belts may be seen, but the moons, when not too near the planet, may be seen in any good pair of field glasses.

The equatorial diameter of the planet on the 25th is 37″, whilst the polar diameter is 2″·4 smaller: this polar flattening is readily observed in telescopes powerful enough to see the belts. If sufficient magnification be used, the Great Red Spot on the belts may be seen, and the period of rotation deduced. This is very short, and accounts for the oblateness, being only $9^{h}\ 55^{m}$.

The following table gives the Satellite phenomena:—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M. H. M.
July				July				July			
1	I.	Sh. I.	10 24	6	II.	Sh. I.	10 [illegible]	24	I.	Ec. D.	[illegible]
1	I.	Tr. E.	11 27	8	I.	Tr. I.	11 [illegible]	24	III.	Ec. R.	[illegible]
2	I.	Ec. R.	9 44	[illegible]	III.	Tr. E.	1[illegible] 45	25	I.	Ec. R.	[illegible]
2	II.	Sh. I.	11 17	10	I.	Oc. D.	[illegible]	Aug.			
2	II.	Tr. E.	11 36	17	I.	Tr. E.	9 4[illegible]	2	I.	Sh. I.	9 14
								[illegible]	I.	Sh. I.	[illegible]

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse and "Ec. R." its reappearance.

The configurations of the Satellites as seen in an inverting telescope, and observing at 9.30 p.m., are as follows:—

Day.	West.		East.		Day.	West.		East.	
1	43	⊙	2		17	42	⊙	3	
2	43	⊙		●1	18	4		1 3	●2
3	421		3		19	41		23	
4	4		213		20	42		31	
5	41		23		21	4321			
6	243		1		22	34		12	
7	321		4		23	314		2	
8	3		124		24	2		14	●3
9	3		24	●1	25	2		34	●1
10	21		34		26	1		234	
11			134	●2	27	2		314	
12	1		234		28	1		4	
13	2	⊙	14		29	3		4	
14	321		4		30	31		24	
15	34		12		31	2		4	
16	431		2						

The circle ( ) represents Jupiter: ⊙ signifies that the Satellite is on the disc; ● signifies that the Satellite is behind the disc or in the shadow. The numbers are the numbers of the Satellites.

Saturn:—

Date.	Right Ascension.	Declination.
	h. m.	
July 1	3 0	N. 14° 47′
" 16	3 6	15° 6′
Aug. 1	3 10	N. 15° 21′

Saturn rises E.N.E. on July [illegible] and on August 1st at 11.5 p.m. The planet is sit[illegible] Aries, and will be more favourably placed for obser[illegible] the next few months than he has been for many y[illegible]

The ring, as seen in the telescope, [illegible] open, the apparent diameter of the outer major [illegible] 40″, and of the outer minor axis 15″; the southern [illegible] the ring is visible, and inclined to our line of vision [illegible] of 22°.

Uranus:—

Date.	Right Ascension.	D[illegible]
	h. m. s.	
July 1	20 1 28	S. 21° 5′ [illegible]
Aug. 1	19 56 21	S. 21° 20′ 15″

Uranus rises in the S.E. at 9.26 p.m. on July 1st and at 7.12 p.m. on August 1st. The planet is in opposition to the Sun on the 21st, hence about this date he appears due South at midnight; he is describing a retrograde or westerly path, about 2° S.E. of σ Capricorni and can just be discerned with the naked eye on a very clear night. The planet's remarkable spectrum of broad dark bands is well worth the attention of observers, even though they possess only small instruments.

Neptune:—

Date.	Right Ascension.	Declination.
	h. m. s.	
July 1	7 20 33	N. 21° 16′ 20″
Aug. 1	7 34 23	N. 21° 6′ 2″

Neptune is not observable this month, being in conjunction with the Sun on the 14th.

Meteor Shower.—The most notable shower in July is that of the δ Aquarids, which occurs on the 28th. The radiant is situated in R.A. $22^{h}\ 36^{m}$, Dec. S. 11°, and the meteors are slow, with long tails.

The Perseid shower also commences about the 10th, the radiant being initially near α Cassiopeiae.

Mira (o Ceti) was due at maximum on June 30th, but as the exact date is somewhat uncertain, observations of magnitude should be made for some time after this date. The mean period is about 331 days. The star is also remarkable for its spectrum, which may be well observed in a three-inch telescope, using a Maclean or Zollner spectroscopic eyepiece; the spectrum consists of broad dark bands, in which bright lines, due to hydrogen, occur.

Telescopic Objects (Double Stars, &c.):—5 Serpentis, XV.^{h} 13^{m}, N. 2° 13′, mags. 5·1, 10; separation 10″.

β Serpentis, XV.^{h} 41^{m}, N. 15° 44′, mags. 3·8, 10; separation, 31″.

θ Serpentis, XVIII.^{h} 51^{m}, N. 4° 4′, mags. 4·0, 4·2; separation, 21″·6. Both are yellow, the primary being paler than the smaller star.

ξ Cephei XXII.^{h} 1^{m}, N. 64° 8′, mags. 4·7, 7; separation, 6″.

δ Cephei XXII.^{h} 26^{m}, N. 57° 57′, mags. 4·2, 7; separation, 40″. A pretty pair for small telescopes, stars respectively yellow and blue. It is also a typical short period variable star, not of the Algol type, the period being $5^{d}\ 9^{h}$, with a sharp rise from minimum to maximum in $1^{d}\ 9\frac{1}{2}^{h}$.

Cluster in Libra, M 5. A compact cluster situated about one-third of a degree North of the double star 5 Serpentis; it appears like a large nebulous star when viewed with a pair of opera glasses.

Cluster in Serpens, N.G.C. 6633; about one-third of the way from θ Serpentis to α Ophiuchi. The cluster is visible to the naked eye.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, D.Sc., B.A.

THE SUN'S DISTANCE DETERMINED FROM EROS. Last year Mr. A. R. Hinks published the result of a very exhaustive discussion of the Sun's distance from the observations of Eros at the time of its near approach in 1900-1901. His final value for the Sun's parallax is 8″·806. Taking the Earth's equatorial diameter as 7925·45 miles, the Sun's distance is 92,831,000 miles, with a probable error of some 30,000 miles. This result is very close to that previously deduced by Harkness from a Least-Square adjustment of all available material, and also to Gill's result from the minor planets Iris, Victoria and Sappho. It is expected that Eros will in the course of years afford a much more accurate determination than any yet made, by the very large perturbations which the earth causes in its motion. Careful observation of these will give the ratio of the Earth's mass to that of the Sun, from which the distance of the latter readily follows. These perturbations can be expressed as a series of regular waves, or Sine-curves, of various periods. The largest wave has a period of 40·6 years, the amplitude of the Cosine part of it being − 703″, and the argument seven times Eros' Mean Longitude—four times that of Earth. There is another large term with amplitude 259″ and multipliers of the longitudes 37 and 21: period 82·6 years. A more accurate knowledge of the period of Eros is required before this last term and others of longer period can be accurately calculated. Forty-six revolutions are so nearly equal to eighty-one years that it is still uncertain in which direction they differ. The shift in the planet's place due to these terms is increased by the eccentricity of the orbit, and by the fact that the planet is at times so near the earth that the heliocentric shift is increased sixfold. A total range of some 3° may thus arise, and as the range due to parallax is only 2′ at most, it will be seen how much the method of perturbations will eventually surpass the other. It will probably not attain its full accuracy till two or three times the forty-year period have elapsed. But it is likely that before the Transit of Venus in 2004 the Sun's distance will be so well known that observations of the Transit will be useless for this purpose, and will simply be employed for correcting the elements of Venus' orbit. I have taken the above figures from a paper by Heinrich Samter in *Astr. Nach.*, No. 4498.

NEW DETERMINATION OF THE MOON'S DISTANCE. During the last six years the small bright crater Mosting A has been regularly observed on the meridian both at Greenwich and the Cape. It is much easier to bisect the crater with a micrometer wire than to place it tangential to the Moon's limb, which is often serrated by mountains. About a hundred nights are available on which the crater was observed at both stations, and comparison of these has given a new determination of the Moon's distance. The chief source of uncertainty in the result is the fact that the shape of the earth is not yet known with great precision. The distance was accordingly computed on two assumptions of the shape, viz., compression 1/293½ and 1/300; these about cover the present uncertainty. On the first assumption Hansen's parallax (which is 57′ 2″·23) needs a correction of plus 0″·50, and on the second of plus 0″·12. On the former assumption the Moon's distance comes out 238,817 miles. Another way of finding the distance is based on the observed period and the force of gravity at the Earth's surface. This method also gives results that vary, though to a less extent, with the Earth's figure. The deduced corrections to Hansen's parallax are 0″·45 and 0″·36 on the above assumptions. Hence to make the two methods agree we must take the compression as 1/294½. This applies to the mean meridian of Greenwich and the Cape, for it is quite possible that it is sensibly different for different meridians. Sir David Gill has for many years been endeavouring to have South Africa geodetically connected with Europe, and only a few links are now needed to complete this great work, which would give a measured meridian extending from the North Cape to South Africa, and would give the compression of this meridian very accurately. It seems to me that it would be advisable for equatorial observatories to measure the moon's distance by the diurnal method (comparing observations made east and west of the meridian at the same station). The equatorial parallax of the moon would thus be given, free from uncertainty arising from the figure of the earth, and it would in addition be possible to test whether the equator has any ellipticity by comparing the results obtained at different equatorial stations. The measures might be made photographically, for Professor Pickering and Mr. H. N. Russell have lately shown that good photographs of the moon for position can be obtained by giving the surrounding stars a time exposure, the moon being screened by a disc except for a fraction of a second, the time of which may be automatically recorded. This plan is analogous to that used for many years at Greenwich for photographing Neptune and its satellite, and double stars that differ much in brightness.

BOTANY.

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

THE BIOLOGY OF LICHENS. A vast amount of controversy has centred around the relationship between the two components of the thallus, or plant body, of the Lichens. A recent short paper by Tobler (*Ber. deutsch. bot. Ges.*, 1911) serves as a reminder that the question is by no means settled, and the following notes may be of interest to the student of plant life who knows something of the general characters of these curious organisms.

The Lichens form a quite exceptional group of plants, with various peculiar features. A Lichen is a compound plant, consisting of a Fungus individual and numerous Alga individuals. The Fungus, composed of branching and interlacing threads, has grown around the Algae, enclosing them in a sort of nest, in a manner which has often been compared to the enmeshing of a fly by a spider. The result is that the Lichen can grow in places which would be unsuitable for the independent existence of either the Fungus or the Algae of which it is composed. Algae grow in water or in moist places, and very few can live without a regular and abundant supply of moisture, while (apart from the leathery bracket-like forms) Fungi are very sensitive to cold and drought. Yet the Lichens thrive in the bleakest positions and in the most severe climates, as on bare mountain rocks where they may get no water for weeks on end, or may be soaked with rain and mist for equally long periods, and where they are exposed to great extremes of heat and cold.

In a typical Lichen the Fungus provides the organs of fixation; protects the Alga cells from drought and other injurious influences; absorbs water with dissolved salts, and air with carbon dioxide; and it alone produces the spore fruits. The Alga, on the other hand, manufactures organic food, with the help of light, from carbon dioxide and water and salts, and it shares with the Fungus in producing the asexual brood bodies or soredia.

Both the Fungus and the Algae which make up a Lichen can, under suitable conditions, be induced to grow independently, though in the Lichen body itself they are mutually dependent upon each other. The isolated Alga cells grow and multiply when supplied with water, a few simple salts, and air containing carbon dioxide. The Lichen spores will germinate in a culture solution containing organic substances (sugar, and so on) and produce a small thallus which contains, of course, no Alga cells.

The reproduction of a Lichen is somewhat complicated, for we have to consider the processes of multiplication carried on by (1) the Alga cells, (2) the Fungus, (3) the Lichen as a whole. (1) The Alga cells increase in number by growing and dividing as if they were living independently, but do not bring about the reproduction of the Lichen as a whole. (2) In spore formation the Fungus alone is concerned, the spores being formed in special sac-like threads (asci) which develop from the Fungus web. The spores on being carried by the wind to a suitable place, germinate and, if the right Alga is at hand, the Fungus threads surround them and a Lichen thallus is woven. By sowing Lichen spores on plates on which minute Algae are growing, we can readily observe the production of a Lichen. In Nature, the Algae usually present in Lichens are widespread, so that the formation of a young Lichen thallus depends largely on the existence of suitable general conditions for growth. (3) Many Lichens are largely propagated by means of small brood-bodies (soredia), budded off by the thallus. Each soredium consists of a few Alga cells, or only one, surrounded by a web of Fungus threads. Sometimes these soredia are produced in definite clumps, but more often they form a powdery layer sprinkled over the thallus.

It must be remembered that the view of the symbiosis, or mutually beneficial partnership, relation between Fungus and Alga applies strictly only to the Lichens that grow on bare rocks and stones. In fact, even in these cases the Fungus proceeding from the germinating Lichen spore must be supplied with some organic substances derived from decaying plant or animal remains on the rock or stone. The Lichens that grow on ordinary soil, and on trunks of trees, resemble ordinary Fungi in being saprophytic—that is, they live at the expense of decaying organic matter, so far as the Fungus constituent is concerned. Moreover, many Lichens that grow on leaves in the Tropics, as well as some that grow on trunks, are more or less distinctly parasitic, drawing part, at least, of their nourishment from the living cells with which they are in contact by their underside or by their fixing and absorbing organs (rhizines).

As a matter of fact, various writers have maintained that the relation between the Fungus and the Alga in a Lichen is simply one of parasitism on the part of the Fungus. In some cases, the Fungus threads have been seen to penetrate the Alga cells instead of merely spinning an enclosing web around them, and the presence of dead Alga cells in various Lichens has suggested the view that the Fungus kills the Alga by means of ferments. Possibly the Fungus makes use of the Alga for some time after its spores have germinated, and then proceeds to live in the same way as an ordinary saprophytic Fungus when on a substratum rich in organic matter. This view is supported by the fact that Fungi which normally form part of a Lichen have been found growing independently, and there seems little doubt that in most Lichens the Fungus is capable of absorbing organic food from the substratum and is not dependent upon that which is manufactured by the Algae.

From the structure of the Lichen thallus it is clear that the Alga cells are placed in somewhat unfavourable conditions for the making of food by carbon assimilation. They are not at all well situated with reference to light and air, being covered by the thick dense cortical tissue which often contains various pigments and is thus darkened, while the compactness of the overlying tissue makes difficult the access of atmospheric air to the green cells. The latter difficulty is in many cases obviated by the presence of special canals and slit-like rifts in the cortex. In some of the *Parmelia* [illegible], which have been carefully examined by Rosendahl ([illegible] *Acta Leop.-Carol. Acad.*, 1907) the cortex, elsewhere thick and consisting of dense tissue, shows at places a loose texture corresponding to the lenticels in the cork of tree stems, while in those species which have a thin and delicate cortex these features do not occur. That lack of light and air tend to restrict the growth of the Algae is further shown by the fact that the usually continuous Alga layer is often interrupted below the fruits of the Lichen, and also below the places occupied by parasitic Fungi which are sometimes found growing on the surface of the Lichen thallus.

An interesting line of research in the physiology of Lichens is opened up by the striking results obtained by Treboux and other workers, with reference to the nutrition of the simpler Green Algae. It has been shown that many of these unicellular Algae can utilize organic acids (acetic, lactic, oxalic, and so on), as a source of carbon, light being unnecessary for the process, and that among the simple forms (*Pleurococcus* and others), which can obtain food in this way, the common Algae found in Lichens are included. These Algae, when supplied with organic acid solutions, can grow and develop in complete darkness. Lindau (*Lichenologische Untersuchungen*, 1895), noticed in a Lichen (*Pyrenula nitida*) that not only the Fungus threads but also those of the Alga, penetrated the bark of the tree on which the Lichen was growing, although the Alga (in this case a filamentous one belonging to the genus *Trentepohlia*) is only loosely bound up with the Fungus threads.

Tobler suggests that the Alga in a Lichen may utilise as its source of carbon organic acids which are formed as bye-products in the nutrition of the Fungus. It has long been known that oxalate of lime frequently occurs in crystalline masses and incrustations on the threads of the Fungus in Lichens, as well as on the threads of ordinary Fungi. In Lichens, the oxalate is never found associated with the Alga cells. Oxalate is also produced abundantly in cultures of isolated Lichen Fungi, even in cases where the Lichen itself is free from it. From his culture experiments, using the common yellow Lichen, *Parmelia parietina*, Tobler finds that (1) calcium oxalate is freely produced by the Lichen Fungus grown on gelatine; (2) on the other hand, developing Lichen plants on the same substratum, arising from the addition of the Algae to the Fungus, produce no oxalate; (3) fully developed plants of this Lichen, growing on bark, contain no oxalate; (4) in fluid cultures, containing no source of carbon excepting the carbon dioxide of the atmosphere, the Alga cells remain green and grow in the normal manner; (5) if the Lichen Fungus is also present in the culture the Algae become colourless, but continue to grow luxuriantly.

Many other facts support the view that the Alga in a Lichen may use the oxalic acid, and possibly other organic acids, produced by the Fungus. For instance, Rosendahl showed that in the brown Parmelias, thinness of the cortex and presence of oxalate of lime go hand in hand—evidently in such cases the Alga receives sufficient light to enable it to make food by photosynthesis, hence it does not use up the oxalate.

EVOLUTION OF THE FLOWER.—Wernham, in his second article on Floral Evolution, in the *New Phytologist*, (see "KNOWLEDGE" for June, 1911), deals with the Lower Dicotyledons (Archichlamydeae) in some detail, with special reference to their phylogenetic relations to the Higher Dicotyledons (Sympetalae or Gamopetalae). It is remarkable that whereas the flowers of barely twenty per cent. of the former have the stamens equal to or less than the corolla segments, this character is found in nearly ninety-five per cent. of the species of Sympetalae. Again, only about eighteen per cent. of the Archichlamydeae have a pistil composed of two syncarpous carpels, while in the Sympetalae fully seventy-five per cent. of the species have a bicarpellary pistil. The conclusion to be drawn is that the progressive tendency to economy of production, observable at work in the Archichlamydeae, has reached a high degree of realization in the Sympetalae, in [illegible] case we find higher adaptation to insect visits. In the Sympetalae, zygomorphy occurs in nearly fifty per cent. of the species, as against barely fifteen per cent. in the case of Archichlamydeae. Aggregation into dense inflorescences is the chief feature of the Compositae, an order which comprises over twenty-seven per cent. of the total number of Sympetalae, and, indeed, over ten per cent. of the sum total of flowering plant species.

The author then gives a summary of the various cohorts and orders of Archichlamydeae, tracing the evolutionary tendencies through this series. Taking first the essential organs—the androecium and the pistil—the general tendency to economy in production of parts is emphasized, and the question is raised, "To what extent has the working of the principle of economy been accompanied by the compensatory tendency of progressive adaptation to insect visits?" In this connection attention is called to the absence in Archichlamydeae of a strong tendency to *floral aggregation*, such as we find realized and expressed in the Compositae among the Sympetalae. Dense inflorescences occur in isolated cases throughout the Lower Dicotyledons, but aggregation does not characterize any relatively large group except one, the Umbelliflorae, in which the inflorescence unit is typically a close umbel. The general tendency to *zygomorphy* goes hand in hand with progressive aggregation, the outer florets tending to bilateral symmetry and especially to increased development of the corolla on the outer side. In the Lower Dicotyledons, however, the zygomorphy of relatively large and solitary flowers occurs only in isolated cases here and there, but does not form a critical character of any great group comparable with the Personales and Lamiales in the Sympetalae. Again, *fusion* plays a very inconspicuous part among the Lower Dicotyledons: a corolla tube is, of course, absent, though some specialised "apetalous" groups (*e.g.*, Proteales) have flowers with a typically gamophyllous perianth. In the Geraniales and the Papilionaceae, however, a tube is formed by the cohesion of the filaments of the stamens. But a far more extensive tube-forming tendency in the Archichlamydeae is that produced by means of the progressive hollowing of the flower receptacle.

In the higher families of Archichlamydeae, from the Buttercup cohort (Ranales) upwards, we find various stages of *perigyny*, leading to *epigyny*. The inferior position of the ovary may, however, have been produced in descent in other ways than by a gradually increasing degree of perigyny, though this method alone has left any continuous trace among existing plants. Whatever the evolutionary methods of its production may have been, the inferior position of the ovary conduces to economy in production, since in this way receptacular tissue can be pressed into the service of ovule protection and fruit formation. At any rate, it is certain that these floral types, such as the Compositae, which are admittedly in the van of evolutionary advance, invariably have an inferior ovary, while no epigynous flower can be called unquestionably primitive.

In attempting to find some phyletic connection between the Archichlamydeae and the Sympetalae, one can hardly suppose that the cohesion of the petals, which is the sole essential difference between the two groups, followed upon one line of evolution, nor that sympetaly originated at one point only of any particular line. That is, there is a *primâ facie* presumption that the Sympetalae are polyphyletic in origin, yet even if the series is composite it is also synthetic, in so far that its component members may be connected on the lines of certain well-marked progressive tendencies to biological advance. These tendencies do not differ fundamentally in any way from the tendencies seen at work in the Archichlamydeae, but they do differ in degree, as might be expected from the relatively high biological organisation of the group. The tendency to reduction of parts has already reached an advanced stage of realisation, and it plays a secondary rôle in the Sympetalae, in which the prominent factor is that of progressive adaptation to insect visits.

In the Sympetalae, the tendency to economy in production is expressed by (*a*) reduction of stamens to a number less than that of the corolla segments, following upon zygomorphy; (*b*) progressive reduction of the calyx to a pappus or to zero; (*c*) reduction of the carpels to two, the loculi to one, and the ovules to one.

The tendency in Sympetalae to progressive adaptation to insect visits is shown in (*a*) the general introduction to zygomorphy in Tubiflorae on the one hand and in Aggregatae and Campanulatae on the other, representing the two types of zygomorphy shown in Archichlamydeae; (*b*) the pollen presentation mechanism, a general feature of the Campanulatae and especially of the Compositae order.

CHEMISTRY.

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

MEASUREMENT OF POLLUTION OF THE ATMOSPHERE. Hitherto, the only chemical means of determining the degree of pollution of the atmosphere has been to estimate the proportion of carbon dioxide, and draw a deduction from the amount by which it exceeded the normal quantity. This method could only be regarded as giving approximate values, since carbon dioxide is one of the products of combustion as well as of respiration, and its estimation afforded an indication of the degree of ventilation rather than that of the vitiation of the air, which is due to the condensation of animal products of excretion.

An ingenious method of measuring these condensed products has been devised by MM. Henriet and Bouyssy (*Comptes Rendus*, 1911, CLII., 1180). It is based upon the fact that pure air always possesses oxidising properties, whereas excretory products are all reducing substances, and thus an estimation of the reducing property of a measured volume of the air is strictly proportional to the degree of pollution. The foreign bodies of organic origin to which pollution is due, are condensable simultaneously with the moisture in the atmosphere, and the method, therefore, consists of three steps:—(1) Condensation of a given volume of water from the atmosphere by means of a freezing mixture; (2) Calculation of the quantity of air corresponding to the amount of water condensed; and (3) Estimation of the amount of potassium permanganate solution reduced by the organic impurities in an aliquot part of the condensed moisture. The results are calculated into the corresponding quantity of oxygen, and expressed in milligrammes per one hundred cubic metres of air.

By this method the relatively pure air in the Montsouris Park, in Paris, gave a value of one, whereas the air in the vicinity of the Hôtel-de-Ville had a value of ten. A room in which several rabbits and monkeys had been kept gave the value thirteen, and the same figure was obtained with the air in a printing works. The figure fourteen was given by the air in a badly-ventilated office, and seventeen by that in a dark passage, while a dressmakers' work-room in which twenty people had been working all day with the windows closed gave the extremely high value of twenty-one. It seems probable that this method will prove a very valuable aid to the hygienic investigation of the air in closed places, such as submarine vessels.

BACTERIOLOGICAL STUDY OF HONEY.—An interesting investigation of the species of bacteria present within the cells of the honeycomb derived from different parts of France, has been published by MM. Sartory and E. Moreau (*Annales des Falsifications*, 1911, IV, 259). Among the bacteria of common occurrence in the air, which had been introduced by the bees into the cells, were the following species:—*B. subtilis*, *B. megaterium*, *Sarcina lutea*, *B. aerophilus*, and *Staphylococcus pyogenes*. There were also several mould-fungi and yeasts, including *Penicillium glaucum*, *Saccharomyces cerevisiae*, *Mucor racemosus* and *Aspergillus gracilis*. Among the bacteria was a golden yellow species, which secreted a bright yellow pigment soluble in absolute alcohol. It had a strong liquefying action upon gelatin, and differed in its biochemical characteristics from several very similar yellow bacteria. It appeared to be intermediate in its properties between the *Bacillus luteus* of Flugge and the *B. flavus* of Mace.

A NEW RADIUM PREPARATION.—An extremely active preparation of radium is now produced at the Neulenbach radium works, by means of a combined acid and alkaline fusion process, which extracts the radium directly from the minerals in the form of a crude sulphate. According to A. Fischer (*Chem. Zentralblatt*, 1911, I., 1190) it is possible by this means to treat ten thousand kilogrammes of pitchblende residues and obtain crude radium chloride from them within six weeks, while ores containing ten per cent. and less of uranium oxide, which hitherto could not be economically worked up, may now be used in the preparation of radium compounds. Preparations of radium showing an activity of upwards of three hundred thousand units (Mache) per 10 c.c. are now produced at these works. Experiments have shown that radium enters the human system chiefly by inhalation and not through the pores of the skin.

ARSENIC IN SEA-WEEDS.—It was shown by Gautier some years ago that arsenic was a normal constituent of certain marine algae, and this has recently been confirmed by MM. Tassilly and Leroide (*Bull. Soc. Chim.*, 1911, IX., 63). There are numerous secret medicinal preparations made from algae, including some of the anti-fat remedies, and experiments have shown that the whole of the arsenic will pass into these products. In addition to this, a small proportion of arsenic may be derived from impurities in the other ingredients of these remedies. The proportion of arsenic in marine algae and mosses of the same species varies but slightly, though there are considerable differences in the case of different species. The following results, expressed in milligrammes per hundred grammes of the algae, containing twenty to thirty per cent. of water, are typical of those obtained:—*Chondrus crispus*, 0·070; *Fucus vesiculosus*, 0·010; Corsican moss, 0·025; *Laminaria digitata*, 0·050; *L. saccharina*, 0·010; and *L. flexicaulis*, 0·010.

GEOLOGY.

By RUSSELL F. GWINNELL, B.Sc., A.R.C.S., F.G.S.

A GIGANTIC GEMSTONE.—A remarkable crystal of the precious beryl (a mineral which is known as emerald or as aquamarine, according to the particular shade of colour which it exhibits) was recently described in a paper read before the New York Academy of Sciences. This crystal, the largest beryl ever found, was discovered by a Turkish miner in a pegmatite vein in the State of Minas Geraes, Brazil.

The crystalline form was the usual hexagonal prism terminated at both ends by the basal plane. Although measuring 48·5 centimetres in length, the crystal was so transparent that it could be seen through from end to end when viewed through the basal termination. Its width was from forty to forty-two centimetres, and its weight 110·5 kilograms, or well over two hundredweight. It is estimated that the crystal would furnish at least two hundred thousand carats of aquamarine gems of various sizes, when cut. Twenty-five thousand dollars is said to have been paid to the finder for the stone.

For comparison with this gemstone, it may be interesting to recall the figures for some celebrated diamonds. The *Koh-i-Nur*, when brought from India, weighed one hundred and eighty-six carats (about one and a quarter ounces) and now, after recutting, weighs one hundred and six carats. Brazil produced the *Star of the South*, weighing two hundred and fifty-four carats when cut, but while holding the record for beryls, Brazil is easily surpassed by South Africa in diamonds. Thus the *Stewart* weighed two hundred and eighty-eight carats and the *Porter Rhodes* no less than four hundred and fifty seven carats (about three ounces) when found. But all previous records were beaten when, in the newly-discovered Premier mine in the Transvaal, the *Cullinan* diamond was found in the yellow ground, in 1905. More than three times the size of any known diamond, this stone weighed three thousand and twenty-five and three-quarter carats, or one-and-a-third pounds, and was clear and water-white throughout. The largest of its surfaces appeared to be a cleavage plane, so that it might be only a fragment of a much larger stone. Purchased by the Transvaal Government in 1907, the *Cullinan* was presented to King Edward VII. It was cut, in Amsterdam, into nine large stones and a number of smaller brilliants.

THE GREAT PROVINCES OR BRANCHES OF IGNEOUS ROCKS.—The old system of grouping the whole assemblage of igneous rocks along one line of variation, from *acid* through *intermediate* to *basic*, is gradually giving way to a more complex, but apparently more natural, system. In "The Natural History of Igneous Rocks" Harker states that we shall make a decidedly closer approach to the facts if we assume, not one, but two main lines of variations. Each line may be conceived as spanning the interval between the basic and acid extremes, the two diverging most widely near the middle of their course. These great provinces or branches are spoken of as the "Atlantic" or "alkalic" group and the "Pacific" or "sub-alkalic" group. These two great branches of igneous rocks have a well-marked areal distribution, and define two petrographical regions of the first order of magnitude, which stand in relation to the grandest tectonic features of the globe.

Although in the main the Atlantic type of rocks occur towards the Atlantic sea-boards both in the American continent and the Eurasian continent, and the Pacific type towards the Pacific sea-board, yet many exceptions occur. Moreover, in a country like Patagonia, where the Pacific and Atlantic Oceans come near together the types are curiously interwoven, as in the case cited below.

In a recent paper, also dealt with below, there is established a third "natural family" of igneous rocks, the *spilitic suite*, which is clearly distinguished from the Atlantic and Pacific suites.

In the *American Journal of Science* for May, Professor L. V. Pirsson refers to "Geologisch-petrographische Studien in der Patagonischen Cordillera; von P. D. Quensel."

Travelling from Cape Horn northwards along the chains of the southern Andes the author throws much light on the geology of this little-known region.

A feature of interest to petrographers is the occurrence, at a number of places, of alkalic rocks. These consist of intrusive masses of essexite in stocks, exposed domes, and so on. These rocks are composed of purple pleochroic titaniferous augite, brown barkevikite, labradorite and analcite, the latter regarded as secondary, perhaps after nepheline. They are accompanied by a series of dykes of bostonite and camptonite with essexite porphyry, and the author parallels the occurrences with those of Southern Norway, made classic by the researches of Brögger. In other places aegirine-granite-porphyry is found with the essexite. The occurrence of these alkalic types in the sub-alkalic province of the Andes is interesting.

In the *Geological Magazine* for May and for June, 1911, Messrs. Dewey and Flett deal with "British Pillow-Lavas and the Rocks associated with them." These pillow-lavas are a group of basic igneous rocks, occurring only as submarine flows and very frequently exhibiting "pillow-structure." The term "spilite" is used to designate these lavas, which are found among Carboniferous, Devonian and Ordovician rocks in Devon and Cornwall. A great variety of types are comprised in the family, and they range from ultra-basic picrite to such acid extremes as quartz-keratophyre, soda-felsite and albite granite. The essential characteristics of the family are the abundance of soda-felspar and the remarkable frequency with which they have been albitised. The albitisation is not due to weathering or to shearing, but it may be grouped as a post-volcanic or juvenile change, produced soon after solidification of the rock. Like the Atlantic and Pacific igneous suites the spilite group has an intimate connexion with certain types of geological conditions. They are essentially rocks of districts that have undergone a long continued and gentle subsidence, with few or slight upward movements and no important folding.

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

The weather of the week ended May 20th, as presented in the Weekly Weather Report of the Meteorological Office, was rainy at first, but became dry, though mostly dull.

Temperature was above the normal in all districts, the greatest excess being in the Midland counties, where the mean was 3°·6 above the average. The highest readings recorded were 73° at Norwich, and 72° at Raunds and at Southampton. In Ireland, N. the maximum did not exceed 66°. The lowest of the minima were 33° at West Linton on the 17th, and 34° at Balmoral on the 16th. Slight frost was recorded on the grass at several stations, the lowest reading being 29° at Markree Castle, Co. Sligo.

Rainfall was in excess in Scotland, E. and England, E., but was in defect elsewhere, very greatly so in various parts, many stations being rainless for the week. Sunshine was above the average in Scotland, W. and Ireland, N. and was normal in Ireland, S. In all other districts it was in defect. The least sunny district was the Midland Counties with a total duration of only 19 hours (17%) while the most sunny was Scotland, W. with 56 hours (50%). The sunniest station was Castlebay, Isle of Barra, which reported 70 hours of sunshine (61%).

The mean temperature of the sea-water round the coast ranged from 55°·4 at Teelin and Seafield to 45°·8 at Scarborough. Thunderstorms were reported at several stations, and during the early part of the week there was much mist or fog on the coast.

The week ended May 27th was unsettled, with thunderstorms and very heavy rains during the latter part. Temperature was again above the normal in all districts, that with the greatest excess being England, N.E., where the mean was 5°·7 above the average. The highest reading reported was 81° at Shaftesbury on the 27th. In Ireland, N., the maximum was only 66°. At Greenwich it was 78°. The lowest minima for the week were 29° at Balmoral and 30° at Llangammarch Wells. On the grass the minimum fell to 24° at Llangammarch, and to 25° at Crathes and at Greenwich.

In spite of very heavy local falls, the week's rain-fall was below the average in all districts, and at many stations the week was rainless. In England, E., the total for the week was only 0·01 inch as compared with an average of 0·44 inch. The thunderstorm rains towards the end of the week were very heavy and caused floods in many places. At Great Billing, Northants, as much as 2·0 inches fell in one day, and at Bere Alston, Devon, 2·5 inches was collected in one-and-a-half hours.

Bright sunshine was in excess in most districts, but in England, S.E., and Ireland, N., it was normal; while in Ireland, S., it was slightly below. The sunniest district was the English Channel with a total duration of 73 hours (68%) while the sunniest station was St. Mary's, Scilly, with 83·3 hours (76%). At Westminster the total duration was 42·2 hours (38%). The temperature of the sea-water ranged from 44° at Scarborough to 58° at Scilly and Seafield.

During the week ended June 3rd, the weather was fine and bright, but with many thunderstorms.

Temperature continued much above the average, and the mean values in most cases were higher than any recorded in the corresponding week during the last thirty years. The highest reading was 83° which was recorded at Fort William, Balmoral and Aspatria. At several other stations readings of 80° or upwards were reported. The lowest of the minima were 34° at Markree Castle on the 28th, and 35° at Balmoral on the 29th, the same day as that on which the maximum reached 83°.

On the grass, frost was experienced in Scotland, E., and Ireland, N., the lowest reading being 28° at Markree Castle. Rainfall was deficient nearly everywhere, and at quite a number of stations the week was rainless. Some very heavy thunderstorm rains were, however, reported, 0·92 inch at Rothamsted, 1·00 inch at Greenwich, and 2·86 inches at Epsom. Of this latter amount 2·44 inches fell between 5.20 p.m. and 6.10 p.m., on May 31st.

Sunshine was above the average at each of the reporting stations. The sunniest district was England, N.W., where the mean was 90 hours (79%), while the sunniest stations were Newton Rigg, near Penrith, 97·4 hours (84%), Stornoway 96·8 hours (80%) and Rhyl 96·7 hours (85%). At Westminster the total duration was 73·9 hours (66%). The temperature of the sea-water was higher than usual, except on the South-West coast of England. The individual readings ranged from 47° at Aberdeen to 62° at Seafield.

The weather during the week ended June 10th continued very fine generally, though thunderstorms occurred in many parts.

Temperature was still much above the average, an excess being reported from every station. England, S.W., was the district with the highest mean temperature, 61°·8, as compared with the average for the same district during twenty-five years of 55°·8. The highest of the maxima were 84° at Fulbeck, Lincolnshire, and Greenwich, with 83° at Tottenham, Westminster and other places. The lowest of the minima were 34° at Llangammarch Wells, and 35° at Newton Rigg, Blackpool and Glencarron. In nearly every case the lowest reading was recorded on June 10th. In the Channel Islands the minimum did not fall below 52°. Frost was still experienced on the ground, readings as low as 25° being reported at Llangammarch and Burnley, with 27° at Southport and Wisley. Rainfall was in defect in all districts except the English Channel, where the excess was due to a thunderstorm rain on June 8th, which in Guernsey yielded between 1·1 inches and 1·7 inches. In very many places (eighty-one stations out of a total of one hundred and seven stations) the week was rainless. Bright sunshine was in excess in all districts, especially in the South of England and the West of Scotland, where the mean total for the district amounted to 86 hours. The stations reporting the greatest duration were Brighton 99·8 hours (88%) and Pembroke, 98·5 hours (86%). At several other stations totals exceeding 90 hours were recorded: Tenby 95·5 hours (84%), Douglas 94·4 hours (81%), and Worthing and Eastbourne 93·5 hours (83%). At Westminster the total was 76·4 hours (68%).

The sea temperature was much higher than in the corresponding week of last year, and ranged from 49° at Lerwick to 67° at Seafield.

MICROSCOPY.

By A. W. Sheppard, F.R.M.S.,

with the assistance of the following microscopists:—

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

Cytology of the Bacteria.—In the current number of the *Quarterly Journal of Microscopical Science*, Vol. 56, pages 395–506, appears an important paper on the above subject by C. Clifford Dobell. The author's main object has been to decide the question, whether or not the bacteria are nucleate cells. In making the investigations detailed in the paper the author selected certain large bacteria found in the intestines of some animals; they belong to four different groups, namely, cocci, bacilli, spirilla and the so-called "fusiform bacteria." The method of preparation described as the "drop" method, is said to be applicable also to small infusoria and other protists. A drop of the material to be examined is taken up on a platinum loop and placed on a slip, by its side is placed another drop of one per cent. Osmic acid or formol (forty per cent. solution of formaldehyde). These two drops are intimately mixed and spread in a thin film. When dry, no heat being applied for that purpose, the film is treated with absolute alcohol—this is necessary in the case where formol is employed as formaldehyde fixes protoplasmic structures without precipitating them in an insoluble form.

From the facts detailed in the paper the author deduces the following chief conclusions:—

All bacteria which have been adequately investigated are—like all other Protista—nucleate cells. The form of the nucleus is variable, not only in different bacteria, but also at different periods in the life-cycle of the same species.

The nucleus may be in the form of a discrete system of granules (chromidia): a filament of variable configuration; in the form of one or more relatively large aggregated masses of nuclear substance; of a system of irregularly branched or bent short strands, rods or networks; and probably also in the vesicular form characteristic of the nuclei of many animals, plants and protists. There is no evidence that enucleate bacteria exist. Finally, in addition to these purely morphological conclusions concerning the nucleus, the author thinks it is highly probable that the bacteria are in no way a group of simple organisms, but rather one displaying a high degree of morphological differentiation, coupled, in many cases, with a life-cycle of considerable complexity.

THE GENUS *POLYTREMA* (FORAMINIFERA).—At the meeting of the Linnean Society, held on May 4th, Professor Sydney J. Hickson, F.R.S., communicated a revision of the above genus. The discovery of some very large specimens of Foraminifera belonging to the species described by Carter as *Polytrema cylindricum* in the material collected by Professor Stanley Gardiner in the Indian Ocean, led the author to make a careful examination of this and of other species attributed to the genus *Polytrema*. The result of this examination was to prove that the specimens usually labelled *Polytrema* in collections may belong to three quite distinct genera.

Polytrema cylindricum of Carter is the type of a genus for which the generic name *Sporadotrema* is proposed. The specimen described by Carpenter under the name *Polytrema rubra* Lamk., and many others that are labelled *Polytrema miniaceum* Pallas, in collections, belong to another genus for which the generic name *Homotrema* is proposed. The specimens described by Merkel, Lister and others under the name *Polytrema miniaceum* belong to a genus distinct from the other two, and for this it is proposed that the generic name *Polytrema* be retained.

A description of the principal characters separating the three genera is given in the paper.

As regards the geographical distribution of the three genera, it may be observed that *Sporadotrema* has only been found in the Indian Ocean and on the Macclesfield Bank in the China Sea, that *Polytrema* and *Homotrema* appear to have a much wider distribution in temperate and tropical seas, but at present the author has not seen any specimens of *Polytrema* from the shores of the American continent, nor has he seen any specimens of the genus *Homotrema* from the Mediterranean Sea.

COCCIDIOSIS IN GROUSE.—In an interesting paper contributed to the current number of *Science Progress*, Vol. V., pages 565-583, on the diseases of Grouse, Professor Arthur E. Shipley, F.R.S., describes the complex life history of *Eimeria* (*Coccidium*) *avium*, one of the seven distinct unicellular or protozoan parasites which live either in the intestines or in the blood of the grouse.

The chief source of contamination on the moors is the droppings of other diseased grouse. The droppings contain thousands of cysts (oöcysts) or spores of the parasite and these spores, with their hard coats, are extremely resistant and can endure for very long periods without the death of their contents, which gradually divide to form four smaller spores (sporocysts) inside. The spores are scattered over the moors by the action of the wind and rain and, alighting on the heather or in the tarns of the moors, are taken up by the grouse in their food or drink. When the cysts are swallowed, they enter the gizzard of the bird and pass unchanged into the first part of the intestine, called the duodenum. Here the pancreatic juice is poured into the intestine, to aid in digestion, and under its influence the cyst-wall is softened and dissolved, and the four small spores (contained within the ripened spore or oöcyst) are set at liberty. Each small spore contains two active motile sporozoïtes, which emerge from the softened spore-case and proceed to penetrate the epithelium of the duodenum. The young parasites ultimately cause the destruction of the lining of the first part of the small intestine—the region where, normally, the most active digestive processes occur. The *Coccidium* parasites multiply in the duodenal epithelium and then invade the caeca or "blind-guts," with disastrous results.

Sooner or later a limit is reached, on the one hand, to the power of the grouse chick to provide nourishment for the parasites, and on the other to the multiplicative capacity of the parasites themselves. The *Coccidium* then begins to reproduce sexually. Many small male parasites are produced, together with larger food-containing female *Coccidia*. The male and female parasites conjugate and then encyst, bursting through into the cavity of the gut and giving rise to the spores found in the caecal droppings on the moors.

PROTOZOA OF THE SOIL.—At the meeting of the Royal Society held June 1st, 1911, a paper was read by T. Goodey forming a contribution to our knowledge of the protozoa of the soil.

It gives an account of work carried out on the soil protozoa which are considered to be chiefly instrumental in limiting the activity of bacteria in the soil and thus in helping to render the soil comparatively infertile. Methods of obtaining protozoa in cultures of soil are described, and a list of the different species found so far is given. An experimental method for quickly finding the earliest ciliated protozoa occurring in a soil culture is described, in which use is made of the galvanotactic response which many of the protozoa show when stimulated by means of a continuous electric current. By means of this method, active ciliated protozoa have been found in from $1\frac{1}{2}$ hours to 4 hours.

Experiments on the length of time required for a ciliated protozoon *Colpoda cucullus* to develop from its resting cysts have also been conducted in similar media and at the same temperature as used in the soil cultures. It has been found that the times required for development in both soil and cyst cultures are comparable, and that the first *Colpoda cucullus* to occur in soil cultures are almost identical in appearance with those which emerge from resting cysts.

The conclusion drawn from the experiments is that the ciliated protozoa are only present in the soil in the encysted condition, and do not, therefore, function as the factor limiting bacterial activity in the soil.

The protozoa of the soil are referred to in a paper by Dr. H. B. Hutchinson (see "KNOWLEDGE" N.S. Vol. VIII, pages 123-126.

QUEKETT MICROSCOPICAL CLUB.—May 23rd, 1911. Dr. E. J. Spitta, F.R.A.S., F.R.M.S., vice-president, in the chair. Mr. C. D. Soar, F.L.S., F.R.M.S., read a paper on "The work of the late Saville-Kent on British Hydrachnids." Together with Mr. Williamson, of Edinburgh, the author is preparing a monograph of British Hydrachnids, and had obtained from the British Museum (Natural History) Authorities permission to examine all the slides, notes and drawings which Mr. Saville Kent had brought together. The collection was begun in 1867. Mr. Soar found it possible to identify forty species from the mounted preparations, and a further ten from various notes and drawings. A detailed list of the species identified is added to the paper.

A paper by Mr. E. M. Nelson, F.R.M.S., on "Methods of Illumination" was read by the honorary secretary. Mirror illumination was first dealt with. The proper way to centre a concave mirror is:—First focus the object, then, looking *at* the eye-lens, by moving the mirror, bring the image of the light source central in the Ramsden disc. It is better to have centred illumination even at the expense of an incompletely lighted field. The use of ground glass then received attention, and surprise was expressed at the appreciative remarks made by Dr. Carpenter and Lewis Wright in their well-known books, when discussing the use of this medium. After exhaustive trials of ground-glass, and particularly in relation to its effect on the image. Mr. Nelson summed up the result by one word —"Fog."—The simplest condenser, even a single lens so used, gave a better image than could be obtained with ground-glass.

Sir D. Brewster, in 1836, was the first to employ colour screens in microscopy. Mr. Nelson recommended the use of a screen composed of a piece of peacock-green glass combined with a very light blue for visual daylight work, and for lamp-light a piece of thicker peacock-green glass combined with a blue glass of the tint of the blue cornflower. Reference was also made to the various forms of Gifford's screen and to that used by Dr. Miethe.

One other form of illumination dealt with by Mr. Nelson is that of using part of the spectrum. A prismatic spectrum is brighter than that given by a diffraction grating, although on the other hand, the dispersion obtained with a fourteen thousand line grating between E and G in the first order is more than double that of an ordinary flint-glass prism.

The Chairman in asking the meeting to pass a very hearty vote of thanks to Mr. Nelson, made some very appreciative remarks on the "M" series of screens issued by Messrs. Wratten and Wainwright. He considered them almost indispensable to the careful worker, as they afforded full control of the colour of the lighting and consequently of the amount of contrast obtained with all classes of coloured objects.

THE ROYAL MICROSCOPICAL SOCIETY.—May 17th, 1911, H. G. Plimmer, Esq., F.R.S., President, in the chair. Mr. J. E. Barnard made a communication on a method of disintegrating bacteria and other organic cells. The author first mentioned that bacterial toxins were of two kinds, extra-cellular and intra-cellular. The former were excreted into the medium, e.g., beef broth, in which the organism was cultivated, so that by a process of filtration the organism could be removed and the toxin was obtained in the filtrate, but the majority of pathogenic micro-organisms did not excrete their toxins, at least to any great extent, and the toxins were retained within and formed integral parts of the cells of the organisms.

One method of obtaining these toxins was to mechanically disintegrate the bacterial cell, so that the cell contents were expressed, and the apparatus described accomplished this.

It consisted essentially of a containing vessel in which, by a suitable rotation of steel balls, the organisms were crushed.

The principal conditions to be fulfilled in such an appliance were:—

(1) Approximately every cell should be brought under the grinding action.

(2) Little or no rise of temperature should take place.

(3) The disintegration should be carried out in a vessel which was sealed so that, when dealing with pathogenic organisms, none could escape at any stage of the process.

These conditions were, in the main, complied with in the apparatus described. Experiments indicated that by this method the cell juices were obtained unaltered, and so were suitable for investigation on the chemical composition and properties of the bacterial proteins and other cell constituents. Also that, after the grinding process had been carried on for a sufficient time, practically no cells remained which could be properly stained by any recognised bacteriological method, and which, therefore, could be regarded as whole cells containing a normal quantity of cell juice.

Mr. James Murray presented a third portion of his report on the Rotifera observed by the Shackleton Polar Expedition of 1909, dealing with the new species, and so on, from the Pacific Islands. He said that in Fiji fifteen Bdelloid Rotifera were collected, in Hawaii twenty-four, ten species being common to the two groups of islands.

In Fiji two new species were distinguished, *Callidina pacifica* and *Habrotrocha nodosa*, the latter previously known, as a variety, in India, and elsewhere.

In Hawaii there were no peculiar species, but some very distinct varieties.

In the various Pacific Islands there have been recorded thirty-one species of Bdelloids.

The attention of the Fellows of the Society was then directed to the collection of specimens of Pond Life, which had been arranged for the evening.

ORNITHOLOGY.

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

THE DISTRIBUTION OF THE NIGHTINGALE IN GREAT BRITAIN DURING THE BREEDING SEASON. —Discussion of this subject is revived by an article contributed to the June number of *British Birds* (Vol. V., No. 1, pages 2-21), by Mr. N. F. Ticehurst and the Rev. F. C. R. Jourdain. The chief value of the paper lies in the carefully worked out details given under those counties in which the distribution of the species is local, or which mark the limits of its range in England and Wales. This faunistic information is very valuable and full, and summarises present-day knowledge on this part of the subject, making clear the well-known and curiously partial character of the bird's distribution. Commenting on the last-named point, the writers express the opinion "that the real obstacles which prevent the general distribution of this species over the greater part of England and Wales are the ranges of elevated land, which it instinctively avoids." This seems adequate only in so far as it is limiting and negative in character, and the condition laid down is in no way peculiar to the Nightingale. Height of land is a factor which affects the distribution of species generally, but many other considerations come in. That the Nightingale is not found on elevated land, and that its distribution is restricted or limited by such elevations, may account for its absence there: but this reason seems an incomplete explanation of its presence in its frequented haunts and known stations, and not in contiguous places where the conditions are apparently similar. It would seem that Professor Newton's judgment must still stand, viz.:—"No reasonable mode of accounting for the partial distribution of the Nightingale has hitherto been propounded" ("Dictionary of Birds," 1893-6, pages 339-340).

THE BIRDS OF ST. ALBANS.—This famous old city, like the county in which it is situated, has rather a meagre avi-fauna, due, chiefly, to the absence of maritime conditions. Nor does there seem to be any great fly-line of migrants across the county from which records might be gathered. Hertfordshire birds number about two hundred and ten species in all, and the St. Albans list includes one hundred and twenty-eight of these. Mr. W. Bickerton gives a good account and classification (for the city and a radius of five miles around) in a work entitled "St. Albans and its Neighbourhood" (1911), published by the Hertfordshire Natural History Society, in connection with the Annual Congress of the South-Eastern Union of Scientific Societies recently held in that city. Mr. Bickerton's article (pages 240-243) lays a sound basis for further observations and bird-study in the district.

ACCOUNTING FOR THE ROOK.—The thinning-out of the Rook, recommended by some authorities, is not neglected in some districts. For instance, Mr. C. C. Ellison, Bracebridge, Lincoln, writes to *The Field* that one day's shooting each year for thirty years on the same estate has produced 20,793 Rooks. The biggest bag was 1,220 to seven rifles; the best was 1,210 to two rifles only. Mr. Ellison adds that there are probably not half the Rooks in the country now that there were in 1880.

THE BOYD ALEXANDER COLLECTIONS.—The great collections formed by the late Mr. Boyd Alexander on his African expeditions, and bequeathed by him to the Natural History Museum, South Kensington, have now been handed over to that institution by his executor, Mr. Robert Alexander. They comprise nearly four thousand bird-skins of African species, and include the type-specimens of no fewer than eighty species.

ANTARCTIC BIRDS.—The Scottish National Exhibition, now open at Glasgow, contains a section illustrating the Antarctic Expedition of the "Scotia." There is a good display of the birds and seals of the Antarctic, shown in artistic representations of their natural surroundings. One of the cases represents a scene in the South Orkneys, and conveys a vivid impression of Antarctic bird life. Five species of penguins, with eggs and young, are represented. Notably there are three Emperor penguins, standing in solitary state on an ice floe, one of them trumpeting a love-song to his mate. Among the smaller birds, the most prominent are black-throated or adelia penguins. A pair are seen hurrying back to their nests after having had an excursion to sea in search of food. An anxious mother is seen feeding her young, while another pair sit expectant alongside an unhatched egg. There are also the gentoo penguins, with red-marked bills and white-striped heads; the macaroni penguin of the golden crest, and the ringed penguin.

Twelve other species of Antarctic birds are represented. These include the blue-eyed shag, in its nest of seaweed; the Dominican gull, resembling the black-back gull of our own waters; and the fierce skuas fighting over the body of a penguin. The only land bird of the Antarctic, white and in form like a chicken, is also shown. Then there are the petrels, —the giant petrel, sitting on its nest of stones; the silver petrel, the Antarctic petrel, the blue petrel, and the snowy petrel, whose presence is indicative of the ice pack. There is a fine specimen of the mottled black and white Cape pigeon, whose eggs the "Scotia" naturalists were the first to discover, although the bird has been known for at least three hundred years.

PHOTOGRAPHY.

By C. E. Kenneth Mees, D.Sc., F.C.S., F.R.P.S.

THE FOGGING POWER OF DEVELOPERS.—A paper on this subject appears in the June number of the *Photographic Journal*. It is, of course, well known that developers differ in the amount of fog which they produce on unexposed plates, but this appears to be the first systematic attempt to compare the fogging power of different developers and to distinguish the conditions which tend to produce fog in development. In order to compare the fogging power of different developing solutions, it is necessary to measure the amount of fog which they will produce in the time necessary to produce a given degree of contrast.

In the development of an exposed plate, the rate at which density grows is usually expressed by what is called the "velocity constant," which quantity may be denoted by the symbol K. (See "Knowledge" "Notes," May, 1911.) The value of K for a given plate and developer is easily determined and if we can find some equally simple means of determining and expressing the rate at which fog grows in an unexposed plate, it is obvious that a comparison of the two constants should give an idea of the fogging power of the developer used.

For example, if the rate of growth of fog on an unexposed plate is exactly equal to the rate at which the density grows in exposed parts of the same plate, it is obvious that no image can result, the fogging power being so great that we can only obtain a uniform deposit over exposed and unexposed portions alike. A developer giving such a result will be useless, and it is in all cases necessary that the velocity of the fogging action shall be less than that of development.

If we express the fogging velocity by the symbol F, just as we express the developing velocity by the symbol K, then the ratio of F to K can be taken as a measure of the fogging power of the developer, and therefore we may measure F and K separately, and then, dividing F by K, obtain a quantity which can be used as a measure of the fogging power.

In the production of measurable degrees of fog on unexposed plates very considerable duration of development was necessary and, as any oxidation of the developer affected the results, the plates were developed in a tube which was quite full of developer, a rubber cork fitted with a stop-cock being pushed in until the developer spurted out from the stop-cock, which was then closed. In order to avoid temperature errors, the tube was a vacuum-jacketed Dewar tube.

The developer used was Hydroquinone and Caustic Alkali and the results obtained showed that the fogging power of such a developer is mainly due to two causes—oxidation products of the developer itself, and the sodium sulphite used as a preservative. The fogging power of non-oxidised developers not containing sulphite was independent of the amount of alkali present, increase of the alkali increasing the development of both exposed and unexposed bromide in the same proportion, leaving the ratio unaltered.

The oxidation product of the hydroquinone developer, quinhydrone, was found to be a powerful fogging agent in the presence of alkali, developing exposed and unexposed bromide at the same rate and consequently developing no image on an exposed plate. Since this compound cannot exist in the presence of sodium sulphite ordinary photographic developers do not give oxidation fog! But sulphite itself is a source of fog, the amount of fog depending on the concentration of the sulphite and rising to a maximum at a low concentration, decreasing again as the concentration is increased.

The explanation given by the authors for the phenomena described by them is based on a discussion of the reduction potential of developers.

The reduction potential of a reducer, or the oxidation potential of an oxidiser is the analogy for chemical affinity of electric potential in electricity.

On the other hand, the resistance potential of a chemical substance (e.g., silver bromide) may be compared to the "back potential" of an arc lamp. It requires a certain voltage (about forty volts) to enable an arc with carbon poles to burn, and if the potential of the source of electric energy is lower than this, then the arc will not burn.

If iron poles are used in the arc a higher potential (about sixty-five volts) is required to enable the arc to burn; so that there is a range of voltages (from forty to sixty-five volts) where carbon arcs can burn but iron arcs cannot.

The authors suggest that the difference between fogging agents and developers is analogous to this difference between the voltages, which will work arc lamps with different poles. A substance with a low reduction potential (e.g., neutral hydroquinone) cannot reduce either exposed or unexposed silver bromide. If the reduction potential is higher then exposed silver bromide becomes developable, but the resistance potential of unexposed silver bromide is still too high. All substances which have reduction potentials higher than the resistance potential of exposed silver bromide, but lower than that of unexposed silver bromide will be developers. If the reduction potential of a substance is higher than the resistance potential of unexposed silver bromide (as is the case with alkaline quinhydrone, for instance) then it will be a fogging agent.

Any substance which tends to lower the resistance potential of unexposed silver bromide will increase the fogging power of a developer, and, since the resistance potential of a substance depends upon its insolubility, any substance, such as sulphite, which increases the solubility of silver bromide will increase the fogging power of a developer, while a substance, such as an alkaline bromide, which decreases the solubility will decrease the fogging power.

The subject would seem to require a good deal more investigation and probably the theory outlined above will require much modification, but it is satisfactory that some progress is being made with a subject about which so little has hitherto been known.

PHYSICS.

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

Physicists have had the opportunity of examining the fruit of each other's work during the past month. The Physical Society has enjoyed the opportunity of visiting the National Physical Laboratory; while the Conversazione of the Royal

Society, on May 10th, included exhibits of very great interest. Further than this, many illustrious men from foreign countries have honoured their scientific cousins with their presence in this country, strengthening thereby the absolute internationality of science. Among these one may mention Professor Svante Arrhenius, Professor Richards and Professor Wood. It will be well this month to note shortly a few of the contrivances which have thrown light on the subjects recently investigated.

Professor Wood, in a lecture to the Royal Institution, on Friday, May 19th, described many experiments which he has made on ultra-violet light. Using quartz lenses and silvering them with a uniform coating of silver, he has been able to photograph objects by ultra-violet light; the silver absorbs all the visible light. In such photographs the sky is very bright; the ultra-violet light gets scattered by the atmosphere to a very great degree, so much so that no shadows appear. Many quite white bodies, such as Chinese white and most garden flowers, do not reflect ultra-violet light, and so appear black. Professor Wood has photographed the moon by ultra-violet light, and obtained patches which show exceptional absorption. To exhibit this, he had recourse to the ingenious method of projecting two photographs on to a screen so that the two images were completely in register and superposed. The one photograph is taken by ultra-violet light, the other by ordinary light. A red filter is placed in front of one photograph and a green in front of the other, so that any difference in the two is at once detected by a preponderance of red or green light on the screen, instead of a complete neutralisation of the two complementary colours. With infra-red light there is no scattering by the sky, which appears quite black in photographs taken through a screen of cobalt glass and certain organic dyes which cut off all light of shorter wave-length than λ 6800. But the leaves of trees reflect this deep red light almost completely. These effects were dealt with more completely by Dr. Mees in "Knowledge" a few months back.

Professor Wood has been able to isolate short ultra-violet waves from a magnesium spark by a system of quartz lenses. The centre portion of one of the lenses is stopped out altogether, while the distance apart of the lenses is so arranged that the ultra-violet light alone can pass through the outer portion of the second lens, the more refrangible rays being stopped from passing by the centre blackened portion of the lens. There is another way of isolating the ultra-violet waves alone, but this latter method only obtains the more refrangible of these rays: those which can penetrate glass. A screen made of nitrosodimethylaniline combined with a cobalt glass attains this object.

Messrs. Wratten and Wainwright supply such light filters. Their list includes colour filters for many purposes, such as the isolation of the green mercury line; a screen which in combination with a mercury lamp gives an absolutely monochromatic beam. The balancing of the colours in the tricolour screens is very perfect and they should have many applications; the researcher, the lecturer, the photographer and the microscopist will find many uses for them.

Lord Rayleigh has pointed out that transparent objects are only visible when they are illuminated unequally. Kaufmann has devised a simple method of illustrating this point. A funnel of white cardboard is illuminated inside by a glow lamp and vertically up the axis of the funnel is fixed a glass rod. Looking through a slit in the side of the funnel the rod is invisible until it or the lamp is shifted to one side of the axis of the funnel. A transparent object immersed in a fluid of the same refractive index is invisible; for instance, the end of a glass rod is invisible when dipped in Canada balsam (or, better, in a solution of eight volumes of chloral hydrate in one volume of glycerine) while, when withdrawn, the end appears to melt.

When using interferometers it is often very difficult to obtain sufficient magnification of the bands of light obtained without too great a loss of light. Lord Rayleigh some years ago devised a most ingenious way of getting over this difficulty. He constructed a telescope with a cylindrical lens as an eyepiece and a lens tilted at an angle to the vertical plane as object glass; in this way he obtained a telescope magnifying in only one direction.

It is only possible to compare intensities of light definitely when the light is of the same colour, *i.e.*, of the same wave length. The comparison of differently coloured sources should be made by means of a spectrophotometer—a spectrometer with a Nicol prism which, on rotation, cuts off more or less of the light of any particular wave length. The numerical value of the total intensity of any light source may be obtained from the monochromatic intensities by allotting to each colour a co-efficient, and then summing up the intensities obtained thus for all the colours. M. Thovert has recently worked on these lines and has selected the distinct vision of form as the basis from which to deduce the value of these co-efficients. This method is preferable to that based on obtaining a colour sensibility curve. In the one method a grating spectroscope is used, and a monochromatic ray is isolated by means of a slit, and the luminosity regulated by suitable means; a pattern is placed in the path of the light at the limit of distinct vision, and the wave lengths found for any particular degree of illumination for which the pattern is just visible. The other method is dependent on finding the extreme wave lengths visible when the light from a spectrum is shielded by grey-tinted glass of different depths. There are many problems of great interest in photometry of light of different colours, the subject of colour blindness being intimately connected with it. We must return to the question in another issue.

The measurement of resistance of a mercury column has been employed by T. R. Merton to calibrate capillary tubes, always a troublesome proceeding when done by measuring the change in length of a pellet of mercury. The ends of the capillary tube communicate with two mercury cups which are connected to one arm of a Wheatstone's bridge. The mean radius r is given by $r^2 = \frac{l + 2dr}{\pi \kappa f}$ where l is the length of the capillary, f the found resistance and d a correction for the stream lines at the ends of the capillary, κ the specific conductivity of mercury. It has occurred to the writer that measurements of volume in gas burettes might be made by inserting an iron resistance wire down the burette inside so that the mercury uncovers more or less of the wire as it is raised or lowered, the change in resistance of the wire being accurately measured.

Professor Theodore Richards has employed a method of electrical contacts for measuring volumes very accurately. As the mercury is lowered so it can be set to just make or break an electrical contact consisting of a fine platinum point. He has used the method to determine differences in the compressibilities of liquids.

Mr. E. H. Rayner has recently described an ingenious arrangement for measuring small thicknesses and displacements with far greater sensitiveness than the micrometer will attain to. It consists of three conical feet, two in one plane and the other half-way between them, but slightly out of the plane, so that they rest in a hole, slot, and plane at the corners of a very obtuse angled triangle. The three feet are affixed at the upper end, to a lever carrying a concave mirror focussing a spot of light into a screen. Any slight shift of the third foot, the one that lies slightly out of the plane, causes a slight rotation of the lever, which is magnified considerably by the spot of light. The author has employed the apparatus to measure the expansion of short bars of quartz, only fifteen centimetres long; also uses are found for it in measuring thicknesses of mica, paper and foil; or, again, as an adjunct to a chemical balance, to obtain a first approximation to the weight. In the latter case the three legs of the tilting table are affixed to the end of three rods fitted at their other ends into a block of metal. The centre rod, on being bent by affixing a weight to it, will then tilt the table proportionally to the weight applied and the position of the weight on the rod.

In Messrs. Paul's recent catalogue there are to be found two instruments of considerable interest which have been designed and placed on the market. The one is a thermoelectric junction and unipivot galvanometer combined with a special compensator patented by Mr. C. R. Darling. This compensator eliminates any error due to the heating of the cold junction. Any change in the temperature of the cold junction is compensated for by means of a metallic thermometer which twists the spring of the unipivot galvanometer so as to counteract the inaccuracy of the reading due to this change of temperature of the cold junction. Thus the instrument can be employed without any corrections to read conveniently any temperature, being specially adaptable to the measurement of low temperature, e.g., refrigerators, and so on.

The other instrument, the "Ampall" we must leave till next month to describe.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A.

BIOLOGY OF A HAY INFUSION.—Everyone knows that a "hay infusion" becomes a little world teeming with animal and plant life, and that it goes through a cycle of changes, form after form rising into dominance and then disappearing. Professor L. L. Woodruff, who has made so many interesting studies on *Paramoecium*, has begun a series of precise studies on the biology of the hay-infusion, by devoting himself particularly to what happens in the case of this infusorian. "The interdependence of the organisms of a hay infusion is so complex that, taken as a whole, it is almost beyond the possibility of analysis, and accordingly the logical method of approach to the subject is to study the interaction of isolated organisms and small groups of organisms on themselves and on each other." His first question was: "How is *Paramoecium* affected by different volumes of the culture medium?" and his answer is that the greater the volume the more rapid is the rate of division. He went on to enquire into the effect of changing the culture-medium, and found evidence that *Paramoecium* excretes substances which are toxic to itself when present in its environment. These substances are more effective when the organisms are confined in limited volumes of culture fluid. These poisonous excretion-products play an appreciable part in determining the period of maximum numbers, the rate of decline, and so on, of *Paramoecium* in the "hay-infusions."

AN INTERESTING MARINE HELIOZOON.—Some years ago, Sassaki described a large Heliozoon, *Gymnosphaera albida*, which occurred in the salt water aquarium of the Zoological Institute at Munich. It was supposed to have been transported from Rovigno. Maurice Caullery has been fortunate enough to rediscover *Gymnosphaera* on seaweed at Banyuls, and he adds some notes to Sassaki's description. It is a large Protozöon, easily visible to the unaided eye; it has long pseudopodia which sometimes anastomose; and it may have as many as twenty or thirty nuclei. In some cases it armours itself with numerous borrowed spicules of sponge and Holothurian.

LUMINESCENCE OF FIRE-FLIES.—Notwithstanding numerous investigations there seems to be still a great deal to be discovered in connection with the luminescence of fire-flies. F. A. McDermott and C. G. Crane have been recently studying some of the American Lampyrids. They find practical identity in the structure of the light-producing organs in these beetles, which are popularly called fire-flies. The organ has two layers, an inner one, white and opaque, which seems to serve as a reflector, and perhaps protects the insect from its own brightness, and an outer one, yellowish and translucent, which is the seat of the actual photogenic process. Physiological work led long ago to the conclusion that the photogenic process was of the nature of an oxidation, and this is corroborated by the study of the structure, e.g., by the demonstration of the innumerable tracheae which penetrate the organ.

RHYTHMS OF ACTIVITY AMONG TERMITES.—It is probable that there is a rhythmic character in animal activities to a greater extent than we as yet realise. Internal rhythms have been established in the course of ages in adaptation to external periodicities. But it does not, of course, follow that there is greater activity during the day. In a termites' nest, for instance, Andrews and Middleton have shown that there is about five times as much a-doing, as expressed by the traffic in the arcades, in the greatest bustle of night work as in the greatest ebb of noon. With great patience they counted the comings in and goings out. "In one case the number of termites going into the nest each hour varied from 1,702 between 1 and 2 p.m. to 8,100 between 2 and 3 a.m., while in the same case the numbers going out of the nest were 1,194 between 12 and 1 noon, and 6,820 between 1 and 2 a.m." The curves show that the termites work at all hours of day and night. Yet there are distinct rhythms in the activities of the entire community.

DISSEMINATION OF DISEASE BY HOUSE-FLIES.—The part that is played by flies in disseminating tropical diseases is well known, and our house-fly is a typhoid distributor. In regard to another common fly, the Biting Fly (*Stomoxys calcitrans*), it has been recently proved by Prof. A. Schuberg and Dr. Ph. Kuhn that if it is itself artificially infected with deadly Trypanosomes and Spirochaets, it can transfer these to higher animals.

SYMBIOTIC MICRO-ORGANISMS IN A CATERPILLAR.—In many animals there are minute inmates of the food-canal which have a useful action on the food. There are, for instance, some beautiful Infusorians which seem to be always present in the horse's intestine, helping in the breaking down of the hay and other food-stuffs. Some other animals are known to have a friendly contingent of intestinal bacteria. P. Portier has been working lately at the interesting caterpillar of *Nonagria typhae*, which feeds inside the stem of bulrushes. The digestive area is very restricted, and no ferment able to digest cellulose could be found. But there was great abundance of minute "pseudo-bacteria", probably small moulds, which work at the vegetable tissue, breaking it down. They pass through the wall of the intestine and are engulfed by the caterpillar's amoeboid blood corpuscles. The case requiries further investigation, but it looks like a genuine partnership, as if the "pseudo-bacteria" were middle-men between the animal and its food.

MOUNTING MINUTE ARTHROPODS. In spite of many recipes it is often difficult to make a satisfactory business of mounting minute Arthropods, such as small Diptera, Hemiptera, and Acarines. Maurice Langeron recommends very strongly the following method. He kills the specimens in hot alcohol, and after a few minutes transfers them to "chloralphenol," either in a large drop on a slide or in a little tube. This secures clearing and dehydration, and the specimens can be transferred directly to balsam dissolved in xylol. The fluid that works so well is Amann's chloralphenol. It may be prepared by mixing two parts of hydrate of chloral with one part of phenol, or by mixing equal parts of para-monochlorophenol and hydrate of chloral. The mixtures are liquefied at a gentle heat.

INCUBATION OF CYCLAS EMBRYOS.—It is well-known that these develop in the shelter of the inner gill-plate. The incubatory sacs have been recently studied in detail by Poyarkoff, who brings out the interesting point that they are in the main due to leucocytes. In other words, they arise by a process analogous to inflammation and the gill-lamella requires some patching afterwards, especially as regards its ectodermic epithelium.

QUERIES.

44. COLOURS OF THE SPECTRUM.—Can the green part of a spectrum be divided into yellow and blue? If so, how is it that the prism does not cause the yellow to fall within the yellow limits, and the blue within the blue limits, leaving the green position blank? If not, can every colour of a definite wave length be called a "Primary colour"?

H. T.

45. HEAT AND A VACUUM.—If heat can travel over a vacuum, how is it that a vacuum flask prevents a liquid from cooling?

H. T.

46. GLOBE LIGHTNING. I stated recently in conversation as a positive fact the existence of the phenomenon called "Globe Lightning," and described as a luminous ball which moves slowly and finally explodes with violence. The assertion was warranted by text-books of Meteorology, published not very long ago, but in the new edition of the "Encyclopaedia Britannica" I can find no reference to the subject.

Can you or any of your readers kindly inform me whether the phenomenon is now discredited and must take its place, with "the all-dreaded thunder-stone," among the myths of popular science? A. D. W.

REVIEWS.

BOTANY.

An Introduction to Vegetable Physiology. By J. REYNOLDS GREEN. 470 pages. 182 illustrations. 9-in. × 5¾-in.

(J. & A. Churchill. Price 10/6 net.)

Professor Reynolds Green's book on Physiology first appeared some ten years ago, and the third edition which has now been brought out has been altered considerably in the light of the experience gained in the interval, while the progress of science has rendered it necessary to re-write certain sections. The chapter on the differentiation of plant body has been expanded and, generally speaking, the author has set himself throughout to combat an idea which has arisen during the last few years that many alterations may go on in protoplasm "without involving any interchange with its substance."

CHEMISTRY.

Science and the Criminal.—By C. AINSWORTH MITCHELL. 240 pages. Illustrated. 7½-in. × 5-in.

(Sir Isaac Pitman & Sons. Price 6/- net.)

Readers of "KNOWLEDGE" have long been familiar with Mr. Ainsworth Mitchell's writing, and know that he is an expert on the subjects of inks and the age of handwriting. They will therefore be prepared to find that Mr. Mitchell has produced a very interesting and readable volume, not only in the directions indicated, but on the whole question of the relationship of science to the criminal.

In his introduction he cites a case where the whole of the chemical and medical evidence in connection with a poisoning trial was, on the advice of the judge, submitted to an independent scientific authority, with the result that six reasons were given pointing to the guilt of the accused, while eight were in the opposite direction. Mr. Mitchell claims that there is abundant justification for the plea that the poor prisoner should have the same advantages as regards scientific assistance as he now possesses in legal matters, and thus be placed on an equality with the wealthy prisoner. He further adds that it ought not to be a difficult matter to draw up a list of men of recognised standing in chemistry and medicine who would be willing to serve in this capacity when selected by the judge in a trial.

The first part of the book deals with methods of detection, capture and identification, and shows how science makes it increasingly difficult for the guilty to escape. Interesting details are given concerning trials in which scientific evidence has proved of importance, and a chapter deals with identification of human blood and human hair, which will prove of interest to the biologist. The book, however, as a whole, cannot fail to be attractive both to the scientific and to the general reader.

The Mechanism of Life.—By DR. STÉPHANE LEDUC. 172 pages. 64 illustrations. 9-in. × 6-in.

(Rebman Limited. Price 6/- net.)

We have already reviewed Professor Leduc's "Théorie Physico-Chimique de la Vie et Générations Spontanées," of which the present volume is an English Translation made by Mr. Deane Butcher, and revised and corrected, as well as in many places re-written, by the author himself. Mr. Deane Butcher has from the beginning taken the very greatest interest in Osmotic growths, which he has experimented with himself, and of them he says there is no more wonderful and illuminating spectacle. "A crude lump of brute inanimate matter germinating before our eyes, putting forth bud and stem and root and branch and leaf and fruit, with no stimulus from germ or seed, without even the presence of organic matter. For these mineral growths are not mere crystallizations, as many suppose; they increase by intussusception and not by accretion. They exhibit the phenomena of circulation and respiration, and a crude sort of reproduction by budding; they have a period of vigorous youthful growth, of old age, of death, and of decay." We congratulate Mr. Deane Butcher on his successful attempt to put the question before the British scientific public.

ENTOMOLOGY.

The Lore of the Honey Bee.—By TICKNER EDWARDS. 72 pages. 1 illustration. 7-in. × 4¼-in.

(Methuen & Company. Price 1/- net.)

To those who are interested in Natural History generally, or in Bees in particular, this little volume will prove most attractive. Although it contains much solid information it is yet written in a way that encourages one to read on, and it is historical as well as biological and apicultural.

Our Insect Friends and Foes.—By F. MARTIN DUNCAN. 296 pages. 16 plates. 7¾-in. × 5-in.

(Methuen & Company. Price 6/-.)

The facts of natural history never become dull, and though writer after writer brings them before us and even chooses the same themes, they never become tiring. For each naturalist puts them before us in his own way, dwelling on something which has not been emphasised before, adding sometimes to the store of knowledge and, may be, putting a new interpretation upon old and familiar observations. Mr. Martin Duncan is well known to many as a lecturer who puts before others the things which interest him in a quiet but effective and convincing way. In dealing with the subject of insects (in connection with which he has done much work), whether it be the useful burying bettles, mimicking butterflies, the forms which are of value in commerce, or dangerous by transmitting diseases, he is always lucid, accurate and entertaining.

GEOLOGY.

Geology for Engineers.—By LIEUT.-COL. R. F. SORSBIE, R.E. 423 pages. 94 illustrations. 8-in. × 5¼-in.

(Charles Griffin & Co. Price 10/6 net.)

This is an ill-balanced book. The first part, dealing with theoretical geology, is a thorough and painstaking compilation from authorities, many of which, as can be seen from the list of works consulted, are antiquated and now only of historical value. Consequently, this part contains many curious slips which would have been avoided had the author kept his knowledge of the science up-to-date. The second part treats of the practical application of geology to various engineering problems, such as water supply, building materials, roads, canals, rivers, and coast-erosion. In this the author is evidently at home, and has produced a practical manual of the utmost value to engineers, who have too often to regret their small amount of geological training. This part is indeed so good that it is a matter for regret it was not expanded so as to fill the entire volume. The need for which the first part was written could have been met by a reference to modern elementary text-books, or by a recommendation to the student-reader to take a class in elementary geology. Misprints are commendably few, although we read "rainful" for "rainfall" on page 240. A full and accurate index is provided.

G. W. T.

The Student's Lyell.—By E. JOHN W. JUDD, F.R.S. 645 pages. 736 illustrations. 8-in. × 5¼-in.

(John Murray. Price 7/6 net.)

We welcome the appearance of the second edition of "The Student's Lyell" edited by Professor Judd, which the latter has corrected and endeavoured to bring up-to-date. In Professor Judd's words: "Now that the doctrine of Evolution—as applying alike to the Inorganic and the Organic world—is universally accepted, the writings of Lyell, who was truly 'the Forerunner of Darwin,' acquire a new interest and are invested with a permanent value. The 'Origin of Species' has been justly asserted by Huxley to be 'the logical sequence to the "Principles of Geology"': it has therefore seemed fitting to prefix to a new edition of the present volume a history of the events which led up to the production of Lyell's epoch-making work."

The Geology of Building Stones.—By J. ALLEN HOWE, B.Sc., F.G.S. 455 pages. 46 illustrations. 7½-in. × 5 in.

(Edward Arnold. Price 7/6 net.)

This is the fourth volume of Arnold's Geological Series, and, like the preceding ones, deals with a particular aspect of economic geology, the growing importance of which is urged in the breezy introductory chapter to this work. A brief survey of the rock-forming minerals is first given. An account of igneous rocks, sandstones, grits, limestones and slates follows, in which, while the purely scientific side is not forgotten, emphasis is placed on the various practical aspects appealing to the architect and engineer. Notes on the distribution of the various types are given, and, naturally, most space is allotted to rocks occurring in the British Isles. Much useful information, hitherto hard to get, is contained in the chapter on the decay of building stones. The book closes with an excellent section on the testing of building stones, giving a resumé of all known methods, and estimating their comparative values. This is a most valuable part of the book, for, as the author says, architects are deterred, by the fear of risk, from using many good stones with which they are unfamiliar, because no reliable tests have been made of these materials. Some appendices contain lists of quarries, and a bibliography. A very full index is given. The book is illustrated with several good plates and informative maps, and will be invaluable to the architect or engineer who cares to apply its scientific principles to practice.

G. W. T.

MATHEMATICS.

A New Trigonometry for Schools and Colleges.—By the Rev. J. B. LOCK, M.A., and J. M. CHILD, B.A., B.Sc. 488 pages. 180 illustrations. 8-in. × 5½-in.

(Macmillan & Co. Price 6/-.)

In opening a book bearing the names of two experienced authors, we expected to find much that was sensible and practically useful. In this we were not disappointed; but a surprise was in store for us in the arrangement of the subject matter and also in some of the matter itself. This is a very "live" book, and a student of fair ability will probably acquire from it a sound working knowledge of Trigonometry up to and including de Moivre and Infinite Series and Products with very little waste of time. In particular we may call attention to the admirable diagrams, the descriptions of instruments, the model solutions of triangles with the aid of logarithms, the proofs and figures for general formulae, the treatment of interpolation, and errors of observation. In the preface, attention is drawn to the fulness of the answers, in which hints for solutions of the harder questions are given, as there is no intention of issuing [illegible]. One of these hints is "Use Ptolemy's Theorem." Ptole[illegible] not in the index, but we ran him to ground on page 38[illegible] familiar with his haunts. Little omissions of this kin[illegible] appear in a second edition. We cordially commend the [illegible] the attention of all teachers of mathematics.

MICROSCOPY.

Practical Photo-micrography.—By J. E. B[illegible]. 322 pages. 10 plates and 79 figures. 8¾-in. × 5[illegible]-in.

(Edward Arnold. Price 15/- net.)

The usefulness of the microscope and the advantages of photography being so great and so well recognised, it follows that photo-micrography must be equally important. The thanks, therefore, of all those who are about to take up the work are due to Mr. Barnard for affording them an opportunity of obtaining an insight into the subject, before beginning operations, while those who have had to gain their experience for themselves cannot fail to find some points of interest in "Practical Photo-micrography." The book fulfils the promise of its title: for all the information is given clearly, and in such a way that the directions and advice can easily be followed. The microscope is briefly considered, then two chapters are given up to the optical equipment necessary, while an account of sources of illumination, and descriptions of the various photo-micrographic cameras are followed by hints as to the use and manipulation of a microscope, and after the more purely photographic part of the subject has been considered, some very useful appendices are added. In his introduction, Mr. Barnard most properly advises a microscopist who is anxious to start the work, to acquaint himself thoroughly with the processes of ordinary photography; while, similarly, he urges the photographer to master the general technicalities of ordinary microscopic work. The book under consideration should always be at the elbow of every worker with the microscope.

TIDES.

Moxly's Theory of the Tides.—By J. F. RUTHVEN. 103 pages. 18 illustrations. 9½-in. × 6-in.

(J. D. Potter. Price 2/-.)

Lieut. Ruthven worked with the late Rev. J. H. S. Moxly in perfecting the theory which the latter put forward with regard to the tides. The present book is a reprint of four chapters dealing with the subject, to which have been added several new ones and a number of quotations from Mr. Moxly's book which he did not live to rewrite. In the preface Lieut. Ruthven points out that in the theory there was an error due to accepting the assumption of the dynamical theorists that the only way that the tangential component of tidal force could work was by means of surface currents. Closer examination convinced Moxly and Ruthven that it, like the normal component, produced pressure.

TOPOGRAPHY.

The Evolution of Kingston-upon-Hull.—By T. SHEPPARD. 203 pages. 29 illustrations. 9-in. × 5¾-in.

(A. Brown & Sons. Price 3/6 net.)

At the request of the Museums and Records Committee of the Hull Corporation, Mr. Thomas Sheppard has elaborated a presidential address of his to the Hull Literary Club, and has shown by means of plans, dating from the sixth century to the present time, the way in which the city of Hull has gradually come into being. He describes no less than three hundred and ninety-seven plans, twenty-nine of which are reproduced to form illustrations. The book should prove most useful for reference to those interested in the history of Hull. The remarkable feature of a plan made in the time of Elizabeth, but evidently copied from one of much earlier date (probably the middle of the fourteenth century) is the large amount of space within the city walls which was devoted to gardens. They practically surround the buildings on all but one side.

THE BRITISH MUSEUM (NATURAL HISTORY).

THE tide of opinion against the erection of a new science museum between the Imperial College and the Natural History Museum at South Kensington, continues to gather strength. At present the plot of land bounded on the north by Imperial Institute Road, on the south by Cromwell Road, and lying between Queen's Gate and Exhibition Road, is occupied by the two great institutions just mentioned. At the back of the Natural History Museum is the Spirit Building, between it and the Imperial College are the temporary buildings of the Science Museum. The suggestion is that the Spirit Building, which cost £50,000, shall be pulled down, that the ground which it occupies and some on each side of it shall be taken away from the British Museum and form the site of a new science museum.

A glance at the plans issued with the Government white paper, numbered Cd. 5650, will show at once how each of the institutions will hamper the others. There will be absolutely no hope for the Imperial College to spread, the Science Museum will be in the same predicament and the Natural History Museum which long ago ought to have been enlarged will not only lose a part of the land definitely allocated to it, but even the space which is left, if the Government scheme does get carried out, will be encroached upon, because it is proposed to erect a new spirit building along the frontage to Queen's Gate making it for all practical purposes under ground, and bringing the roof four feet above the level of the pavement. The accommodation in the present building is bad enough, but why should it be proposed that those who work at the animals themselves, rather than their stuffed hides, bleached bones, and mummified remains should be condemned to carry on their researches in a subterranean excavation.

It is no wonder that the trustees of the British Museum and lovers of Natural History throughout the British Isles, though quite as anxious as other scientific people that the new museum should be erected, should wish that some other site might be found for it.

In the case of private individuals a bargain would have to be kept, and why should not the Government be expected to fulfil an arrangement definitely made. There are plenty of open spaces on the east side of Exhibition Road and, comparatively speaking, few houses. No doubt it would be some hardship for private individuals to have to part with their dwellings, but surely the development of scientific collections belonging to the nation is as important as the making of a railway by private persons, and it is necessary to look beforehand, not for twenty, but for many hundreds of years.

The original memorial to the President of the Board of Education with regard to the Science Museum was signed by over one hundred scientific men, mostly chemists, physicists and astronomers. Dr. Shipley, Master of Christ's College, Cambridge, has already sent in the names of nearly a thousand eminent men and women, who have signed a memorial expressing their emphatic opinion that nothing should be done which interferes with the development of the Natural History Museum or which limits the scope of the proposed science museum.

The Entomological Society, knowing that the Insect Department of the Natural History Museum greatly needs more space, has also passed a resolution of a similar character; the South London Natural History Society and the South-Eastern Union of Scientific Societies have done the same, as well as the Essex Field Club, and we have received the following resolution which has been still more recently passed at a special Council Meeting of the Selborne Society, which now numbers nearly three thousand members.

"That the Council of the Selborne Society learns with grave concern, the declared intention of the Government to alienate a part of the British Museum (Natural History) in order to form the site of a new museum, and respectfully urges upon the authorities that they should seek another site for the new institution, so that both museums may have room for their due expansion."

NOTICES.

THE NEW FAIRY FLY. As we go to press Mr. Fred Enock telegraphs to say that he has succeeded in breeding a female of *Mymar regalis*, the male of which he recently discovered, and describes and figures on pages 271 to 273 of the present number of "KNOWLEDGE."

X-RAY APPARATUS. The Admiralty has ordered from Messrs. Newton and Co., of 3, Fleet Street, London, ten sets of X-Ray apparatus for the new battleships for service afloat, making thirty complete installations that this firm has recently supplied to the Royal Navy.

INTEREST TABLES. We have received from Messrs. Charles and Edward Layton, Layton's Simple Interest Tables (price 5/- net), by Alexander S. Sellar, which deal with amounts ranging from £1 to £100,000 for intervals of one day up to three hundred and sixty-five days and for intervals of one month up to twelve months.

MICRO-CINEMATOGRAPHY.—Messrs. Pathe Freres have prepared, under the direction of Dr. J. Comandon, of Paris, a series of cinematograph films of microscopic objects for use by lecturers, scientific societies and in schools. At a recent demonstration arranged for "KNOWLEDGE" these films were seen to be of great interest, showing, as they do, the circulation of the blood, Brownian movements of the platelets in the plasma, phagocytosis by the white corpuscles or leucocytes, clearly illustrating the extrusion and retrocession of pseudopodia, and, most interesting of all, living trypanosomes and spirochaetes in the blood of infected animals. The phenomena of agglutination of the spirochaetes in the later stages of relapsing fever and haemolysis of red corpuscles were extremely well displayed.

For more popular purposes films were shown of the life-history of the swallow-tail butterfly, caterpillars feeding on wild carrot plants, their movements and the extrusion of their horn-like scent appendages, pupation, the emergence of the imago, the drying of the wings, and then the beginning of the active life of the perfect insect among the flowers. Another film showed the development of the Axolotyl within the egg, its emergence and, subsequently, its preying on tadpoles. Students who are not aroused to enthusiasm by such exhibitions must indeed be hard to please.

SUMMER FLOWER SHOW AT OLYMPIA.—The Flower Shows of the Royal Horticultural Society are famous throughout the world for their excellence and beauty, and they well deserve the popularity which they enjoy. The Society fosters, and by its Exhibitions nourishes, the love of plant life in the hearts of English people, and its direction is sought by an ever-growing body of people representing all classes of Society. The increase in the number of Fellows, and the crowds attending the Flower Shows, are putting a great strain on the Council and Officials, who are doing all that is possible to do to meet the demands of the times in horticulture. Therefore, friends of the Society welcomed the proposal that the Summer Show of this important year should be on a scale of magnificence and comfort hitherto wholly unprecedented in the Society's history, and the great Hall, "Olympia," was accordingly engaged for it. The dates fixed are July 4th, 5th and 6th. Many exhibits will, in themselves, be quite considerable gardens. Summer being at its height, the exhibits will largely comprise open-air trees and plants, rock-gardens and water-gardens.

On July 4th the Show will be open from 12 noon to 10 p.m.; on July 5th from 9 a.m. to 10 p.m.; and on the 6th from 9 a.m. to 6 p.m. In order that the public with narrow purses and little spare time may take advantage of the opportunity thus offered, the price of admission after 6 o'clock on the first two days is to be one shilling.

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, 1911.

THE TRUE STRUCTURE OF THE DIATOM VALVE.

By T. F. SMITH.

It is not within the scope of this article to enter into the biological details of Diatoms, the writer assuming, and rightly too, he thinks, that they are already known to the readers of "KNOWLEDGE." His purpose is rather to treat of them as test objects; of the part they have already played in the development of the achromatic microscope; of the part they still should play in opening up the road towards further advancement. He also wishes to state his own views of the structure of the valve, the nature of which has given rise to so many discordant opinions.

In Ehrenberg's monumental work, "Die Infusionsthierchen," published in 1838, diatoms are treated as animals, in opposition to almost all the authorities of that day. This can be of but little importance to us now, save in showing how a great mind can be led astray by the following up of preconceived opinions. Of greater interest, so far as diatoms are concerned, are the superb coloured drawings giving us a clear insight of the definition of the microscope then. He describes the various species, some as smooth, some as striated; yet, on carefully going over the corresponding striated forms, under the microscope, it will be found that they can all be resolved by an inch objective of ·30 N.A.

While upon the subject of comparative capacity, it may be of interest also to give an example from a slightly later date. One species described and figured by Ehrenberg as smooth is *Navicula* (now *Pleurosigma*) *hippocampus*. In 1841, a Mr. Harrison, of Hull, discovered longitudinal striae upon this form, and sent specimens to the Microscopical Society of London, for confirmation. After keeping them for six months they were returned to him with the intimation that the members could see nothing. A little later he also discovered transverse striae on the same diatom valve, but found them more difficult to exhibit. These can be easily resolved now by a half-inch objective of ·50 N.A.

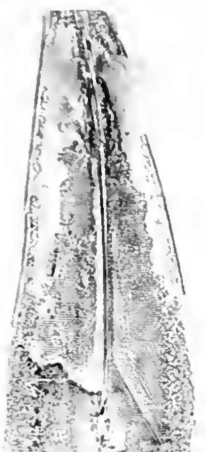


FIGURE 1.
Upper layer.

FIGURE 2.
Under layer.

Two layers of a valve of *Pleurosigma angulatum*. In each case entirely separated from the other and left sticking to the cover glass and to the slip respectively. Taken with a six millimetres objective, by Zeiss, ·95 N.A., and enlarged twice.

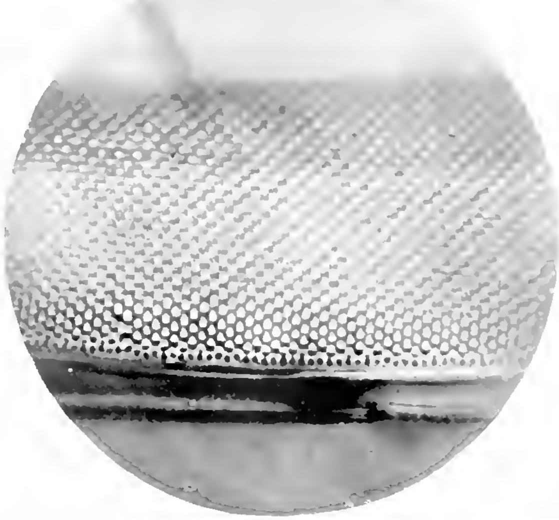


Figure 3. The outer side of *Pleurosigma formosum* when the valve is sound. × 1750.

When it was recognised that every increase of aperture in the objective revealed "markings" on forms deemed smooth before, there naturally arose from the students of diatoms a demand for more, and still more, light. It is customary with biologists to sneer at such as mere "diatom dotters," yet nearly all the optical improvements of the microscope have been due to their claims. Only by the consequent response of opticians could the science of bacteriology have become possible, which now plays so important a part in their (the biologists') own labours. From 1824 up to within the last twenty years there has been a regular progression of the powers of the objective, culminating in the apochromatic oil immersion. Unfortunately, at this point we seem to stick, though the cry is no less urgent for development.

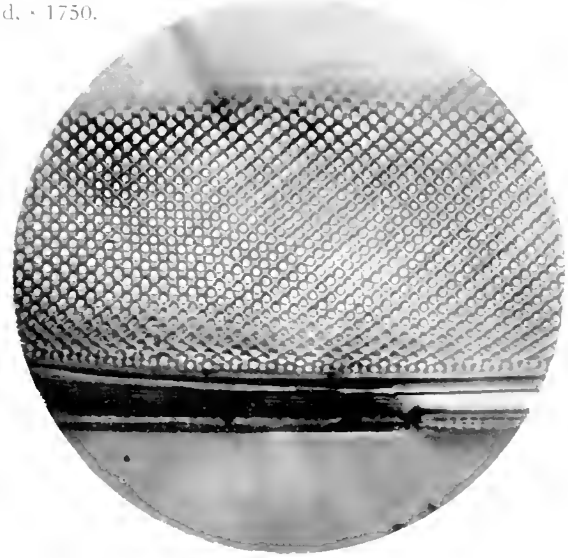


Figure 3A. The same valve as seen in Figure 3, showing the structure immediately below that seen in Figure 3. × 1750.

The right interpretation of the "markings" turned mostly upon whether they were raised "beads" upon the surface, or holes through the substance of the valve. In the larger discoid and other forms it was admitted that the so-called cellules were excavations. Even here, however, Mr. Slack, in 1873, maintained that the hexagonal framework enclosing the cellules was made up of rows of beads. To the imagination of Mr. Slack, indeed, diatom structure began, continued and ended in beads.

The writer also must confess to a former belief in "beads." In a slide of *P. formosum* mounted in balsam were some isolated ones, even under the widest aperture of an oil immersion. Now, except one possesses the lively imagination of the Irishman, who explained the making of a cannon by saying "that they took a big long hole and poured molten metal around it," isolated perforations are unthinkable. One can only explain the puzzle by assuming that the structure around them, mounted in a medium of the same refractive index, was consequently invisible.

From analogy, the two or three layers of structure in the finer valves were merely assumed. It could scarcely be otherwise before the advent of the oil immersion. Rylands, in an article in *The Quarterly Journal of Microscopical Science* for October 1859, on "the markings of Diatomaceae," says of *P. angulatum*: "Individual specimens of this species are far from uncommon in which the outer 'aërolated' layer is partially removed, leaving the inner layer entire. Isolated portions of the outer layer may be found upon the valve, but I have never seen them separated, the force which removes them being apparently only sufficient to break them up into single 'aërolations': the term in this case is unfortunate, for they are, in fact, hemispherical elevations."

Figures 1 and 2 prove that the valves of *P. angulatum* can separate entirely. It seems strange that to demonstrate this should be left to the present writer, nearly fifty years after the discovery of this form. The two pictures will well repay study with a single lens, magnifying some five or six times.

Figure 4. The inner side of *Pleurosigma formosum*. The ordinary appearance of a sound valve. × 1750.

when it will be seen how accurately the broken parts fit into each other. One layer was on the slip and the other tight against the cover glass.

He cannot claim to have been the first, then, to broach the subject of a second layer in the finer forms, yet he thinks he was the first to bring it within the borders of fact, by definition. The work presented here, except in the instances mentioned, was all done with the two millimetres apochromatic of Zeiss, of 1·40 N.A. Not that such an objective is necessary in order to see the structure figured, nor even to photograph the same. It can all be seen with an ordinary cheap oil immersion of 1·30. He has such a lens, of Swift and Son, costing only £5 5s., and it is astonishing to find how nearly it works up to the Zeiss, costing £20. This for the comfort of microscopists with only moderate means—by far the greater number. Every leading maker now produces a similar lens at about the same price.

The points desired to be driven home in the present article are that diatom structure consists of neither beads nor perforations, as commonly understood. The conventional presentment of the *Pleurosigma* every microscopist knows. The figures given here will differ from it in many particulars, as one would expect to follow from every increase of aperture in the micro-objective. A dry lens of any kind will always produce the same appearance from every unit of a particular species: the same can be said of an oil immersion when the valves are mounted in a medium, but when mounted dry, and an oil immersion used, it will be found that they

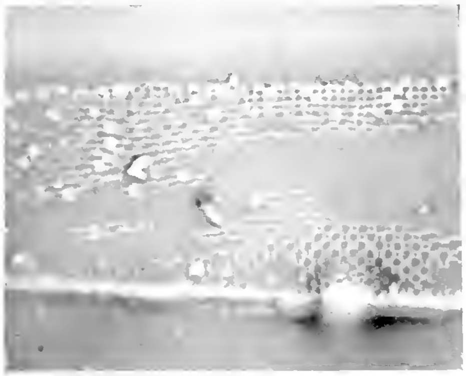


FIGURE 5. The outer side of *Pleurosigma formosum*, showing the structure torn and optically separated from that below, × 1750.

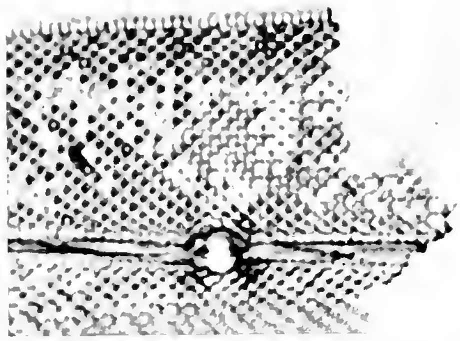


FIGURE 6. The same object as seen in Figure 5, taken with a dry six millimetres lens, by Zeiss; the upper structure is invisible owing to a too great depth of focus in the lens, × 720

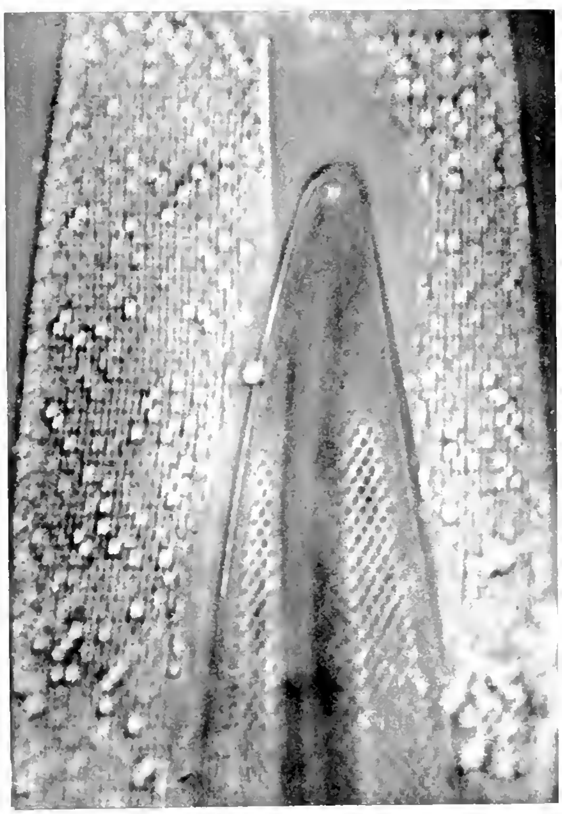


FIGURE 7. The writer's "running down" case, × 1750, and further enlarged to 2500.

differ both visually and in curve. Figures 3, 3*a* and 4, from two valves of *P. formosum*, will attest to this fact. Figure 3 shows the outer side of the valve, 3*a* the structure immediately underneath, and Figure 4 the inner side from another valve.

Now the difficulty attending upon the working of an oil immersion under these conditions, is that the object to be examined must be in optical contact with the cover glass. When against the slip, or even a little way off the cover, the lens is no longer at its fullest available aperture, indeed, it is but little better, if at all, than a dry glass. The same may be said when the object has more than one layer of structure, no matter how slightly they may be separated. There is the fatal film of air between to prevent that below being seen at its best. This is why nothing will be said here as to a third, intermediate, structure in the finer and thinner diatom valves. Analogy with the larger and thicker forms may seem to point in this direction, yet it has never been established by demonstration. Dr. Van Heurck asserts it in his more recent work, yet gives no figures as proofs.

It may be asked, why not examine the objects mounted in a medium? This, certainly, is by far the better way, when thick enough. On the other hand with very thin examples, upon removing one difficulty, one of another kind steps in, equally fatal. Though homogeneous, then, by lessening the angle of refraction, due to the medium, the depth of focus of the objective is increased, with the result that in such objects as a *Pleurosigma* valve, it pierces through all the layers, confusing the image of the whole. No increase of magnifying power will separate the layers, then, though one may know them to be there.

The real cause of failure may be explained in this way. Suppose a sheet of transparent paper with writing upon each leaf, differing, perhaps, in both character and subject. Clearly, if in close contact nothing could be read separate the leaves to a proper distance, when both writing and meaning become plain. The *Pleurosigma* valve, mounted in a medium, is the sheet of transparent paper with the leaves together; mounted dry, the same sheet with the leaves well separated. Figures 5 and 6 will illustrate this point, though taken with different lenses. Figure 5 exhibits certain structure, discovered by the writer, upon the outer side of a valve, *P. formosum*, mounted dry, as seen under an oil immersion. Figure 6 is from the same valve, and the same point, taken with Zeiss' six millimetres aperture of ·95 N.A., a dry lens. The structure seen in the first print is here totally invisible as a recognisable image, though there are certain indications in some scattered dots, of which no one could discover the reason if taken by themselves, without the key. In both instances the magnification is the same.

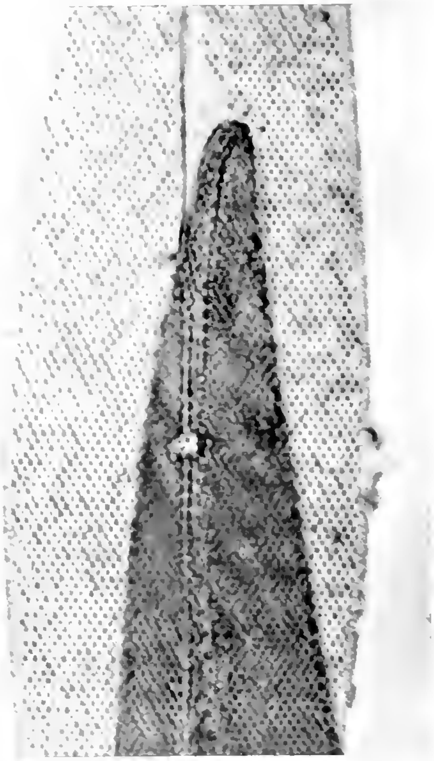


FIGURE 8. The same specimen as seen in Figure 7, × 1720, taken with the same lens and under the same conditions as Figure 6.

Figures 7 and 8 are further examples illustrating the same point. The subject is what the writer has called his "running down case." One minute diatom valve had collided with another and ripped up the deck, if one may be allowed to use such a term. In Figure 7 the torn structure at the sides is seen hanging in strips: so shallow is the focus of the oil immersion with which this was taken, that there are no indications of structure underneath, though of course in the microscope the fine adjustment would give it. It will be of interest to note here that the two valves present opposite sides to the eye. Figure 8 of the same incident is taken with the same dry lens as No. 6, but tells no story: not due to insufficient resolving power, as we shall see in another print, only that the objective has too deep a focus to separate the layers, or even the valves.

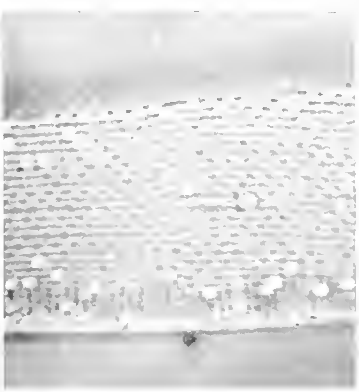


FIGURE 9. The outer side of *Pleurosigma formosum*, showing "chains" of fibrils giving rise to the appearances seen in Figure 3. × 1750.

We are in this position, then: we cannot work with an oil immersion through successive layers of structure when there is air between—that is, not effectively—or separate them optically in a medium when the focus is too deep. This happens with all the species of diatoms given as examples here, except the last, and there seems to be only one other way.

We must examine spread slides in a dry mount, and note the difference in appearance and curves between the valves; study them separately then, remembering that, under an oil immersion, only those tight against the cover will give the distinctive image. Referring back to Figures 3 and 4, it will be seen that in Figure 3 only along the middle is it in sharp focus, shelving down on the upper side into shadow. Figure 6, however, shows the distinctive curve of the outside of the valve still better (though not the distinctive structure): on that side it is V-shaped in section. In Figure 4 of the same diatom, the inside, it is found to be flat across, except in the middle, where that and the median line are seen by the shadow to be below the general level. The same difference of curve between the two sides of the valve occurs also in *P. angulatum*, and seems always to accompany the same distinctive appearance.

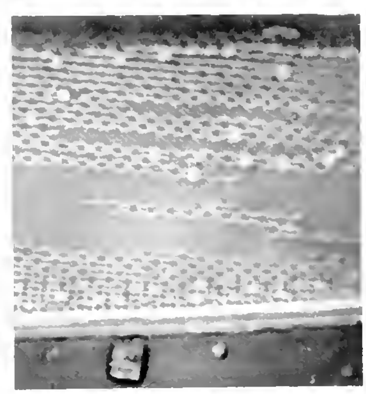


FIGURE 10. A similar specimen to that seen in Figure 9.

These details may seem trivial, yet are necessary in clearing the way towards getting at the key to the real structure. With regard to the outer side of *P. formosum*, Figure 9 seems to supply the key to Figure 3. The structure here is fairly sound, but in some way has been acted upon to leave it bare. It appears to consist of a series of chains, as it were, formed of short bars or fibrils of silex, arranged lengthways on the valve. They run in pairs, parallel, each pair having larger and narrower interspaces between them in regular succession, and so placed that the larger interspaces are set obliquely to the corresponding interspaces between the other pairs, both above and below. Figure 10, from another valve, exhibits the same structure torn, and still more plainly because the "chains" are more isolated.

Now, in explanation of the figures, his theory is this, that what we see in the *Pleurosigma* valve, when sound, is not the structure at all, but simply a same valve mounted in a medium. The valve shown in Figure 11 has been ruptured, leaving in some parts the outer layer well separated from the under, in others normal. We see, then, at the lower part of the picture the characteristic structure; in the middle it is no longer visible, while at the top it re-appears, though not so well indicated. Figures 12 and 13 are taken by the oil immersion from the same spot, the first with the glass slightly stopped down, the second with the widest available aperture; leaving the image by itself, in the air as it were.

Now for all practical purposes Figure 12 is the

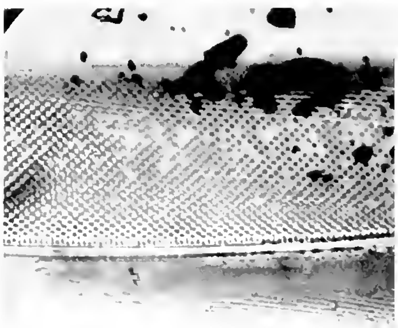


Figure 11. The outer torn structure of another valve taken with the same lens as Figures 6 and 8.

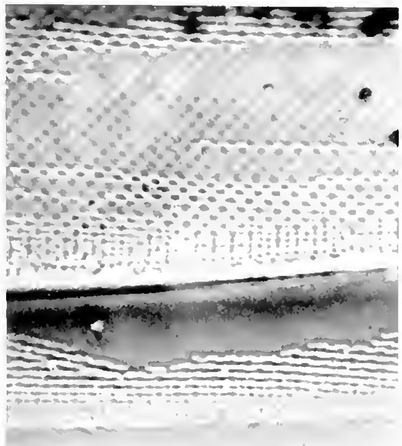


Figure 12. The same specimen as seen in Figure 11, taken with a two millimetres objective of Zeiss, slightly stopped down. × 1750.

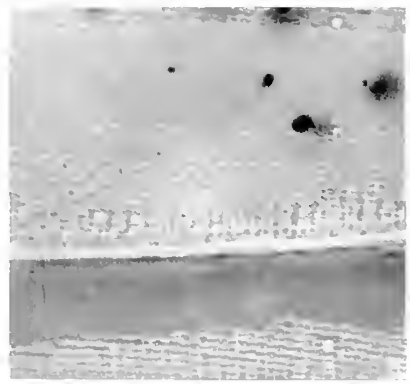


Figure 13. The same specimen as seen in Figures 11 and 12, taken with the fullest aperture available.

collection of focal images thrown from the other layer upon the one nearest the eye, just as a picture is thrown from the optical lantern upon a canvas screen. The fibrils or grating is the real structure, of which the texture is concealed, even as that of the canvas screen is by the picture. We shall see more of this further on.

The next three figures, taken from the outside of another valve, are given more to illustrate the value of aperture than to elucidate structure. Figure 11, photographed by the same dry lens as Nos. 6 and 8, shows that it was not from want of aperture it failed to exhibit the right structure. To repeat, it is simply a matter of possessing too deep a focus to separate the component layers, though a most superb glass. No dry lens could do it when at the normal distance apart, nor even an oil immersion, with the most effective picture, as affording opportunity for comparing the relationship of the two layers; yet it is always well not to give the enemy cause to blaspheme. When these researches began, the results were put down by some to moisture in the dry mount, to oblique light, to interference phenomena; to every cause, in fact, except to a revelation of new structure. Speaking generally, perhaps the most irritating of all criticisms are those which, if they are valid, will not only deprive one of all claims to be looked upon as an accurate observer, but also of common sense in conducting his researches. Naturally, in very self-defence, one was put upon his metal, and, by widening the aperture to the fullest available, produced photographs of which this last print and others are examples.

(To be continued.)

Here the outer structure is only seen where it has been left against a cover glass more than the normal distance from the under layer.

THE FACE OF THE SKY FOR AUGUST.

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

THE SUN.—On the 1st the Sun rises at 4.24 and sets at 7.48; on the 31st he rises at 5.11 and sets at 6.51. Sun spots are not very numerous; small groups are occasionally visible on the solar disc.

The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre of Disc N. of Sun's Equator.	Heliographic Longitude of Centre of Disc
Aug. 4	11° 52' E	6° 2'	335° 40'
„ 9	13° 40' E	6° 21'	269° 42'
„ 14	15° 34' E	6° 37'	203° 30'
„ 19	17° 16' E	6° 51'	137° 31'
„ 24	18° 49' E	7° 1'	71° 20'
„ 29	20° 16' E	7° 9'	5° 23'
Sept 3	21° 34' E	7° 14'	299° 26'
„ 8	22° 44' E	7° 15'	233° 18'

THE MOON:—

Date.	Phases.	H. M.
Aug 3	First Quarter	11 20 p.m.
„ 10	Full Moon	2 55 a.m.
„ 17	Last Quarter	9 11 p.m.
„ 24	● New Moon	4 14 a.m.
„ 31 ...	First Quarter	4 21 p.m.
Sept. 8	Full Moon ...	3 57 p.m.
Aug. 5	Apogee ...	2 24 p.m.
„ 21	Perigee ...	10 30 a.m.
Sept. 2	Apogee	7 18 a.m.

OCCULTATIONS.—The following occultations of the brighter stars are visible from Greenwich:—

Date.	Star's Name	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. point. E	Reappearance. Mean Time.	Reappearance. Angle from N. point. E.
Aug. 18	δ Tauri	5·0	p.m. 11.11	95°	p.m. 11.57	235°
„ 22	λ Cancri	5·0	a.m. 2.13	95	a.m. 3.3	277°
Sept. 1	43 Ophiuchi	5·4	p.m. 7.58	182	p.m. 8.4	101°

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
July 31	10 14	N 11° 10'
Aug 10	10 50	5° 8'
„ 20	11 27	N 0° 15'
„ 30	11 30	S 1° 28'
Sept. 9	11 3	N 2° 14'

Mercury is an evening star setting N. of W. at 8.40 p.m. on the 1st, and nearly due W. on the 20th at 7.40 p.m. The planet is at greatest Easterly elongation of 27° 25' on the 13th, when he sets at 8.7 p.m. The elongation is not a favourable one on account of the low declination of the planet.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
July 31	11 20	N 2° 18'
Aug. 10	11 36	S 1° 32'
„ 20	11 48	4° 34'
„ 30	11 45	6° 14'
Sept. 9	11 28	S 5° 53'

Venus continues to be a very conspicuous object in the evening sky, looking S. of W. immediately after sunset. The planet is at "greatest brilliancy" on August 10th, when 0·26 of the disc is illuminated and the apparent diameter is 38".

As seen in the telescope the planet appears crescent, like the new moon, three or four days old, and on account of the large apparent diameter, the crescent form is easy to see, even in small telescopes magnifying about ten times.

Venus is a severe test for most telescopes, but observations are somewhat easier if they are made whilst it is still broad daylight. On the 1st, the planet is on the meridian at 2.45 p.m. and sets at 8.55 p.m.; on the 20th the planet souths at 1.57 p.m., and sets at 7.38 p.m. During the past month, many persons have been able to see Venus as early as 3 p.m. with the naked eye, but there is little difficulty in picking up the planet half-an-hour before sunset. Towards the end of the month the planet becomes unobservable, as she sets too soon after the Sun.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
July 31	2 34	N 12° 53'
Aug. 10 ...	2 58	14° 44'
„ 20	3 20	16° 20'
„ 30 ...	3 41	17° 42'
Sept 9	4 0	N 18° 40'

Mars rises in the E.N.E. at 10.45 p.m. on the 1st, and at 9.30 p.m on the 31st. At the beginning of the month the planet is about 1° South of σ Arietis, and at the end of the month about 5° South of the Pleiades. The apparent diameter of the disc is only 10", and the planet is not very bright or well suited for observation in small telescopes.

The summer solstice of the Southern hemisphere of the planet occurs on August 1st, and since it is the South polar cap that is visible from the earth, we may expect that the snow cap will not be very conspicuous when the planet is in a favourable position for observation at the opposition in November.

The planet is in quadrature on the 9th.

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
July 31	14 10	S 12° 20'
Aug. 10	14 16	12° 50'
„ 20	14 24	13° 15'
„ 30	14 29	13° 44'
Sept. 9	14 35	S 14° 15'

Jupiter is getting more to the West, but still remains a conspicuous object in the evening sky, and is available for observation for a few hours after sunset, as he sets W.S.W. at 9.28 p.m. on the 20th. On account of increased distance from the earth, the apparent diameter is diminishing, the equatorial diameter on the 20th being 34", whilst the polar diameter is 2"·2 smaller.

The Moon appears near the planet on the evenings of the 1st and 29th.

Only few satellite phenomena are observable on account of Jupiter appearing in a bright part of the sky: these are as follows:—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.
Aug.				Aug.				Aug.			
2	I	Sh. E.	9 14	9	I	Sh. I.	57	11	III	Sh. I.	[illegible]
3	II.	Ec. R.	[illegible]	10	I.	Ec. R.	15	18	I	Sh. I.	[illegible]

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse and "Ec. R." its reappearance.

The configurations of the Satellites as seen in an inverting telescope, and observing at 8.30 p.m. are as follows:—

Day.	West.	East.	Day.	West.	East.
1	4	3 ●1	17		423 ●1
2	41	23	18	2413	
3	4 ⊙	13	19	432	1
4	42		20	431	2
5	43	1 ●2	21	432	1
6	431	2	22	421	3
7	423	1	23	4	123
8	421	3	24	41	23
9	⊙	423	25	241	3
10		134	26	32	
11	21	4	27	31	24
12	3	14 ●2	28	32	14
13	31	24	29	21	34
14		14	30		1 34
15	21	34	31	1	234
16		1243			

The circle ( ) represents Jupiter; ⊙ signifies that the Satellite is on the disc; ● signifies that the Satellite is behind the disc or in the shadow. The numbers are the numbers of the Satellites.

SATURN:—

Date.	Right Ascension.	Declination.
	h. m.	
Aug. 1	3 10	N. 15° 21'
„ 16	3 13	15° 28'
Sept. 1	3 14	N. 15° 29'

Saturn rises on the 1st at 11.5 p.m. and on the 31st at 9.15 p.m.; each week he becomes more favourably placed for observation. Towards the end of the month the planet may be observed looking North of East at 10 p.m. a few degrees above the horizon; he appears as a bright star shining with a leaden hue. The telescopic view of the planet is extremely fine on account of the ring encircling the planet, and a good view may be obtained in small telescopes of about two inches aperture, if the object glass is good and the instrument is held steady. A magnifying power of about fifty is sufficient to show the ring, but a greater magnification is required to see the belts on the disc, as they are not so conspicuous as those on Jupiter. The ring appears well open, the plane of the ring being inclined to our line of vision at an angle of 22°; the southern surface is visible. The diameters of the outer major and minor axes of the outer ring are 43" and 16" respectively, whilst the polar diameter of the ball is 17". The planet is stationary on September 3rd. [illegible] its motion is retrograde or westerly. The plan[illegible] time on the 13th. The Moon appears near th[illegible] the morning of the 17th.

URANUS:—

Date.	Right Ascension.	
	h. m. s.	
Aug. 1	10 50 21	S. 2[illegible]
Sept. 1	10 51 55	S. 21

Uranus though somewhat low down in the [illegible] placed for observation during the early evening, the [illegible] being due South on the 15th at 10.21 p.m. He is situated about 2° S.E. of σ Capricorni. Uranus is just perceptible to the naked eye, but can easily be seen with a pair of opera glasses. The diameter of the disc is nearly 4", and the colour is greenish. As seen in large telescopes the planet appears more luminous at the centre of the disc than at the limb somewhat similar to Jupiter and Saturn. The planet has a fine spectrum containing broad dark bands.

NEPTUNE:

Date.	Right Ascension.	Declination.
	h. m. s.	
Aug. 1	7 34 23	N. 21° 6' 2"
Sept. 1	7 38 40	N. 20° 56' 10"

Neptune does not rise till 3 a.m. on the 1st August and 1 a.m. on September 1st; thus for all practical purposes the planet is unobservable.

METEORS:

Date.	Radiant. R.A.	Radiant. Dec.	
	h. m.		
Aug. 10-12	3 0	N. 57°	Great *Perseid* shower; radiant moving E.N.E. about 1° per day.
„ 15-25	19 24	N. 60°	σ Draconids; bright slow meteors.

The *Perseid* shower lasts nearly all the month, the earth encountering the densest portion of the swarm about the 11th; the radiant then being near η Persei. The meteors are quick with yellowish streaks.

Minima of Algol occur on the 7th at 11.40 p.m., the 10th at 8.30 p.m., and the 30th at 10.20 p.m. The period is $2^d\ 20^h\ 49^m$., from which data other minima may be calculated.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—Polaris, mags 2·1, 9·5; separation 18"·6. The visibility of the small star is used as a test for a good 2-inch object glass.

σ Scorpii, R.A. $16^h\ 15^m$; S. 25° 23'; mags. 3·0, 7·6; separation 20"·6.

ζ Sagittae, R.A. $19^h\ 45^m$; N. 18° 54'; mags. 5·7, 8·8; separation 9"·0; colours, white and blue.

α^1, α^2 Capricorni, R.A. $20^h\ 13^m$; S. 12° 50'; mags. α^1 4·5 α^2 3·8; naked eye double; separation 373"; very easy with opera glasses.

γ Delphini, R.A. $20^h\ 42^m$; N. 15° 46'; mags. 4·1, 5·0; separation 10"·8; very pretty double for small telescopes; colours, orange and light green.

NEBULA, &c.—Dumb Bell nebula in Vulpecula, nearly 4° due North of γ Sagittae. Rather faint object in a 3-inch telescope.

(M8) Cluster in Sagittarius; large luminous field of small stars; fine object in a pair of field glasses. About a degree E. of the star 4 Sagittarii.

NOTES OF A NATURALIST IN THE MEDITERRANEAN.

By G. B. HONY.

I PROPOSE in this article to give a brief outline of bird life noticed while on a four-months' cruise round the Mediterranean: particular attention being given to those birds which visit England as summer migrants. Little—far too little—is known of these birds in their winter haunts, and as I find that the dates at which I saw some of them in various places differ very considerably from those given in most books on the subject, they may be of interest.

I first saw swallows at Alexandria on March 5th. (J. E. Harting gives March 25th as the date of its re-appearance in Egypt, "Our Summer Migrants" page 179). At Cyprus they were common on March 14th. They arrived at Platea (S. Greece) in large numbers on April 1st, and when I finally left, a fortnight later, they were still there, but I saw no signs of nesting. One came on board on April 4th, when going up the Adriatic (42° 21′ N., 16° 30′ E., wind W.N.W.). At Malta they seemed common in the middle of the island on April 27th, though none appeared by Valetta. One came on board on May 1st (37° 18′ N., 10° 55′ E., wind N.W.) when going to Gibraltar. At the latter place they were common on May 6th.

Swifts were common at Cyprus on March 14th, and at Gibraltar on May 5th.

I saw a few House Martins at Venice on April 4th. One joined us when four miles from Malta, on April 19th, and there were quantities of them with the swallows at Malta, on April 27th. I did not actually see one at Gibraltar, but I expect there must have been some at the beginning of May.

There were some Sand Martins at Gibraltar on January 21st, this being the only time I saw any.

Hoopoes were common in Egypt at the beginning of March, at Cyprus on March 14th, and I saw one at Platea on March 23rd.

There was one pair of Ringed Plovers at Platea for about a week at the end of March, then they seemed to go.

Turtle Doves were numerous at Alexandria on March 3rd, and some of them seemed to be paired off by that date. One came on board on April 16th (36° 58′ N., 17° 50′ E., wind N.), when going from Platea to Malta. A pair boarded us on April 23rd, when about eight miles S.W. of Malta (wind N.E. by E.) One joined us on May 1st (37° 18′ N., 10° 55′ E.) when going from Malta to Gibraltar (wind N.W.).

Blackcaps and Whitethroats seemed common at Gibraltar on January 21st. At Malta the place was crowded with these and Wood Warblers, on April 25th. Blackcaps were again at Gibraltar on May 6th.

Pied Flycatchers and the allied species *Muscicapa albicollis* (the latter has a complete ring of white round its neck) were common at Malta on April 25th.

A Grey-headed Yellow Wagtail joined us on April 23rd, when about eight miles S.W. of Malta, but the main flocks arrived at Malta on April 25th, as did also the Meadow Pipits (wind W.N.W.) A Golden Oriole was caught at Malta on April 28th. I give the last facts on the authority of the bird catchers at Malta; these men had cages full of the birds mentioned and sold large numbers for a few pence each.

I also saw Meadow Pipits at Alexandria, on March 3rd, and on the same day I saw numbers of Spotted Flycatchers.

Black Redstarts were common at Gibraltar, on January 21st, and at Platea, on March 26th.

Of course the dates given above do not refer to the dates of arrival (except where so stated), but only to those on which I first saw the birds at such and such a place.

Amongst other interesting birds seen I may mention a pair of buff-backed Herons, which joined us when going from Platea to Malta, on April 16th. There was a strong wind from the North at the time; the birds seemed very tired and looked as though they wished to perch, but every time they got far enough up to windward they fell back and had to beat up again.

I never saw Blackbirds anywhere but at Gibraltar. Here they had a different note of alarm from the birds in England.

It is rather remarkable that whereas when we visited Malta in April it was full of birds, at the end of February I do not think I saw any birds except Sparrows, which by-the-bye are slightly different from English examples, being slighter and altogether more "gentlemanly" looking.

Flocks of Ravens were more or less tame in Cyprus, and when feeding on garbage would allow one to approach them much nearer than would rooks in England.

The flocks of Kites over Cairo are really wonderful. One day I counted sixty-five birds on the wing at once; a few may have been hooded crows (for at a great height it is hard to distinguish between them) but the majority were certainly Kites. At Platea I watched with some interest a pair of Common Buzzards. I found their nest on March 21st, when it had four eggs; they were not hatched when we left on April 13th.

Granada was crowded with Nightingales on March 10th. The people told me that they would all leave in a month's time, but I think that this opinion is only held because the birds stop singing.

THE NEW FAIRY FLY.

THE DISCOVERY OF THE FEMALE OF *MYMAR REGALIS*.

By FRED ENOCK, F.E.S., F.L.S., F.R.M.S.

In the course of my investigations into the life-histories of the British Mymaridae I have found it to be of the utmost importance and help to note the exact locality, not only of the ground, but the actual plant on which I have made a particular capture. I did so on June 3rd and 8th, bringing away some of the stem and leaves and placing them in a special breeding box. I scarcely need to say how frequently I scanned these stems with my magnifier in the hope of finding the royal partner of my new Mymar.* Day after day passed, without anything but tiny midges emerging. The longest day passed after a boisterous south-west wind—followed by cooler breezes—then on the 22nd, the Coronation day of King George V. and Queen Mary, when the grand procession had passed, down came the long-wished-for rain. Each day brought more rain, and Fairy Flies appreciate a gentle shower and moist atmosphere, which softens the hard stems through which the imprisoned Mymar has to bite its way.

On June 27th, I carefully examined all my breeding boxes, finding a number of various species combing their antennae and preening their wings. At last I came to my special box, containing stems from Burnham Beeches, and there I saw a Mymar, which, when corked up in a tube, I tremblingly examined with my magnifier, and smiled with great happiness, for it was the royal consort—the female *Mymar regalis* with its under-wings arching down in a graceful curve, the tip terminating in a few long hairs.

The general colour of the body and legs is ferruginous, with a slight darkening on the dorsal area. The antennae are very delicate and as long as the whole insect, the first and second joint ferruginous, the third and fourth (the latter very long) dark brown, the fifth lighter, and the sixth, seventh and eighth almost yellow, while the ninth (the club) is dark brown.

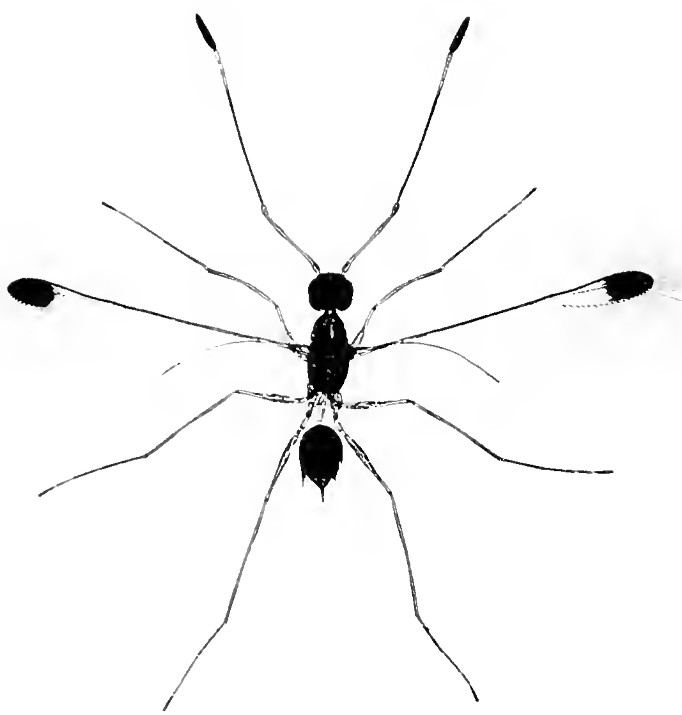


Figure 1.
Mymar regalis, magnified 30 diameters.

After making a detailed description of it, I committed it to the killing phial, and it is now successfully mounted in that most beautiful of all media—Canada balsam. The capture of this most striking species, which is altogether new to the scientific world, proves that there are yet many good things to be taken if only there were more workers in the fascinating study of our Parasitic Hymenoptera.

During the past thirty-five years the writer has captured hundreds of specimens, composing eight new genera, running up and down the panes of glass of a small conservatory, as well as on those of the house.

* In "Knowledge" for July, 1911 (Volume XXXIV, page 271), Mr. Enock described a new species of Fairy Fly under the name of *Mymar regalis* from a specimen of the male which he obtained in Burnham Beeches.—Eds.

SOME NOTES ON *ACTINOSPHAERIUM EICHORNII.*

By EDMOND JOHN HUNT.

THE study of the minute organisms inhabiting pond and stream has ever proved a fascinating field of research to the student of that world of teeming life which the microscope has been instrumental in bringing within the range of man's vision.

Among the numerous forms of surpassing beauty shown by the microscope to be contained in a little water obtained from the weed-covered surface of some sequestered pool, few, perhaps, can surpass in general interest that veritable giant among its compeers—the *Actinosphaerium eichornii*: and the following brief notes, the result of close observation and study of that interesting organism, may possibly prove of some interest to many students of pond life.

Under the generic name, Actinophrys, Actinosphaerium was formerly ranked with the smaller Heliozoön—*Actinophrys sol*—but is now distinguished as *Actinosphaerium eichornii.*

Regarded as a microscopic organism, the *Actinosphaerium* is found to be of comparatively large dimensions; for, while the size of *Actinophrys sol* varies from $\frac{1}{130}$ to $\frac{1}{1200}$ of an inch, that of *Actinosphaerium* is about $\frac{1}{100}$ of an inch. Indeed, so relatively large is its size that, on holding to the light a small aquarium containing specimens of the organism, it may frequently be detected with the naked eye, appearing as a minute spherical speck of a greyish colour, either lying in the *débris* at the bottom of the bowl, or suspended among the threads of confervae which may be floating in the water.

Although holding a lowly position in the scale of life, the structure of the *Actinosphaerium* yet shows some advance on that of the *Amoeba*: the lobose extensions characteristic of the latter organism being in the case of *Actinosphaerium* differentiated into thin ray-like pseudopodia, which, although capable under certain conditions of being withdrawn within the body substance, are yet, as a rule, more often extended for the purposes of locomotion and the capture of food.

Placed on the stage of the microscope, under a lens of low power, the *Actinosphaerium* is seen, like the *Amoeba*, to consist of two layers, namely, an outer layer or ectoplasm, which is of a comparatively firm consistency, and an inner layer or endoplasm. Viewed under a lens of fairly high power, the ectoplasm is seen to be composed of a vacuolated substance, some of the vacuoles being of large size.

In appearance the ectoplasm somewhat resembles the meshes of a net, the lines representing the meshes containing minute dark coloured granules which are in constant motion, while the interspaces appear, as a rule, to be clear and colourless.

Treated with an alkaline reagent these vacuoles may be seen to coalesce.

In the endoplasm the vacuoles are of smaller size than in the ectoplasm; globules and granules of various kinds are present, and embedded in the protoplasmic mass may be seen numerous spherical bodies, each containing a dark-coloured substance. These bodies represent the nuclei with the accompanying nucleoli, and in some cases they appear to be present in very considerable numbers. As previously mentioned, the ray-like pseudopodia, radiating from the body in all directions, show a considerable advance in structure on those of the *Amoeba*, being apparently formed by an extension of the ectoplasm, while running down the centre of each pseudopodium is a structure having the appearance of a minute rod. These rods extend into the endoplasm, and in many cases appear to abut on the nuclei. Whatever may be the nature of the substance of which these rods are formed, and it does not seem to be at all clearly understood, there can be no doubt as to their being characterised by a remarkable condition of toughness and elasticity.

It sometimes happens that a free-swimming infusorian has the misfortune to be caught on the extreme end of one of the long pseudopodia, and, in its violent struggles to free itself, will bend the pseudopodium until the latter assumes the shape of a bent bow, having much the appearance of a fishing rod as seen in the hands of an angler playing a large fish. In such a case the strain must be enormous, and should the infusorian succeed in making its escape, a contingency which not unfrequently happens, the pseudopodium is seen to spring back at once to its original position, apparently quite uninjured by the severe struggle.

Under certain conditions, as, for instance, when transferred from one glass cell to another, the *Actinosphaerium* frequently completely withdraws its pseudopodia within the body substance, but they are soon again extended on the organism being left for a short time undisturbed.

The pseudopodia are used for the purpose of capturing food, and probably also as a means of locomotion.

In all the specimens under observation two and sometimes three contractile vacuoles were always present.

These vacuoles expand very slowly, and when fully dilated project beyond the surface of the body. The outer walls then contract, presumably casting out the fluid contents, although no passage through which these latter could escape can be detected.

In "The Microscope and its Revelations" Dr. Carpenter, in speaking of the contractile vesicle as seen in *Actinophrys sol*, says that "the cavity of this sacculus is not closed externally, but communicates with the surrounding medium, not, however, by any distinct and permanent orifice, the membraniform wall giving way when the vesicle contracts, and then closing in again. This alternating action seems to serve a respiratory purpose, the water thus taken in and expelled being distributed through a system of channels and vacuoles excavated in the substance of the body, some of the vacuoles which are nearest the surface being observed to undergo distention when the vesicle contracts, and to empty themselves gradually as it refills."

Figure 1.

When injured in any way the recuperative power of the *Actinosphaerium* appears to be very great. It sometimes happened that on transferring a specimen from the aquarium to the glass cell for purposes of examination the organism would sustain more or less damage, and on one occasion so great was the injury that a considerable portion of the endoplasm was pressed out of the body and could be seen floating in the surrounding medium, while the pseudopodia were all more or less destroyed. Despite, however, these apparently hopeless injuries, the work of repair was at once commenced and so quickly effected that in a comparatively short space of time the *Actinosphaerium* had made good the damage sustained, and with extended pseudopodia was ready to seize any prey that might happen to cross its path.

It is generally stated that when unsuitable conditions arise, the *Actinosphaerium* becomes encysted, remaining in this condition until the provision of a more favourable environment enables the organism to resume its normal state of existence.

No doubt this is sometimes the case, yet close observation points to the fact that under unsuitable conditions death often supervenes, while encystment more generally takes place prior to reproduction by division.

Previous to death the endoplasm becomes greatly contracted and numbers of the pseudopodia appear to fuse, a process which gives them the appearance of broad spikes protruding from the body. After remaining in this condition for some time the contents of the body break through the containing membrane at some one point, filling the surrounding water with globules of various sizes.

A large portion of the life of the *Actinosphaerium* appears to be occupied with the capture of food, the choice ranging from small particles of vegetable matter to free-swimming infusorians, and even such comparatively highly organised and powerful creatures as the various species of Entomostraca. Of these latter the smaller species are easily captured, eaten, and digested, but with the larger species the *Actinosphaerium* does not appear powerful enough to deal.

The organism appeared also quite unable to cope with some Paramecia when placed in the same cell; the infusorians by a sudden twist of the body speedily freeing themselves from the clutches of the pseudopodia, which latter were invariably much damaged, and not unfrequently completely torn off in the struggle.

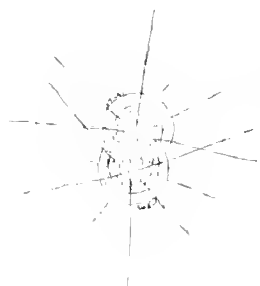


Figure 2.

Figure 3.

Figure 4.

Periods occur when the *Actinosphaerium* rests from the labour involved in securing a sufficient food supply, and it is of great interest to note that during these intervals free-swimming infusorians appear able to come into contact with the pseudopodia with no danger ensuing to themselves.

When food-taking, the method adopted by the *Actinosphaerium* for capturing its prey is of peculiar interest.

Should an infusorian or other organism chance to come into contact with one of the pseudopodia, it is at once captured and firmly held; the capture being generally attributed to the action of a coating of some viscous substance. If this be really the correct solution, it seems clear that this substance can be secreted only during such time as the *Actinosphaerium* is engaged in food-taking: for, as previously mentioned, there certainly occur periods when similar organisms are able to come into contact with the pseudopodia with perfect impunity.

In the event of the captured organism proving to be of small size, it glides up the pseudopodium until, on reaching the body, a portion of the ectoplasm appears, as it were, to be rolled back, thus forming a kind of mouth within which the struggling victim is speedily engulfed.

When, however, an Entomostracan or other comparatively large organism happens to be caught, the mode of procedure adopted by the *Actinosphaerium* appears to be of a different character. In such a case the neighbouring pseudopodia are bent over to assist in holding the captured prey, while, by a process of contraction, the latter is slowly conveyed towards the body of the *Actinosphaerium*. After being engulfed, the Entomostracan or other organism is seen to be enclosed in a vacuole which soon commences a slow circulation round the body, a considerable time,

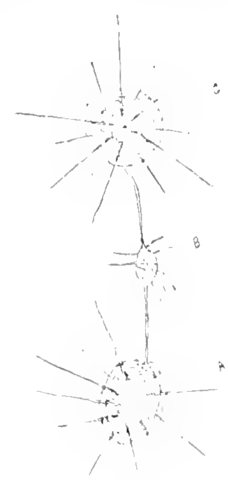


Figure 5.

however, elapsing before the struggles of the captured animal finally cease. In the case of an Entomostracan, the process of digestion being completed, the hard indigestible shell is gradually worked along to the surface of the body and ejected, a depression appearing in the ectoplasm at the place where the hard substance passed out into the surrounding medium.

The process of digestion is of a somewhat tardy nature; in one case an interval of nearly twenty-four hours elapsed from the time an Entomostracan was engulfed to the time the empty shell was expelled from the body.

Waste matter is occasionally ejected from the body of the *Actinosphaerium*. Sometimes this waste material is enclosed in a bladder-like vacuole which, on leaving the body, appears to glide along the pseudopodia, finally floating off into the surrounding water where it gradually collapses, the contents being dissipated. Occasionally these bladders are suddenly ruptured and the contents expelled with some considerable amount of violence.

Another curious phenomenon in the life history of the *Actinosphaerium* may occasionally be witnessed when two of these organisms slowly approach one another, cross their respective pseudopodia, and thus united, glide slowly through the water. In a short time the body substance of the two organisms may also be seen to come into contact, appearing as in Figure 1. After the lapse of about a quarter of an hour, the two bodies apparently become completely fused, as shown in Figure 2, their respective pseudopodia remaining, however, quite distinct, together with the two centres from which they radiate, while there appears to be a dividing line between the two endoplasms. This dividing line soon, however, disappears, the two endoplasms merge into one, while all the pseudopodia are now seen to radiate from a common centre, and in the course of about an hour the two bodies have become as one, as shown in Figure 3. The phenomena of cytotropy, or the mutual attraction of two or more cells, are in all probability closely connected with conjugation, and cytotropy, leading first to contiguity, may result in plastogomy, or the fusion of plasms. The protoplasm, however, must be in the proper plastic condition for such a union, and some of the Heliozoa are apparently always in this condition and contact results in fusion. In many cases, however, plastogomy leads to nothing further, and no nuclear fusion takes place.

Occasionally two large *Actinosphaeria* will unite and form a body as shown in Fig. 4, large spherical vacuoles being visible in the body substance. After remaining in this condition for some hours the two bodies gradually round off into the form of a perfect sphere. Again, it sometimes happens that the two bodies, after remaining fused for some hours, will separate, then appearing to be in the same condition as before the fusion occurred. In other cases, the two *Actinosphaeria* are seen to be united by a narrow band of protoplasm as shown in Fig. 5. In appearance this connecting band resembles an elongated pseudopodium, the only difference being that it is somewhat thicker, while in the centre thereof is an expansion having all the appearance of a very small *Actinosphaerium*. In a short time the band connecting the organisms A and B (Fig. 5) parts, leaving B, now rounded off into a perfect sphere, still attached to C. Soon afterwards the band connecting B and C is also severed, leaving B and C floating in the water as separate organisms.

It is possible that the above-mentioned phenomena form cases of plastogomy, and are not followed by fusion of the nuclei as in true cases of conjugation, although the latter has apparently been clearly established in *Actinophrys sol*.

The *Actinosphaerium* reproduces its kind by means of binary subdivision, which is repeatedly performed under the protection of a cyst.

In such a case the *Actinosphaerium* withdraws most of its pseudopodia, while others coalesce and protrude from the body in the form of broadish spikes. The ectoplasm appears to be very clear and the vacuoles of large size, while the endoplasm is dark and opaque, and the whole body shows a considerable decrease in size. In this condition it sinks to the bottom of the cell and, after an interval of some twelve hours, a kind of gelatinous substance commences to form around it. On touching this substance with the point of a very fine needle it is found to be of a slimy, sticky nature.

The gelatinous covering gradually increases in firmness, and under the protection thereof the body substance of the *Actinosphaerium* undergoes a process of division until from ten to thirteen different parts can be detected.

Each separate part is of a dark colour and is surrounded by an outer layer of some substance of a clear transparent nature. These various parts represent the young *Actinosphaeria*, which, after remaining in this condition for varying lengths of time, finally break through the cyst and soon acquire the likeness of the parent form. It has been stated that the *Actinosphaerium* reproduces itself by simple fission, the cell slowly separating into two parts, and it is further said that, should these organisms be kept for some time without food and then be provided with a superabundance thereof in the shape of Stentors, they will multiply rapidly by division.

However this may be, close observation of these organisms has never shown the *Actinosphaerium* to undergo division save under the protection of a cyst, while, furthermore, the introduction of Stentors into the glass cell invariably caused the *Actinosphaeria* under observation therein to withdraw their pseudopodia, being apparently quite unable to cope with the powerful Stentors.

THE COMMON SANDPIPER (*Totanus hypoleucus*).

Illustrated from Photographs

By E. W. TAYLOR.

A Common Sandpiper on her nest.

The eggs of the Common Sandpiper.

Young Sandpipers hatching.

Young Sandpipers showing their protective colouring.

FAMILY HANDWRITING.

By R. H. CHANDLER.

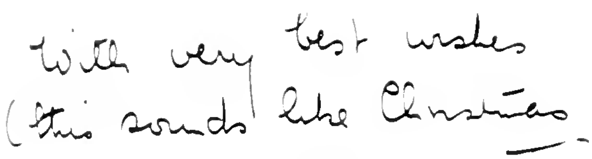
THE likeness which exists between the writing of various members of the same family is often exceedingly strong, and for the purpose of a just comparison it is necessary to have the same words written by related people. The names and addresses on envelopes are very useful, though as these are

a. Brother.

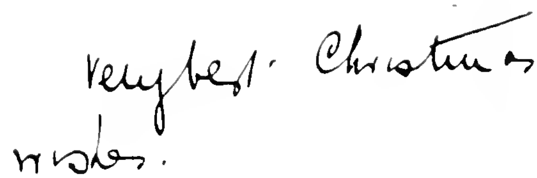
b. Brother.

FIGURE 1.

The words are joined in both cases and there is a great similarity in style.



a. Sister.



b. Brother.

FIGURE 2.

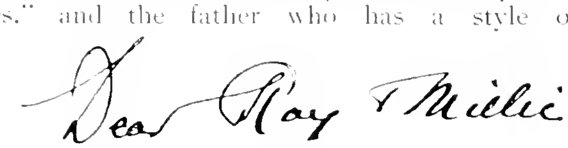
The style of this handwriting should be compared with that of the three brothers, seen in Figure 3.

written carefully when they are unknown, it would be better to have a few familiar words written without any hesitation. The family likeness in the illustrations which we give is apparent to anyone, and if we were not intimately acquainted with the handwriting of all of these it would be easy in some instances to mistake one for the other. Take Figure 3 (*a* and *b*), two brothers; Figure 4 (*a* and *b*), father and son; Figure 6 (*a* and *b*), two brothers; Figure 7, two sisters or Figure 9 (*a* and *b*) two brothers, which are hardly distinguishable one from the other; and even where the likeness does not approach almost to identity (as in the instances just given) there is a very strong family likeness in formation and style—take Figure 2, showing brother and sister where the style is pronounced and very similar, or Figure 3. Figure 5 shows the round handwriting of a father and son (if it were possible to show the signatures the likeness would be very much stronger) and Figure 9, which shows a strong likeness in the angularity (or acuteness) of the handwriting of three brothers.

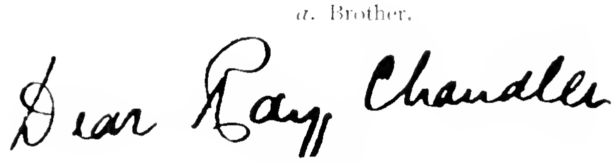
Family likeness in handwriting follows the same general principles as family likeness among human beings, which may be defined as an accumulation of indescribably faint suggestions of similarity rather than any strong identity; for instance, a family likeness may show itself by the colour of the eyes (a very frequent one), shape of the nose, general outline of face, or eccentricity of manner, but more often it is the *tout ensemble* (something that we could not put into words and define accurately), which causes old friends of parents to exclaim, when meeting the children after some years,—"Isn't he like his father?" or, "He is just like his father as a boy."

This brings us to another point of agreement between handwriting and ourselves, viz., likeness at corresponding ages. It would be absurd to expect a grandfather of seventy to write like his son of forty-five, or his grandson of twenty, but there may be made a just comparison between the grandfather's writing at middle-age and his son's at the present time, or between that of the son and grandson at corresponding ages.

Another point of agreement (a sub-species of "family likeness") is what may be called "peculiarities," and the father who has a style of



a. Brother.



b. Brother.

c. Brother.

FIGURE 3.

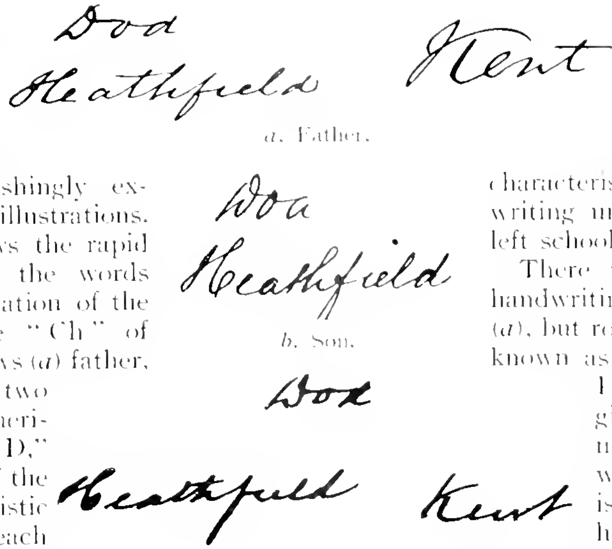
a and *b* are hardly distinguishable.

handwriting that shows these peculiarities will frequently bequeath them, more or less unaltered, to his son.

Bearing in mind these suggestions, that is, the influence of age on handwriting and the meaning of the expressions "family likeness" and "peculiarity," we may proceed to study some more examples.

Peculiarities are astonishingly exhibited in some of these illustrations. Take Figure 1, which shows the rapid writer's trick of running the words together: the peculiar formation of the "r" of "dear," and the "Ch" of "Chandler." Figure 4 shows (*a*) father, aged about seventy, and two sons, both of whom have inherited a peculiar capital "D," "H" and "K." In Figure 7 the writing is not a characteristic one, but the "the" in each case is identical and the "e"s are blind. But Figure 8 illustrates these features better: it is the handwriting of a father and son, and superficially one would say there was no likeness between them: but notice the capital "C"s and "B"s, the flourish at the end of "Chandler" in the father (*a*) has become a detached dash in the son (*b*); they both put "etc." or its equivalent after "Builder" (whose "e" is a Greek one in both cases) and they are liable to stop the pen at the same places—in the word "Chandler" they both leave a space after "h" and "n," in "Builder" after "l," and in "Belvedere" after "v" and "e." This last instance is very curious: for there is no apparent reason for leaving the "e" in the middle of the word all by itself when the four letters both preceding and following it are joined together.

I have been unable to collect such striking specimens of the handwriting of women as of men, and it may probably be taken as a general rule that women do not write such characteristic "hands" as men (the vast majority write very much less than men); besides, I fancy most girls on leaving school write a better (*i.e.* more formed and permanent)



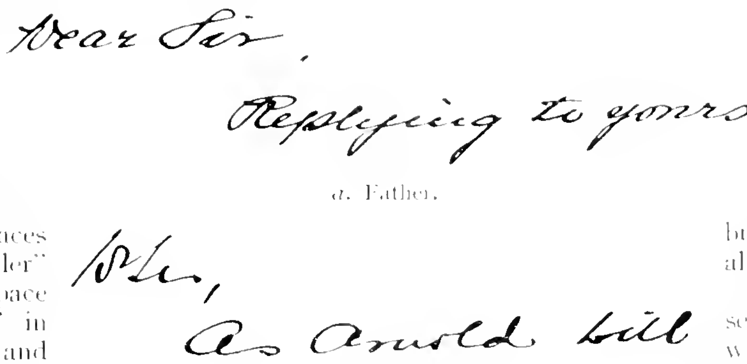
a. Father.

b. Son.

c. Son.

Figure 4.

The capital letters "D," "H" and "K" are peculiar, and there is a strong likeness between *a* and *b*.

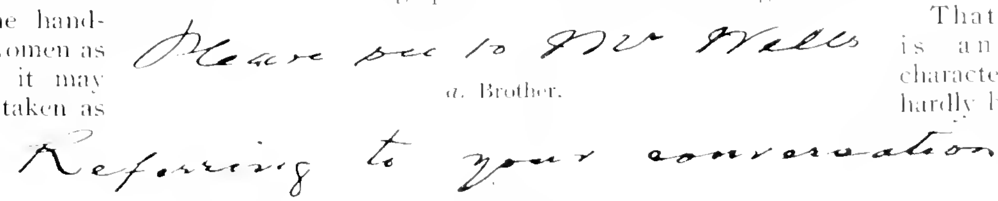


a. Father.

b. Son.

Figure 5.

The roundness of the writing in both cases is striking.



a. Brother.

b. Brother.

Figure 6.

The two handwritings are almost indistinguishable.

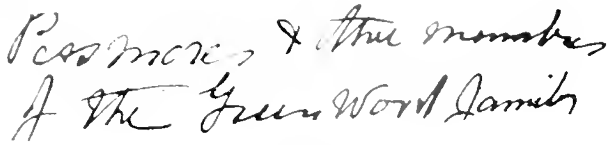
handwriting than boys at a corresponding age, which writing does not change so very much through life, whereas a boy usually does not begin to show his characteristic and permanent handwriting until some years after he has left school.

There is a common style of girl's handwriting (something like Figure 2 (*a*), but rounder and less characteristic) known as the "High School writing," I suppose, because High School girls write it, and if this does not alter later it shows that women write less characteristically than men; anyway, I have met with "High School girl's writing" in a woman of thirty, and I believe it would be rare to find a man whose handwriting had not altered between sixteen and thirty. These remarks apply to women who write a few family letters a week, and not to women in business, who might write as strong or as pronounced a style of handwriting as any man.

In Figure 2, there is not much to choose between brother and sister, and Figure 7 seems more or less weak and rambling, but this very weakness is alike in both.

A curious case is presented by Figure 4 (*a*) which shows strong handwriting for a man of seventy, and whose peculiarities are exhibited in (*b* & *c*) two of his sons, but his eldest son, Figure 5 (*a*), writes totally unlike the rest of the family, and yet he, Figure 5 (*a*), has bequeathed his own handwriting to his own eldest son, Figure 5 (*b*).

That handwriting is an acquired character there can hardly be any doubt. We only inherit the power of learning to write, though it would appear that the members of a family may inherit the power of writing in a particular way. There are, nevertheless, the questions



a. Sister.

b. Sister.

Figure 7.

The word "the" should be specially noticed and the handwriting in these two instances is also nearly identical.

of influence and imitation to be considered.

Charles Darwin, long ago, recognised that handwriting was inherited, and this idea may be found scattered through scientific literature as an axiom for the past fifty years, but, so far as I know, it has not been illustrated before.

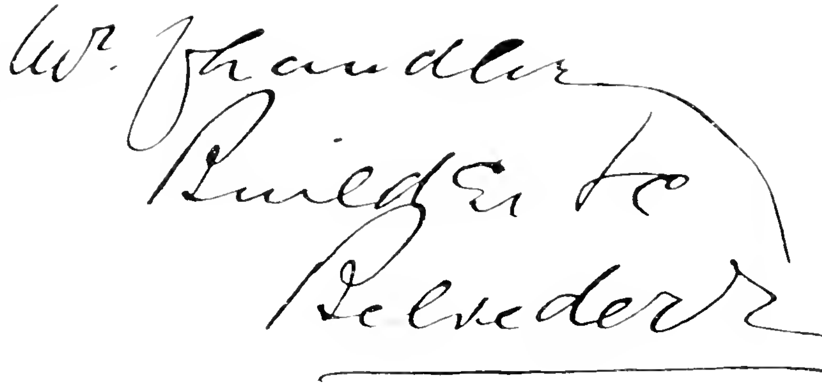
A friend, to whom I mentioned these enquiries, informed me that he had frequently noticed that the juniors in an office came to write more like their chiefs as time went on, and I have since heard the same statement made by other people who had no interest in the subject, but as I am unable to produce any specimens it would not be well to rely upon this, which appears to be a clear case of environment and imitation (conscious or unconscious).

On the other hand, the writer of Figure 1 *a* lives in Wales and has probably not written my name more than two or three times in his life, whilst the producer of *b* has lived in London for the past twenty-five years and has written my name several thousand times.

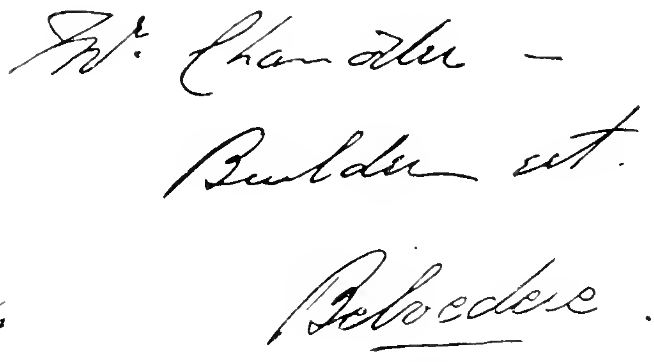
In the case of Figure 3 the two brothers *a* and *c* were at school together, but *b* is fifteen years older and was educated entirely differently, yet the youngest brother *a* writes more like his eldest brother *b* than the middle one *c*.

Belonging to the family of Figure 4 there are two other brothers (besides Figure 5 mentioned above) whose writing is quite unlike these specimens and it seems more difficult to account for such differences than for many similarities.

These illustrations are sufficient to prove that handwriting is hereditary (sometimes to a remarkable extent), and in some instances environment can have had very little to do with it, but in many cases we know so little of the influences brought to bear upon such a flexible growth as handwriting, that it is quite possible to underestimate the effects of environment.



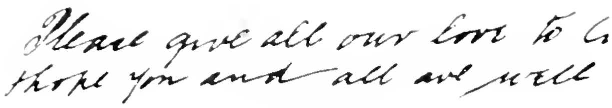
a. Father.



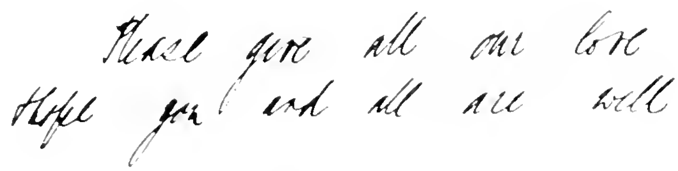
b. Son.

Figure 8.

The capital "C's" and "B's" should be examined and the spaces left between some of the letters are also noteworthy.



a. Brother.



b. Brother.

c. Brother.

Figure 9.

All these specimens are angular, while *a* and *b* are very much alike.

A UNIQUE SUNDIAL.

By O. PAUL MONCKTON.

SINCE the days of Ahab, King of Israel, the art of dialling has been practised by kings and princes as well as by less favoured folk: but although many quaint dials are known to be in existence, the writer quite recently came across a specimen which must be unique in the annals of horology.

This dial, of which a full-size drawing will be seen in Figure 1, 2, and 3, consists of a short cylindrical body, made of wood two-and-a-half inches long by three-quarters of an inch in diameter, surmounted by a wooden conical cap one-and-a-half inches long by three-quarters of an inch in diameter at its thickest section. This cap fits into the top of the cylinder, the latter being made hollow for the purpose.

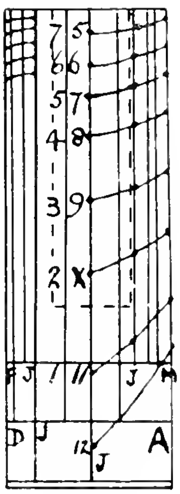


FIGURE 1.

The cylinder. The dotted line shows the hollowed recess.

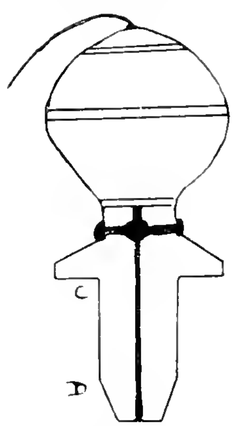


FIGURE 2.

The cylinder cap with the gnomon lying in the saw cut.

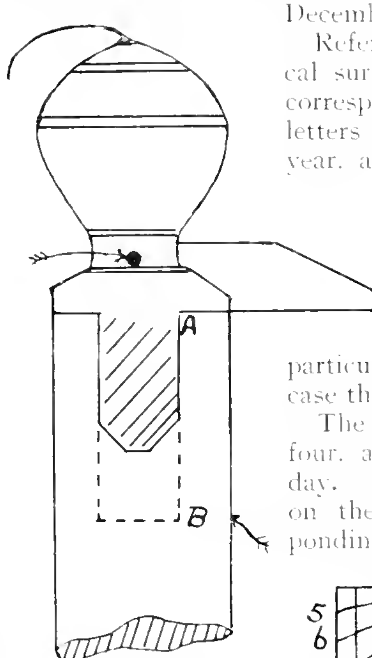


FIGURE 3.

This shows the gnomon in position. The upper arrow indicates the pivot on which it turns, the lower arrow shows the direction of the shadow vertically down the cylinder.

The whole of the dial-cap and cylinder, with the exception of the gnomon, was made of a light yellow wood. Vertical lines are scribed at intervals down the whole length of the cylinder: Figure 4 shows the development of these lines as if the surface of the cylinder were laid flat on a piece of paper.

The shank CD of the cap fits into the hollow AB down the centre of the cylinder. A saw cut has been made half way up the cap as shown in Figure 2 and a piece of tin-plate, Figure 5, inserted in the slot. This piece of plate constitutes the gnomon of the dial, and is pivoted at one end by a nail passing through one corner as indicated. The hole is drilled in such a position that, when the gnomon is in use, the long straight side of the tin-plate is underneath and projects at right angles to the cylinder. The long edge of the gnomon, resting on the flat top of the cylinder, is thus compelled to assume a horizontal position when the cap is pressed home as in Figure 3.

When not in use, the gnomon is twisted through a right angle and rests in the saw cut. Thus the dial can easily be carried in the pocket.

The vertical lines drawn down the cylinder correspond to the months of the year, the letters of the alphabet indicating the different months—D, for December, and so on.

Referring now to the developed cylindrical surface, in Figure 4, the vertical lines correspond to the lines on the cylinder, the letters at the bottoms to the months in the year, and the point marks on certain of the verticals, to calculated intervals measuring from the top of the cylinder. These intervals depend in length on the latitude of the place for which the sundial is designed, the time of day, and the particular length of gnomon taken—in this case three-quarters of an inch.

The vertical numbers, one, two, three, four, and so on, refer to the hours of the day. The cross-curves, drawn in red ink on the original cylinder, join up corresponding points on different verticals. As these points are mere indentations in the wood, made with some sharp instrument, they would quickly become obliterated by dirt or usage unless some distinctive marking were used.

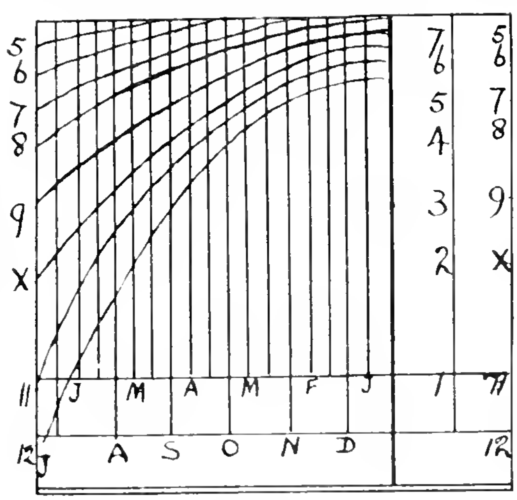


FIGURE 4.

The development of the cylinder.

In order to appreciate the action of the dial, consider the position of the earth with regard to the sun at different periods of the year. In the height of summer, when the sun is high over-head, if a stick of known length be held out parallel with the earth's surface—*i.e.*, horizontally—a shadow will be cast vertically down the body of the person holding the stick, which will be very long at mid-day, decreasing to zero at sunrise or sunset. Also at any particular period of the year the length of the shadow, measured vertically, cast by a horizontal stick, will vary with the declination of the sun and with the time of day—being, in general, shorter in winter than in summer.

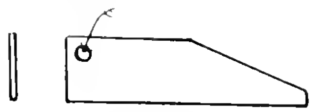


Figure 5.
The gnomon.

The gnomon of the sundial corresponds to the stick in the above illustration, and for a gnomon of given length it is a simple matter to calculate the length of the shadow which ought to be thrown on any particular day of the year, at any time of the day. As it is not possible to construct a dial with three hundred and sixty-five sides, a side for each day of the year, a certain interval only on the cylindrical surface of the dial can be allotted to each month.

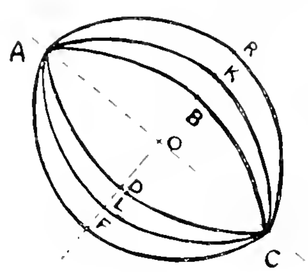


Figure 6.
Angle between the two planes BOADC and KOALC = sun's declination on any day of the year. At Midsummer these two planes will coincide.

These intervals are shown by the vertical divisions and sub-divisions on the developed plan.

The numbers 1, 2, 3, 4, and so on, refer to the hours of the day—1 for one o'clock, and so on.

At 12 o'clock the sun is high overhead, so that one curve represents this hour, but as the sun's angle at 11 is the same as it is at 1 o'clock, each of the other curves can represent the hours in pairs before and after noon.

The vertical for December indicates that the sun rises about seven, because only the curves for 7, 8, 9, 10, 11 and 12 o'clock pass through it. On the other hand the June vertical starts with a point almost at four o'clock, all the curves subsequent to this number being marked upon the vertical.

Although the above description is, of necessity, somewhat lengthy, yet the manner of reading the dial is simplicity itself.

Take the conical top out of the cylinder and after putting the gnomon in a horizontal position replace the cap, jamming it firmly into the top of the cylinder so as to hold the gnomon in that position (Figure 3), but before jamming turn the top round so that the sharp edge of the gnomon rests opposite the vertical for the day of the month in question.

Hold the cylinder vertical, a piece of thread is attached to the cap for the purpose, and spin the dial round until the shadow cast by the gnomon down the cylinder is vertical. The end of the shadow will show the time of day, the reading being taken from that vertical most nearly coinciding with the shadow, while the curves allow an accurate interpolation to be made.

No very great accuracy can be expected from such a simple and cheap instrument, but an accuracy equal to that of a small sundial might be anticipated.

Like all sundials, this curious instrument can only be used in the latitude for which it is designed, though in such a small dial considerable margin in this connection might be allowed.

This particular dial is quite modern in appearance, though there is no indication of the place of manufacture upon it. The writer was given to understand that it was found in use amongst the shepherds in the North of France, though the principal dimensions of the dial, including the gnomon, are in inches, and denote in consequence an English or American origin. It is almost certainly a copy of some older form.

The elementary mathematical theory evolved is as follows (see Figure 6):—

(1) AOBCD is the plane of the sun at meridian.

(2) ROAFC is the equatorial plane at right angles to this plane.

(3) KOALC is any plane within $23\frac{1}{2}°$ N. or S. of the meridian plane.

Then if the sun is supposed to rise at A and set at C on any particular day of the year, it will pursue such a path as ALCKO.

Suppose P be any point on the same paths on this day. Join PO, PB, BK and KO.

Then PKBO is a right-angled spherical triangle of which the angles POK, KOB are known, KOB being the sun's declination from the vertical and POK being $90°$—hour angle.

The solution of this triangle will be found in any good work on surveying, and is of the form

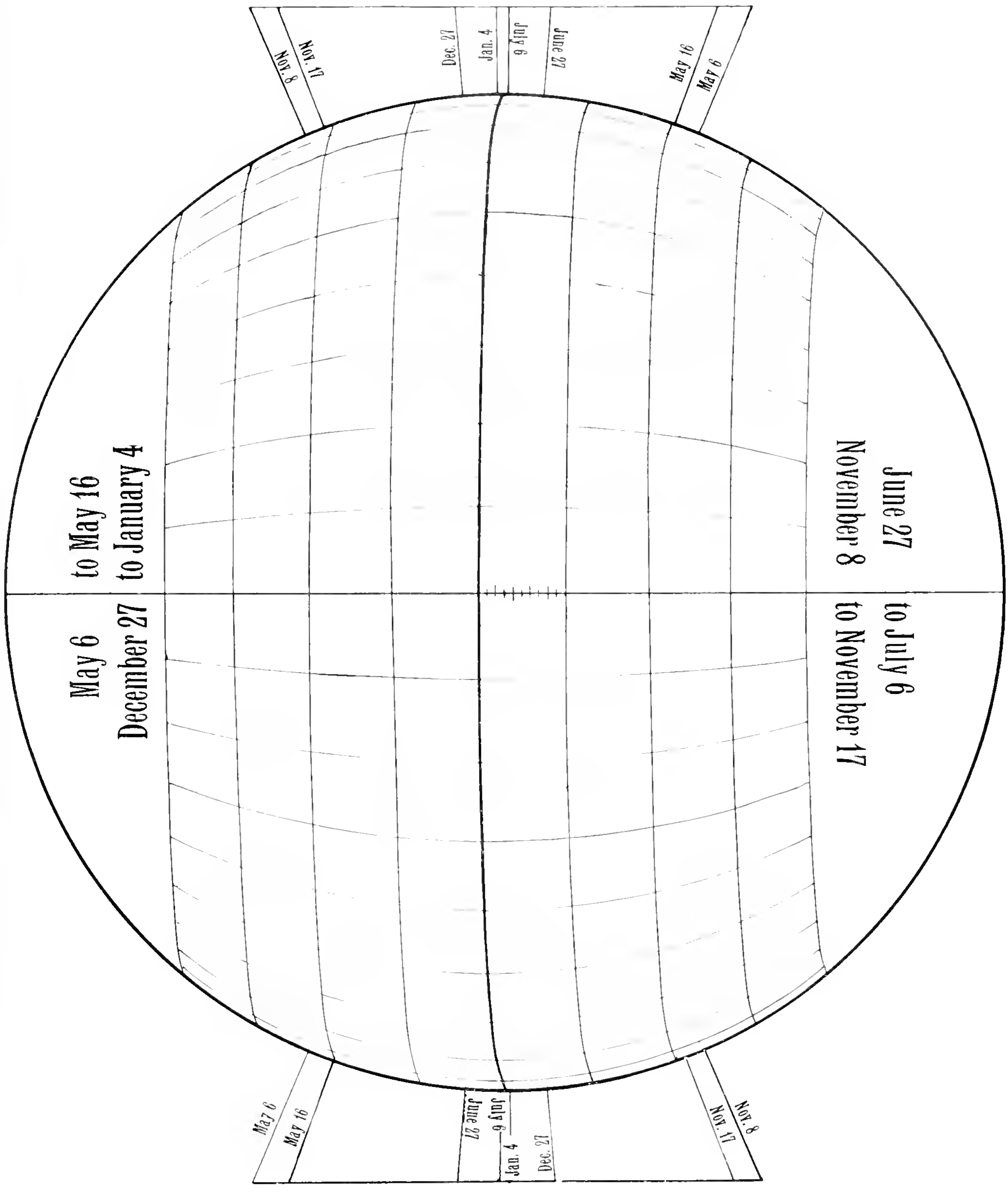
$$\cos \alpha = \cos \beta \cos \gamma.$$

where α β and γ are the angles of the spherical triangle.

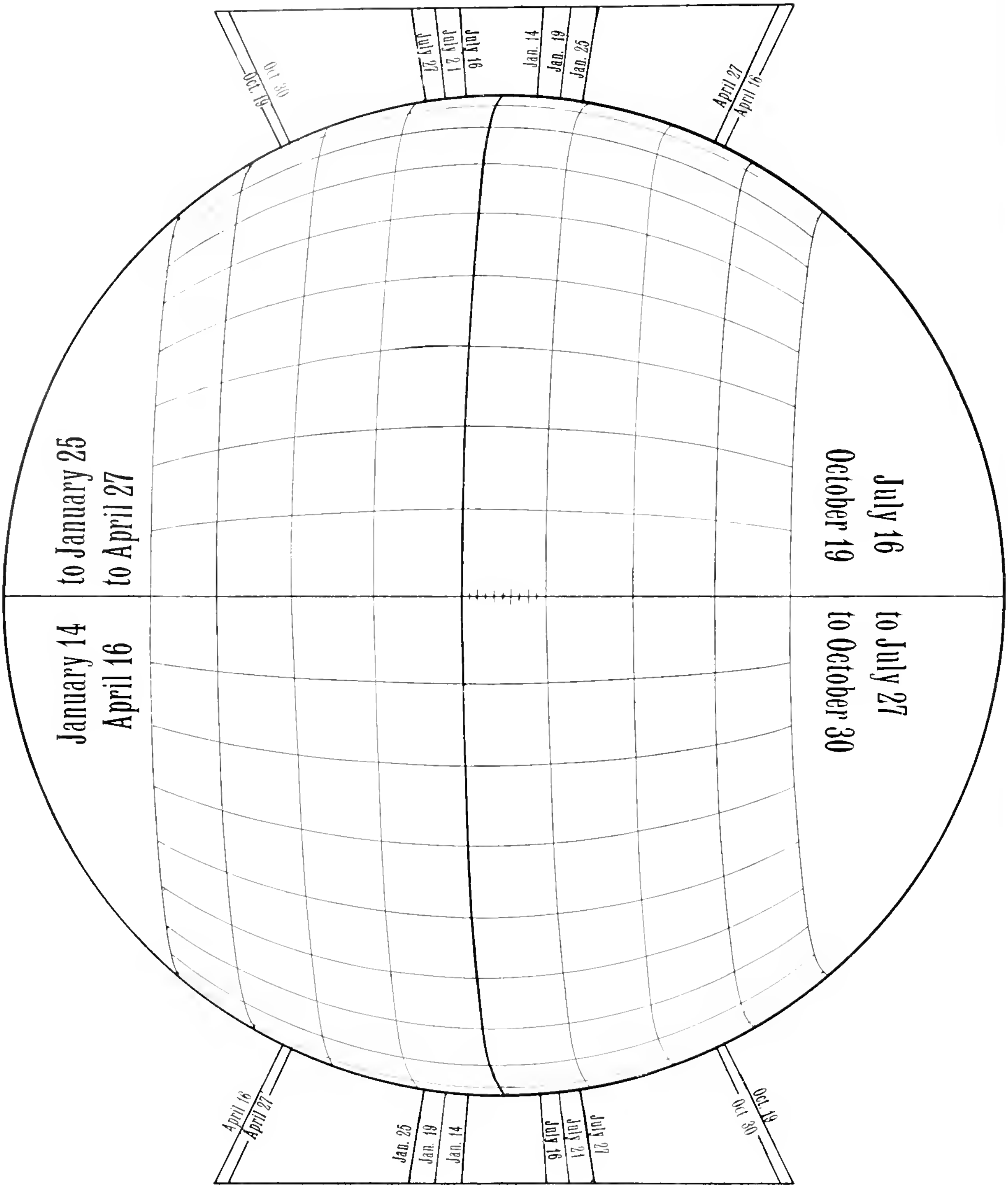
DISCS FOR SOLAR PROJECTION.

By JOHN McHARG, M.A.

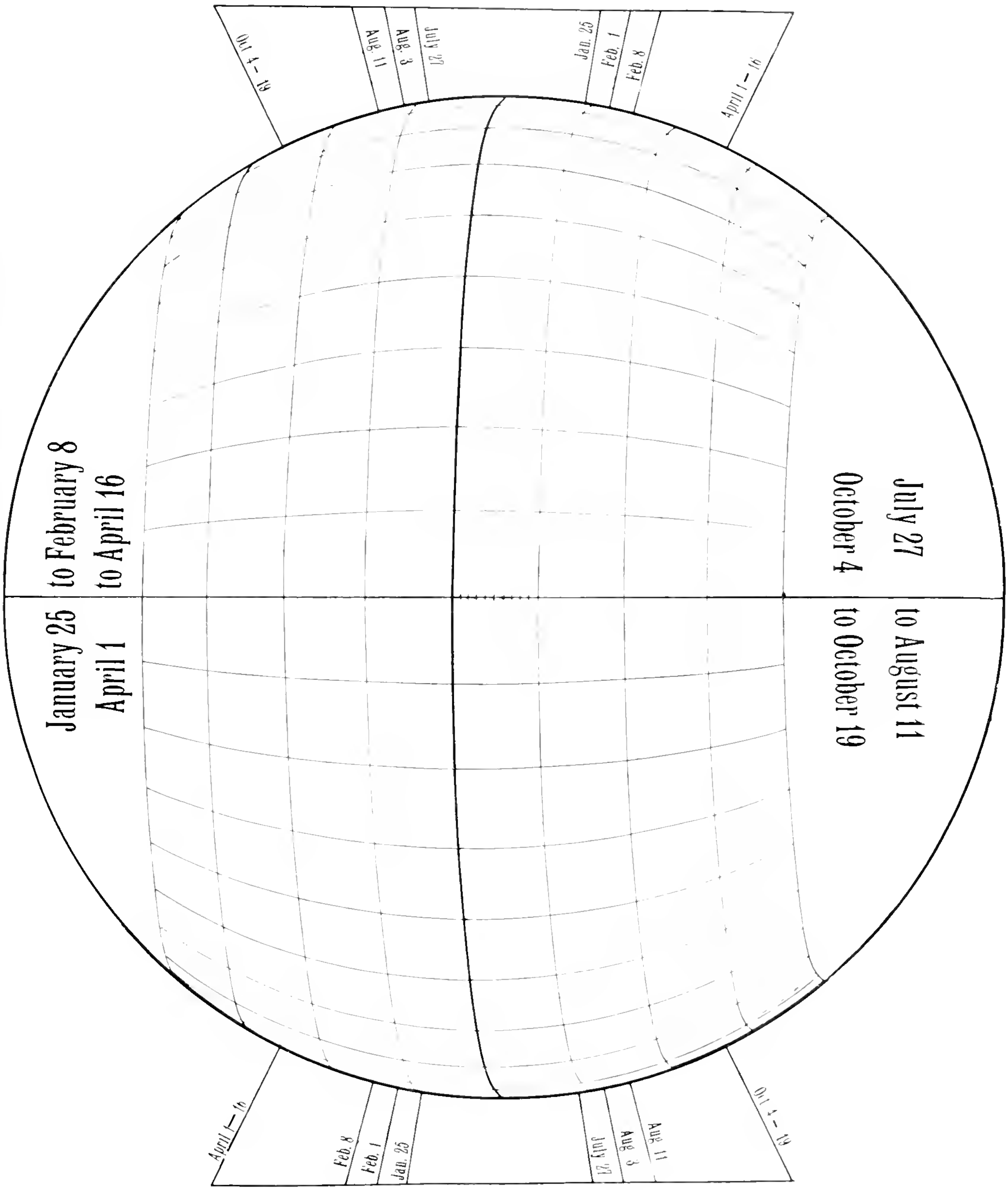
On the following pages are given four more of the Maps for Solar Projection which complete the set. Number V. was printed on page 199 of this volume, while Numbers I., II. and III. appeared in the June issue for this year on pages 207 to 209. It is intended to reprint the series and issue them as a separate publication.



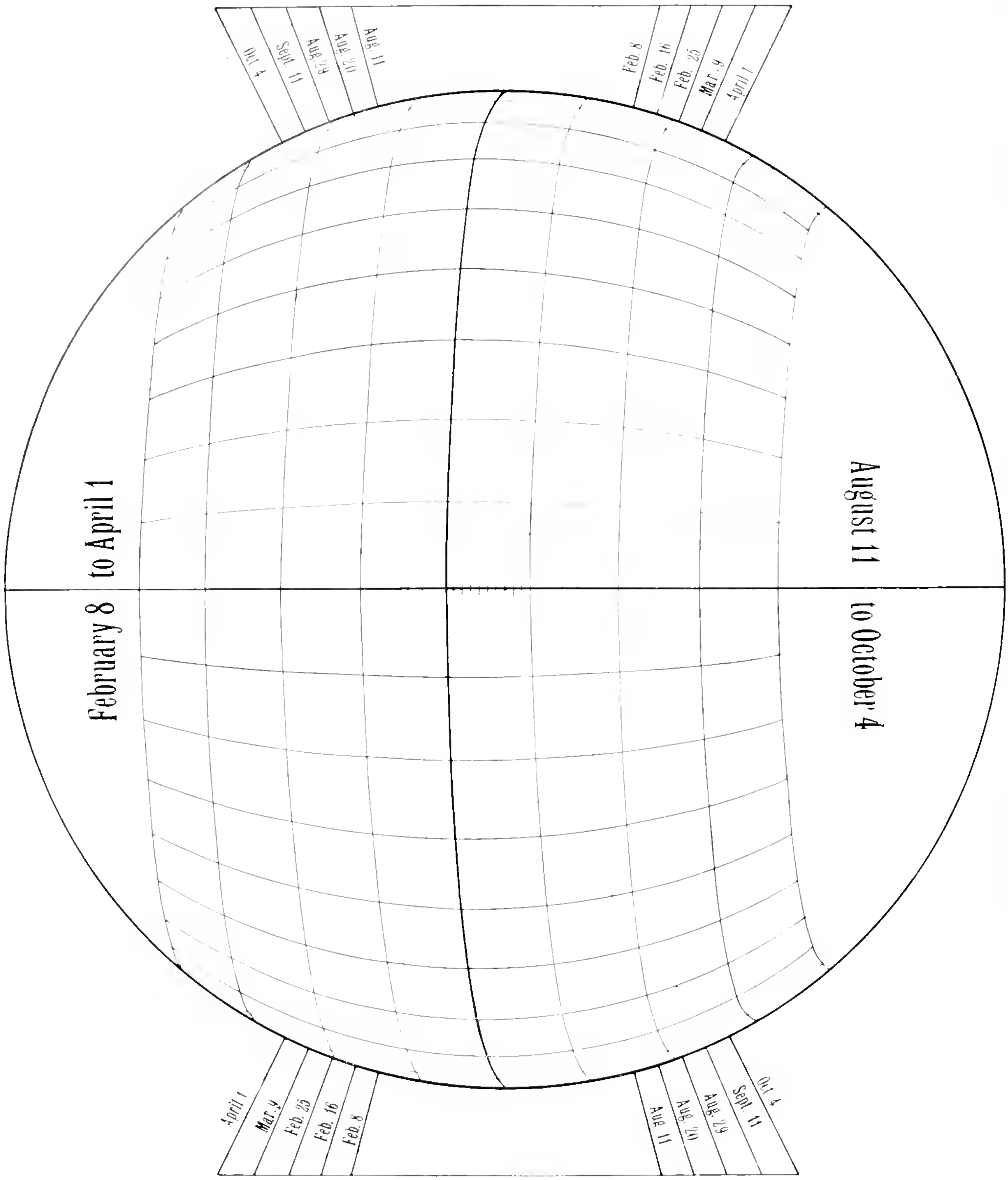
IV. Latitude of Centre ± 3°.



VI. Latitude of Centre ± 5°.



VII. Latitude of Centre ± 6°.



VIII. Latitude of Centre ± 7°.

CORRESPONDENCE.

ASTRONOMICAL QUERIES.

To the Editors of "KNOWLEDGE."

SIRS,—In the course of Astronomical study I have lately found difficulty on three points. I am venturing to lay these points before your readers, in the hope that a solution may be found me through the medium of your columns.

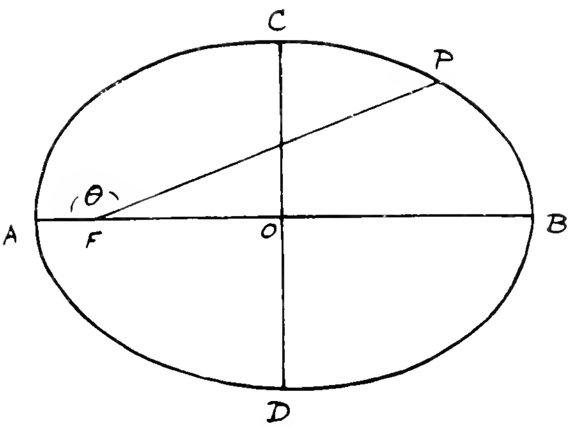


FIGURE 1.

Let a denote the semi-major axis, AO,
b „ „ „ minor „ CO,
e „ „ ellipticity, $\frac{FO}{AO}$,
r „ „ variable radius vector, PF,
T „ „ complete period of revolution,
S „ „ perimeter of the ellipse, that is, the rectified complete path of the body.
R „ „ arithmetic mean of the greatest and least values of r.
R_t „ „ time-average value of r,
R_a „ „ angle-average „ „
R_o „ „ orbit-average „ „

$$\text{Then } R = \frac{BF + AF}{2} = \frac{BO + FO + AO - FO}{2} = a.$$

$$R_t = \int \frac{r}{T} dt = a\left(1 + \frac{e^2}{2}\right).$$

$$R_a = \int \frac{r}{2\pi} d\theta = b.$$

$$R_o = \int \frac{r}{S} ds = a.$$

I.—A uniformly illuminated surface, whatever be its form and whatever be the angle made by the line of sight to its component parts, will appear uniformly illuminated whereever the eye be placed: the amount of light that reaches the eye will be proportional to, and depend only upon, the intensity of the illumination and the solid angle subtended by the boundaries of the surface at the eye. A familiar illustration of this is the case of an opal gas globe illuminated by a gas flame at its centre. The globe appears as a flat uniformly illuminated disc from all positions. This phenomenon is well-known and readily explained. In the case, however, of a surface illuminated by a point-source of light, and shining by reflection, the intensity of illumination varies with the angle of incidence, being, in fact, proportional to the cosine of that angle. Considering the case of a sphere, the intensity falls off to zero at the terminator of the illuminated portion. To an observer, then, such a sphere does not show the same intensity at the different portions of its surface, and the amount of light that reaches the eye depends not only on the solid angle the illuminated surface subtends at the eye, but also on the varying intensity of illumination, due to the varying angle of incidence of the light.

Now the *Nautical Almanac*, in calculating the time of greatest brilliancy of Venus, assumes that the illuminated portion of the planet visible from the earth is of uniform intensity, and that the brilliancy varies only with the solid angle subtended at the earth. Godfray in his "Treatise on Astronomy" gives the same method of calculation. Why should an approximately accurate result be expected on such an assumption?

II.—What is the usual interpretation of the expression "mean distance" as applied to the radius vector of a body revolving in an elliptical orbit about its primary?

The following interpretations occur to one, and there are doubtless others.

(*a*) The arithmetic mean of the greatest and the least value of the radius vector, which has the value a (see Figure 1).

(*b*) The average value at equal intervals of time which is $a\ (1+e^2/2)$.

(*c*) The average value at equal increments of the angle made by the radius vector, which is b.

(*d*) The average value of the radius vector at equal intervals of path of the body in its orbit, which is a.

One reads frequently of the "mean distance" without qualification; its value is generally taken to be the semi-major axis; but the time-average value would seem to be an important interpretation, and this is not the semi-major axis.

III.—It is recognised that the secular acceleration of the moon's mean motion is partly accounted for by change in the perturbation of the moon by the sun as the earth's orbit slowly becomes less elliptical. Here is a difficulty I cannot solve. I will endeavour to state it.

With decrease of ellipticity the time-average value of the earth's radius vector, $a\ (1+e^2/2)$, grows less. As the radius vector decreases the sun's perturbing influence on the moon increases. With increased perturbance the moon's motion is retarded. But the moon is known to be accelerated. There is then some flaw in the above reasoning which I cannot find. I crave help from one of your astronomical readers.

HAMPSTEAD, N.W. C. O. BARTRUM.

THE FOURTH DIMENSION.

To the Editors of "KNOWLEDGE."

SIRS,—I was very greatly interested in Mr. A. L. Annison's paper on "The Fourth Dimension" appearing in your issue for June, 1911. The writer, I think, very clearly shows that there is no valid reason why the "fourth dimension" should not actually exist; but, it may be asked, does this amount to a proof that the "fourth dimension" does actually exist? I hardly think that we may answer, yes; and it is for this reason that I venture to write to you, sirs, in order to call attention to my own work upon the subject, because I believe that I have been able to demonstrate, assuming the truth (1) of the Euclidean conception of space, (2) of the principle of the continuity of mathematical law, that the fourth and higher dimensions do actually exist; the existence of a third dimension of space implying that of a fourth, and so on, to infinity. As to the first of the above postulates (the truth of the Euclidean conception of space), all our experience supports it; but at the same time, I believe the wording of my proof might be modified so as to apply in the cases of the elliptic and hyperbolic space-hypotheses as well as the parabolic or Euclidean. As to the second postulate, this is altogether in accord with all our experience, and is, therefore, rightly employed in discovering facts which lie without the same.

A *very* brief statement of my proof, which was originally presented at a meeting of the Polytechnic Mathematical Society, appeared in a letter to the then editors of "KNOWLEDGE," which appeared in "KNOWLEDGE" for July, 1908 (Vol. V, page 157). A fuller statement will be found in my "Matter, Spirit and the Cosmos" (Rider, 1910), Chapter 6, together with some speculations bearing upon the same subject.

Thanking you in anticipation for affording this letter the hospitality of your columns.

H. STANLEY REDGROVE.

THE POLYTECHNIC,
REGENT STREET, W.

OBSERVATION OF URANUS AND MARS.

To the Editors of "KNOWLEDGE."

SIRS,—Uranus was observed on the early morning of July 1st, being located by aid of the circles on the equatorial of my three-inch Mogey refractor; this is the first observation of this planet I have made this year. It was pale blue or green in colour, quite bright, and very attractive in its field of few other and fainter stars. It presented quite a sensible disc, power eighty-four diameters, and appeared as it usually does, *i.e.*, pale and diffused, like a star slightly out of focus. It is of about magnification six, probably some brighter, and is easily visible in the one and one-eighth inches finder of my three-inch telescope; as it is the only bright star in its locality, it should be easily distinguishable even with an opera glass. Probably Uranus would be visible to the naked eye in clear air, especially as it is in an isolated position, to speak relatively.

Mars was also observed on the morning of July 1st. The disc was rather large and very reddish, powers eighty-four and one hundred and twenty-six, and was very beautiful; near a small star. The South polar cap was easily observable, eighty-four and one hundred and twenty-six diameters, in my three-inch instrument, and was attractive, being almost circular and very white. At and around the South polar regions, the disc was lighter than elsewhere and seemed to shade off gradually into the cap. At or near the equatorial regions, an apparently large continuous marking, running horizontally, was seen, very similar to those visible in the fall of 1909, through my two and a half inches refractor. This marking was dark green in colour, and extended nearly the entire distance across the disc, and at places was observed to be somewhat irregular in outline. The planet also seemed to be slightly gibbous on this date.

FREDERICK C. LEONARD.

LEONARD OBSERVATORY,
MADISON PARK,
CHICAGO, U.S.A.

SOLAR DISTURBANCES DURING JUNE, 1911.

By FRANK C. DENNETT.

THE Sun has been very free from spot disturbances during the month of June. On the eleven days June 7, 8, 10-14, 16, 18, 19 and 24, there appeared to be a complete absence of disturbance, and probably the 25th should be added, although no observations have come to hand for that date. Only faculic markings were seen on the disc upon the nine days June 6, 9, 15, 17, 20-22, 27 and 28, and some of these appeared to be temporary in character. The longitude of the central meridian at noon on June 1st, was 102° 45′.

No. 24 remained visible until June 5th, and so appears on the present chart in its position on the 2nd.

No. 24*a*.—A group of four small pores, 15,000 miles in length on the 2nd, which in the afternoon appeared to be developing into an elliptical outbreak, but only the leader continued visible on the 3rd. The area was marked by faculae, upon the 4th and 5th, which was joined to that surrounding No. 24.

No. 25.—A group of pores, three in number, only seen on June 23rd.

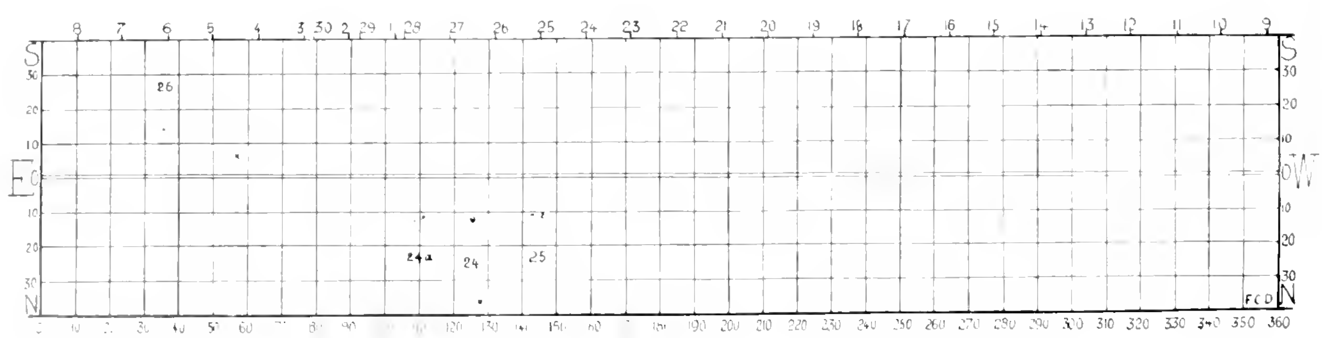
There was a greyish pore visible on the morning of June 28th in a pale faculic cloud near longitude 57°, South latitude 6°, marked by a cross on the chart, but not seen in the evening.

No. 26.—A spotlet, without penumbra, seen on the 29th and 30th only.

Whether studied with the telescope or spectroscope, the amount of disturbance is very small. The spots are generally of an evanescent character, and are mostly found recurring in the same districts of the solar surface, as may be noted by comparing the monthly charts together. Of the thirty-one spot disturbances recorded during the past six months seven were northern. Of these one was in longitude 7°, four between 103° and 146°, one close to the equator, 170°, and one at 226°. Of the twenty-four southern ones nine are between longtitudes 35° and 86°, two between 120° and 130° eleven between 165° and 203°, and the remaining two between 243° and 253°. The intervening areas are thus left seemingly without disturbance, in fact, from longitude 146° right round to 103°—317°—in the northern hemisphere, only three tiny outbreaks occur. The longest vacant district in the southern hemisphere—140°—is between 254° and 35°, three smaller ones occurring between 86° and 120°, 130° and 165°, and 203° to 243°.

Our chart is constructed from the measures and drawings of Messrs. J. McHarg, E. E. Peacock, and F. C. Dennett. Absence from home has unfortunately prevented Mr. Buss from sending in his work in time to be included this month.

DAY OF JUNE, 1911.



NOTES.

ASTRONOMY.

By A. C. D. Crommelin, D.Sc., B.A.

COMETS.—Two comets have been found in the last few weeks. One is Wolf's Periodic Comet, a well-known member of the Jupiter family, which was photographically detected by its original discoverer, Dr. Wolf, when only of the fifteenth magnitude. It was extraordinarily close to the place predicted by M. Kamensky, the error being $0^s\cdot5$ in R.A., $6''$ in Decl. This comet will not pass perihelion till February, 1912, and is, therefore, still at a considerable distance from the Sun.

The other comet is an unexpected one, and promises to be faintly visible to the naked eye. In fact, M. Belopolsky gives its magnitude as $4\cdot0$, on July 9th, and states that it had a tail $\frac{1}{2}^\circ$ in length, in direction 285°. The comet was discovered on July 6th, by Mr. Kiess, at the Lick Observatory, and will therefore bear his name. Professor Kobold, of Kiel, has deduced these elements: Perihelion passage, 1911, June $20\cdot64$, Berlin M.T., Omega $99^\circ\ 32'$, Node $172^\circ\ 28'$, Inclination $148^\circ\ 39'$, Perihelion distance $0\cdot7932$. The comet is now receding from the Sun, but at the same time its position in the sky is becoming more favourable, as it is getting $1\frac{1}{2}^\circ$ further from the Sun in angular distance each day, and is also rapidly approaching the Earth, which it will continue to do till nearly the end of August, when it will be distant some thirty-five million miles, and observable for the greater part of the night.

An interesting feature in this orbit is its close resemblance to that of the comet 1790 I, which was discovered by Miss Caroline Herschel in January, 1790, but only seen on four days. When the new comet has been observed for a month or so, it will be possible to decide the question of identity. Even a close resemblance of orbit is not a proof of identity, for there are several instances of families of comets that travel in practically the same path. The most striking instance is that of the very brilliant comets of 1843, 1880, 1882, 1887. There can be little doubt of common origin in these cases.

This generation has probably seen its last of Halley's comet. Professor Barnard followed it visually till May 24th, and it was photographed at the Lick Observatory till May 27th. It was then outside Jupiter's orbit, and the total period of observation is one and three-quarter years. Doubtless further attempts at photography will be made when it emerges from the sun's rays in the autumn, but their success is doubtful.

It is likely that the large number of periodic comets that have been visible during the last two years has distracted the attention of observers from the search for new ones. I would suggest this as a promising field for amateurs with leisure for sweeping; a three-inch telescope with a low-power eyepiece is sufficient equipment; I think few have seriously taken up this work without success before very long.

THE EIGHTH SATELLITE OF JUPITER.—In addition to the photograph obtained at Helwan, Egypt, Dr. Wolf, at Heidelberg, and Mr. Innes, at Johannesburg, have succeeded in obtaining images of this seventeenth magnitude satellite. This success is very satisfactory in view of the fact that it will be unobservable at Greenwich till 1915, and gives ground for hope that the interval will be bridged over satisfactorily. A number of minor planets, both old and new, were recorded on the plates. About seven hundred of these little bodies are now definitely numbered, and hundreds more have been observed, but their orbits are not accurately known. The zone shows no signs of exhaustion, and the calculation of their orbits and ephemerides is a severe tax on the Berlin Recheninstitut.

TOTAL ECLIPSES.—The eclipse of last April was not a complete failure as observed from Vavau and neighbouring islands in the Pacific. Records of the general form of the corona (approximating to the type of sunspot-minimum) were obtained and we may hope for a few spectroscopic results. But evidently the great humidity of the climate was a drawback, as the fall of temperature caused condensation of vapour. There is a favourable totality in October, 1912, the track crossing Brazil, and emerging a little west of Rio. It is expected that two parties will go from this country to view it, and doubtless other nations will be represented. In April, 1912, there will be totality for a second or two in Portugal and N.W. Spain. It will be a particularly favourable occasion for obtaining impressions of the reversing layer all round the sun, and it should be possible to photograph the inner corona with rapid plates. Great care will be required in selecting a station, its accurate longitude and latitude must be known, as the track of totality is less than a mile broad. Those who desire to witness the eclipse as a spectacle without doing serious work may go to the north-west outskirts of Paris. There will not be absolute totality there, but I anticipate that there will only be a few small patches of sunlight through depressed portions of the moon's limb, not a complete ring. This eclipse is a return after the triple Saros of that of 1858, the last central eclipse in the British Isles. The next will be 1921 (annular, Hebrides and Shetlands) and 1927 (total across Wales and England).

BOTANY.

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

ORIGIN OF CHLOROPLASTS IN SEEDLINGS.—Two widely divergent views have been held with regard to the origin of chloroplasts (chlorophyll grains) in seedlings. According to one view, the chloroplasts originate directly from the general protoplasm of the cell, the mature seed itself containing no chloroplasts. Another group of investigators maintains that the protoplasm of the cell never gives rise to chloroplasts, but that the fertilised egg contains plastids derived directly from the parent plant, and that during development of the egg these multiply and thus provide every cell of the embryo with chloroplasts.

According to Sachs, the chloroplasts arise in the young cells by the separation of the protoplasm into portions which remain colourless and others which become green and sharply defined. He held that the process takes place by very small particles, originally of a different nature from the apparently homogeneous protoplasm in which they are distributed, collecting at definite places and appearing as separate masses.

Mikosch, after examining the seeds and seedlings of the sunflower, concluded that there are no plastids in the resting seed, but that during germination the chloroplasts arise directly from the protoplasm of the cells, owing to condensation of the protoplasm in definite places, this condensation being probably due to loss of water in these parts, which soon become green. The process occurs independently of light, and the bodies thus formed are at first rod or spindle shaped, but later assume the typical disc shape of the chloroplasts.

Belzung, after a long investigation of the ripening seeds, mature resting seeds, and seedlings of many plants, came to the following conclusions: (1) the free growth of starch grains can take place without the intervention of plastids; (2) the chloroplasts are formed directly by differentiation of the protoplasm; (3) the chloroplasts can also be formed at the expense of the starch grains which have their origin in the protoplasm of the cell. According to Belzung, the young embryo contains no chloroplasts, the starch grains formed in it are laid down in vacuoles of the protoplasm, and the green colour of the embryo in many plants is due to green pigment distributed through the protoplasm. No chromatophores are present in the embryo, consequently there are none in the mature seed. At germination the simple starch grains of the seed disintegrate, and numerous compound grains of transitory starch appear in various parts of the protoplasm. Each large vacuole is composed of from two to five smaller ones, in each of which a small starch grain is formed, and as the compound grain thus formed disappears, the green pigment passes in and thus a chloroplast is formed.

Meyer and Schimper, on the other hand, concluded that the origin of chromatophores does not take place in the young cell in any of the cases investigated by them, but that all chromatophores are derived from other cells in which they previously existed, increasing in number by division. Schimper found chloroplasts in the embryo-sac and the egg-cell, and concluded that the chloroplasts thus present in the young embryo persist in the ripening seed, but become colourless and lose their function, again becoming green and functional when germination occurs.

Bredow made extensive observations on seeds, and found that chloroplasts were always present, though often staining very poorly and being therefore hard to detect. Bredow used chiefly picric acid, which colours all proteid material yellow, but stains plastids more deeply than the other cell contents. He found that the chloroplasts of the seed increase during germination by simple fission, and also by the division of one chloroplast into as many as ten or twelve small ones by numerous irregular divisions. He pointed out that the greening of these numerous small bodies led the earlier observers to conclude that the chloroplast originates directly from the protoplasm of the cells of the seedling.

Famintzin made still more detailed observations on the origin of chloroplasts in seedlings, and especially on the manner in which the chloroplasts, if present in the seed, increase by division. Applying various microchemical reagents and stains, and using chiefly the sunflower, Famintzin was able to distinguish between the protein grains on one hand, and the chloroplasts and other protoplasmic structures on the other. He found that most of the chloroplasts in the resting seed lie in the film of protoplasm which surrounds each of the protein grains. On placing fresh sections in the light, he observed that these small bodies on the protein grains took on a yellowish colour, and by identifying these bodies in various stages of the seedling, he concluded that the sunflower seed contains chloroplasts, which by simple fission produce those of the seedling.

The latest investigator of this subject is Miller (*Bot. Gazette*, 1911), who has just published the results of his observations on the sunflower, applying the modern methods of fixing, microtome section-cutting, and staining. Miller confirms the statements of Bredow and Famintzin, who showed that chloroplasts are present in the resting seed and give rise to those of the seedling. Instead of beginning with the young embryo, and working onwards to the seedling, however, Miller has adopted the better method of working back step by step from the seedling to the seed. According to Miller, the chloroplasts in the early stages are present in the usual position in the cell, namely, just within the cell wall. He found the numerous small bodies clustered about the protein grains, but he does not agree with Famintzin that these are the chloroplasts.

ALGAL COAL.—The petroleum-yielding coals known as bog-head, cannel, and so on, have been supposed to owe their origin to Algae. This view, put forward by Renault, Bertrand, Potonié, and other workers in fossil botany, has been somewhat widely accepted. The chief evidence of such an origin is the occurrence in these coals, as well as in bituminous schists and oil shales, of abundant spherical or oval bodies, often arranged in layers, these bodies being interpreted as colonial Algae. They have recently been investigated by Jeffrey (*Proc. Amer. Acad.*, Vol. XLVI., 1910), who has elaborated a method for obtaining numerous thin sections in series, the result being that the structure, and by inference the nature, of these bodies can be brought out with a clearness not hitherto possible.

Jeffrey shows that these bodies are certainly not Algae, but the spores of Pteridophytes and other fern-like plants, which formed an important part of the Palaeozoic flora and which have always been regarded as largely responsible for the formation of ordinary coal. This conclusion destroys the Algal theory of the origin of petroleum and similar substances, and refers such products to the waxy and resinous spores of Pteridophytes, which were laid down on the bottoms of the shallow lakes of the Coal Period. These lacustrine layers, the mother-substance of petroleum, form either cannels, bogheads, or bituminous shales, according to the proportion of spores and the admixture of earthy matter. Pressure and temperature, either separately or combined, in the presence of permeable strata, have brought about the distillation of petroleum from such deposits.

ALKALOIDS AS PLANT FOOD.—It has always been supposed that the various alkaloids found in plant tissues are purely waste products, not entering again into metabolism. However, some recent observations by Comère (*Bull. Soc. Bot. France*, Vol. LVII., 1910) appear to show that some of the alkaloids can be used as food materials. In fact, Comère finds that some alkaloids can be used by plants as the sole source of nitrogen. He worked with the freshwater Algae *Ulothrix* and *Spirogyra*. The alkaloids used (morphine, atropine, cocaine, quinine, and strychnine) were added gradually as assimilated, so that the plants were never subjected to strong solutions. The plants readily assimilated morphine and atropine, and less readily cocaine. Quinine, however, could not be assimilated, while strychnine proved very poisonous even in great dilution.

RESERVE FOOD IN BORDERED PITS.—It has become a commonplace that the most familiar plant repays renewed investigation. A short time ago, it was found that the so-called "scalariform tracheids" of the common male fern and the Bracken, which have served generations of botanical students as types of the fern alliance for dissection and laboratory work, are in reality true vessels similar to those in the wood of the higher plants. Recently, Lakon (*Ber. deutsch. bot. Ges.*, 1911), has shown that the familiar bordered pits in the tracheids of the common coniferous trees, Scots pine and spruce fir, contain at certain stages numerous starch grains and oil drops, and therefore evidently serve as storehouses of food in addition to their ordinary functions in connection with transport of water. Lakon states that while making observations on the reserve foods in various trees, he noticed starch and oil in the pits of the tracheids. At first he thought that some starch and oil must have simply got into these pits by accident from the parenchyma cells of the medullary rays, in the process of section cutting. However, on making more careful preparations he proved that the starch and oil actually occur in the pits, even where the tracheids are not in contact with parenchyma cells, and he found them in microtome sections of material embedded in paraffin—that is, under circumstances which precluded the possibility of the accidental passage of starch and oil into the tracheids from the other tissues of the wood.

Having clearly established the fact itself, Lakon proceeds to its explanation. Two alternatives are possible:—(1) the starch and oil may have been left behind in the pits while the tracheid was developing from a living and food-bearing cell; (2) some of the protoplasm of the tracheid-forming cell may have persisted in the pits, the glucose in the cell-sap being later converted into starch and oil. Lakon inclines to the second explanation. He finds that during the winter, when the parenchyma cells of the rays contain only oil, the pits of the tracheids also contain oil and not starch; and that in spring, when the parenchyma cells contain much starch and little oil, the same change occurs in the pits. Since a change of this kind could hardly occur in the absence of living protoplasm, it appears probable that such protoplasm is present in the bordered pits, and Lakon was able to demonstrate this in some cases.

Lakon states that in the literature there is only one recorded case where protoplasm, starch and oil occur in the fully developed conducting tissue elements of vascular plants, namely, in the stem of various species of plantain (*Plantago*). In the conifers investigated by Lakon, the protoplasmic remains, with the starch grains and oil drops, may persist for several years; they occur only in the younger parts of the wood, but as far inwards as the fifth or sixth annual ring.

AMBROSIA FUNGI.—In continuing his interesting series of papers on Ambrosia Fungi, which have already been noted in "KNOWLEDGE," (May, 1910), Neger adds some further details (*Ber. deutsch. bot. Ges.*, 1911). Neger applies the term "ambrosia" to the Fungus cells which the associated insects eat, as well as to the insects themselves. The insects, including various beetles, mites, and so on, bore in the bark and wood of trees, and the cavities of the galls or tunnels they produce are lined by the Fungus layer which produces the special spherical "ambrosia" cells, serving for the food of the insect. This is, doubtless, a curious case of symbiosis, or mutually beneficial partnership, the insects on one hand being well fed by the Fungus, while the Fungus on the other hand takes advantage of the boring of the insects to gain entrance to the plant tissues and also gets a better supply of air opened up for it.

In his last paper, Neger concludes that the association between the boring beetles and the Fungus is an adaptation on the part of the former to life in wood poor in food substances. The ambrosia-seeking insects are much commoner in the warm and tropical zones than in the cool temperate regions, and they occur not only in standing trees but also in fallen ones, which are not yet dead. In the tropics, such insects often cause great damage to valuable trees yielding rubber, coffee, tea, and so on. This destructive action is not due merely to the attacks of the insects themselves, but to the fact that they introduce the Fungus to the conducting tissue of the wood, and probably more harm is done by the parasites which gain admittance in this way than by the Ambrosia Fungus on which the insects feed.

Neger has cultivated the Fungus found associated with various wood-boring beetles (chiefly species of *Xyleborus*) in order to obtain the spores and to determine its systematic position. Apparently the majority of the Ambrosia Fungi are either identical with, or closely allied to, the simple Ascomycetous genus *Endomyces*.

CELLOSE AND CELLASE.—It has long been known that, just as starch is converted into grape sugar (glucose) by the action of the ferment diastase, so cellulose—the chief component of the cell-walls of plants—is changed into glucose by the action of the ferment cytase. If, however, the hydrolysis of starch is incomplete, the resulting sugar is malt sugar (maltose), and it has recently been found that the corresponding product of incomplete hydrolysis in the case of cellulose is a substance called cellose. Bertrand and Holderer (*Bull Soc. Chim. France*, 1910), have discovered that cellose is converted into glucose by a special ferment, cellase. These authors find that cellose is not acted upon by such ferments as maltase, sucrase, and emulsin. This discovery indicates that there are probably many more ferments in plants than have hitherto been recognised, and that like so many other ferment actions, the digestion of cellulose takes place in several stages.

THE ECOLOGY OF CONIFERS.—The leaves of the conifers show markedly "xerophilous" structure, having thick cuticle, sunken stomata, reduced leaf-surface, poorly-developed air spaces, and so on,—all features characteristic of plants which grow in physically or physiologically dry places, and which must therefore check loss of water by transpiration. It is somewhat difficult, however, to reconcile this xerophilous structure with the fact that conifers often grow in places where apparently there is an abundant water supply, and it has been supposed that in such cases the xerophily is a character fixed by heredity. It has been suggested that the xerophilous leaf structure of conifers is due to the hereditary tracheïdal character of the wood—that is, the presence of narrow tracheïds instead of wide and open vessels—and the consequent limitation of the rate of flow of the water current. But this explanation breaks down, for the Larch shows a rate of flow of water equal to that seen in most dicotyledonous plants.

The assumption that a character shows hereditary fixity is one which calls for independent evidence quite apart from the supposed incompatibility of structure and habitat. The recent work of Groom (*Ann. Bot.*, 1910) has shown that it is fallacious to judge of the xerophily of a plant from its leaf structure alone, and that a factor of fundamental importance is the total leaf area. Groom considers that the northern evergreen conifers are "architectural xerophytes," in which the extensive surface exposed by the evergreen leaves as a whole renders it necessary for the individual leaves to be xerophilous in structure. He thinks it possible that concurrent increases in the assimilatory surface, and in the zerophilous devices generally, increase assimilation in relation to transpiration; but that in the absence of detailed statistics bearing on the subject it is impossible to explain why the conifers should have adopted the device of having a large aggregate surface with a greater degree of xerophytism.

Coulter and Chamberlain (*Morphology of Gymnosperms*) adopt a similar view, implying that the plant is extremely plastic and that in matters of adaptation it will always come to adopt that habit and structure which give the greatest degree of efficiency under the given environmental conditions. Coulter and Chamberlain consider that the development of the small and stiff needle-like leaves or the concrescent scales of conifers from their assumed broad-leaved ancestors "cannot be regarded as the result of a general tendency among Gymnosperms quite unrelated to conditions of living; the leaf is too variable a structure and too closely related in its work to external conditions to permit such an explanation of its changes."

Compton (*New Phytologist*, March, 1911) criticises these views, and urges that the small-leaved type is the primitive one for conifers and is extremely stable. The primitiveness of small leaves in conifers is bound up with Seward's well-known theory that conifers arose from club-mosses (Lycopodiales), but even if the ancestors of the conifers were large-leaved plants, it must be admitted that the same type of small-leaved conifers had persisted from later Palaeozoic times to the present day. The variety in habitat of modern conifers is correlated with less variety in their structure, relations of leaves to stem, size of leaves, and so on, than in the case of Angiosperms. The larch, with its deciduous habit and lesser degree of structural protection against transpiration, but with its retention of the small leaves, is a striking example of the persistence of the typically coniferous form of leaf. The deciduous species of swamp cypress (*Taxodium*) and *Glyptostrobus* also inhabit swampy places without modification of the type of leaf form. In *Phyllocladus* the plant has resorted to the device of producing flattened branches instead of increasing the size of its leaves.

It would appear, therefore, that the coniferae have small power to vary the character of their leaves. The predominant types—the needle-like leaves of pines, firs, larch, cedar, and so on, the lineal lanceolate leaves of yew, and so on, the scale-like appressed and concrescent leaves of cypress, and so on,—are all closely related to each other. The leaf development is in all cases small compared with that of the stem—that is, the conifers are fixedly small-leaved. This appears to be connected with the absence of lateral veining of the vascular bundles in the leaf. In most cases a single or double bundle runs from end to end of the leaf without branching; and even in Araucarias and other forms, where the leaf is broader and many-veined, there is not found that copious lateral branching and anastomosing of the veins which is associated with the free branching of so many dicotyledonous leaves. The failure of the bundles to branch is to some extent compensated by the development of transfusion tissue—this is also found in some fossil lycopods where the same limitation of the power of branching prevails, along with small leaves and often xerophilous structure.

Hence it appears that the conifers are rigidly small-leaved forms, and that the power of freely adapting themselves to ecological conditions is strictly limited by the lack of plasticity in leaf structure. It is suggested that the lack of ability of the foliar vascular system to branch with ease is one of the causes which have contributed to keeping the leaf small, and that this failure may possibly be associated with the presence of transfusion tissue, which, though valuable in itself under the circumstances, may tend to prevent improvement in other directions, such as that of free pinnation of the veins.

Given this cramped hereditary type of structure, ecological adaptation appears to have been the result of two processes going on simultaneously: (1) the development of enormous numbers of the rigidly-constructed leaves with a view to increased assimilation and growth, and (2) the production of xerophily in the individual leaves as a compensation for the resulting increase of surface. It thus seems clear that the hereditary factor is of great importance in the ecological relationships of the conifers. It is conceivable that ecological adaptation may be achieved as efficiently by a suitable modification of the small-leaved type as by another kind of modification of a broad-leaved type—in fact, more than one kind of mechanism may be well adapted to a given set of external conditions. The conifers, however, are predisposed to the adoption of "architectural xerophily" as their mode of adaptation by the persistent hereditary factor of microphylly (possession of small leaves).

THE MAIDENHAIR TREE (*GINKGO BILOBA*).—One of the most interesting groups of Gymnosperms is that which is now represented only by the Maidenhair Tree. The Ginkgotype is of special importance because its reproductive organs show many resemblances to those of the lower Gymnosperms (Cycads and Cordaitales), while its vegetative anatomy resembles in many ways that of the Conifers, so that it may be said to form a connecting link between these groups.

The Maidenhair Tree, as the sole survivor of a family which was well represented in the Mesozoic Period, and perhaps much earlier, has naturally attracted a great deal of attention from botanists, and it is proposed here to summarise some of the literature on *Ginkgo* published during the last few years, including the most recent accounts.

Ginkgo is almost unknown in the wild state, though reported by travellers in the forests of western and south-western China, but it has been extensively cultivated, first in China and Japan, and later in Europe—there is a fine tree in Kew Gardens, for instance. Apart from the strong main trunk and wide-spreading branches, it hardly resembles in habit any of the other Gymnosperms, while its deciduous leaves, having a long slender stalk and a broad wedge-like blade with repeatedly forked veins (strongly suggesting the leaves of Maidenhair Fern), are so characteristic that they form unusually trustworthy evidence of the existence of the Ginkgoales when found in the fossil state. The tree reaches a height of about one hundred feet. The branches are of two kinds; the long shoots bear scattered leaves, while the short ones are dwarfed, slow-growing, and bear few leaves in a cluster. A dwarf shoot may after several years become a long shoot, bearing scattered leaves, and may then resume the slow growth of the dwarf shoot; sometimes it undergoes branching.

The general morphology and anatomy of *Ginkgo* have been described by Seward and Gowan (*Ann. Bot.*, 1900) and in greater detail by Sprecher in his invaluable monograph of this plant (Geneva, 1907), while various details have been added by recent writers. The stem shows the general structure of a conifer, having a narrow cortex, a thick compact zone of wood produced by a persistent cambium layer (contrasting with Cycads), and a relatively small pith (contrasting with Cordaitales); in thed warf shoots, however, the wood zone is narrow and the pitch large. As in the pines and other low conifers, there are well-marked annual rings, and the tracheids have opposite pits and "bars of Sanio."

Tupper (*Bot. Gaz.*, 1911) has shown that frequently the short shoots branch within the wood of the limb out of which they grow, this has recently been seen in a new Triassic Araucarian, *Woodworthia*, but in no other conifers so far as known, and confirms the view that the araucarian conifers are an old group and have possibly come from the same stock as the ginkgoales. Tupper also describes crystal cells and wood parenchyma as occurring in rows or series running longitudinally through the root of *Ginkgo* in radial planes; all these rows are in contact with at least one of the medullary rays, and Tupper suggests that the radial distribution of this parenchyma, as compared with the tangential arrangement seen in conifers, shows that *Ginkgo* is a primitive type.

The primary wood in the stem is endarch (with the earliest wood vessels innermost, and the development of the wood therefore centrifugal), but distinct mesarch structure (*i.e.*, part of the wood centripetal, the rest centrifugal, therefore the protoxylem not innermost) occurs in the bundles of the cotyledons. The leaf receives a double bundle (leaf trace), as in all the more primitive gymnosperms, each bundle forking at the base of the blade and breaking up into the forking system of veins, some of which show traces of centripetal wood and therefore indistinct mesarch structure. The veins are not joined up into a network, so that if a few veins are cut across near the base of the leaf, long streaks of the leaf become withered and dry. The leaves vary much in size and lobing, showing every transition from deeply lobed to almost entire, though typically there is a notch at the middle of the blade. The leaf structure resembles that in cycads; the stomata are chiefly on the underside, and between the veins the loose mesophyll cells are elongated parallel with the leaf surface.

The plant is dioecious; the flowers have no bracts, and they are developed on the dwarf shoots. The male flowers or cones consist of an axis bearing loosely arranged stamens; each stamen has a stalk ending in a knob which bears usually two pendent stamens, sometimes three or four or as many as seven. Miss Starr (*Bot. Gaz.*, 1910) has shown that in the young knob there develop, in addition to the stamens, patches of apparently sporogenous tissue which degenerate into mucilage cavities, suggesting that these cavities have replaced abortive sporogenous tissue.

The stamen of *Ginkgo* suggests comparison with the epaulet-like form seen in the "crossotheca" type of stamen in the pteridosperms. It may also be compared with the stamens of the cordaitales, the whole male dwarf shoot of *Ginkgo* corresponding to the male inflorescence of cordaites, which consists of a thick axis bearing bracts among which are inserted the stamens, each stamen consisting of a long stalk bearing at its tip a cluster of three to six erect pollen-sacs. If the sterile sporophylls in the *Cordaites* cone were suppressed, the general structure of the male flower of *Ginkgo* would be attained, but in *Ginkgo* the pollen-sacs are borne in a different way, being dependent on the lower side of the knob or reduced blade of the stamen. In *Antholithus zeilleri*, regarded as the male cone of *Baiera* (a Mesozoic member of the Ginkgoales), the stamens are repeatedly forked and bear eight pollen-sacs, one on each of the ultimate divisions. Whatever interpretation is placed on these different structures, the facts point to close relationship between ginkgoales, cordaitales and pteridosperms.

The female cones are much reduced, and are carried in groups on dwarf shoots. Each cone consists of a long stalk bearing at its tip two ovules, sometimes more, and below each ovule there is a narrow cup or collar. The latter has given rise to much discussion. Fujii and, later, Seward and Gowan, were led by the study of numerous abnormal forms to conclude that the stalk is a shoot bearing normally two rudimentary carpels represented by the two collars. However, Shaw (*New Phytologist*, 1908), examining the vascular structure of the flower, found that the bundles of the collar show inverse orientation, and suggested that the collar is no carpel but a vestige of the cupule that surrounded the seeds of the pteridosperm genus *Lagenostoma*. If correct, this would even more strongly point to an affinity between ginkgoales and pteridosperms. Shaw regards the general anatomy of the female axis and the occasional occurrence of an apical bud between the ovules as proof that it is a shoot bearing two lateral-stalked ovules, each ovule being attached to the axis by a short pedicel, with the collar at the junction between pedicel and ovule. On the other hand, the female axis has four bundles, which would be expected in a stem bearing two leaves (collars) at its apex, and when there are more than two ovules on a stalk we find twice as many bundles in the stalk as there are ovules at its apex—just as there should be if each collar were a carpel.

The development of the microsporangium (pollen-sac) has recently been described by Miss Starr, and it mature structure and mode of dehiscence by Goebel. In development, apparently a single hypodermal cell divides to form the tapetal and sporogenous tissue, and, outside of the tapetum, the wall of the sac (except the outermost or epidermis layer). The wall consists of from four to seven layers of cells, the hypodermal layer and the layer below it being thickened by fibres serving for dehiscence. Goebel (*Flora*, 1902) has studied the structure of the wall of the ripe pollen-sac; apparently *Ginkgo* is the only gymnosperm that has an endothecium, the dehiscence layer or layers being of hypodermal origin; the longitudinal slits of dehiscence of the two pollen-sacs face each other, and lie at such an angle that the pollen is readily shed for wind dispersal.

The development of the ovule has recently been worked out by Miss Carothers (*Bot. Gaz.*, 1907), who extends the earlier accounts. The ovule resembles in general structure those of cycads and cordaitales, having the typical three-layered integument (outer fleshy, middle stony, inner fleshy), the apical beak of the nucellus, and the pollen chamber; but the set of bundles which in cycads and cordaitales traverse the outer fleshy layer are not present in *Ginkgo*, only the inner bundles in the inner fleshy layer. A single mother-cell (very rarely two mother-cells) functions, and lies among a mass of tissue which may or not be sporogenous, representing a many-layered archesporium, but at any rate functions as a tapetum nutritive tissue. In the mature mother-cell the reduced number of chromosomes is eight; the four spores formed by division of the mother-cell may be in a row, or three with the upper cell divided longitudinally. The tapetal tissue increases in bulk by division, during the tetred division of the mother-cell, and actively encroaches upon the surrounding nucellar tissue; the tapetal zone in its turn begins to be destroyed by the encroachment of the young gametophyte (endosperm), which invades and destroys the tapetal tissue and the surrounding nucellar tissue. The megaspore, which has a well-developed membrane, enlarges greatly, and its nucleus lies at the micropyle end.

Miss Carothers then describes the development of the female prothallus (endosperm). The megaspore, after its nucleus begins to divide, contains a large vacuole, hence the nuclei formed by division are from the first arranged just within the membrane, lying in the thin protoplasmic lining layer. Up to the stage with sixty-four nuclei, the free nuclear divisions are simultaneous, but later they become irregular, until there are over two hundred and fifty-six nuclei; meanwhile the whole ovule and the embryo-sac are enlarging, and the megaspore membrane becoming thicker. Previous to the formation of walls, a delicate but distinct membrane appears on the outer surface of the protoplasm of the embryo-sac, and to this membrane (not to the megaspore membrane, as previously supposed) the first walls of the endosperm are attached; then by the nuclear division and wall formation the prothallus becomes a solid mass of tissue. Before this process is complete, the endosperm becomes green, owing to formation of chlorophyll, as proved by examination with the spectroscope, and the cells are soon filled with starch grains—partly formed no doubt by the green endosperm itself.

The germination of the pollen-grains, the formation of the remarkable ciliated motile male cells, and the act of fertilisation of the two (sometimes three) archegonia were fully described by Hirasé in 1898, and little has been added to his account. Various more recent writers have, however, worked out the development of the embryo. The embryo of Ginkgo was formerly regarded as peculiar among Gymnosperms, owing to the absence of an elongated suspensor, such as occurs in Cycads and Conifers. In *Bennettites*, however, there was no suspensor. Arnoldi (1903) showed that the elongated pro-embryo of Ginkgo is differentiated into three regions:—(1) a micropylar haustorial region, [illegible] middle suspensor region, and (3) an apical region producing the embryo itself; this brings *Ginkgo* into line with the typical embryology of other Gymnosperms, though the suspensor remains short and thick. Another peculiarity in the embryo of *Ginkgo*—the complete filling of the fertilised egg with proembryonic tissue—has lost significance by the discovery that the same thing occurs in *Dioon* and probably some other Cycads. Lyon (1904) gave a very full account of the development of the embryo in *Ginkgo*, greatly amplifying the descriptions given by Strasburger (1872) and other previous authors; in some cases the pro-embryo apparently produces two embryos; three cotyledons occur not uncommonly, instead of two.

CHEMISTRY.

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

USE OF COPPER FOR WATER PIPES.—The owners of a house in Paris, being anxious to instal copper pipes instead of the usual leaden pipes for their water supply, applied to the Prefect of the Seine for the necessary permission. The question was therefore submitted to the Municipal Laboratory in Paris, which reported unfavourably upon the proposal, and also to the Council of Public Hygiene, the head of which, Professor Armand Gautier, spoke strongly in its favour. In his report he pointed out that lead was really an unsuitable metal for water pipes, and that the purer the water the more rapidly was the metal attacked. Although the presence of sulphates in most drinking waters rendered the risk of poisoning insignificant, it was probable, he pointed out, that there would be trouble in the immediate future from this cause in the case of the particularly soft waters which have recently been supplied to the towns in the West of France.

This danger would be entirely obviated by the use of copper pipes, for although a dose of fifty to one hundred milligrammes of copper sulphate was poisonous, the system could soon become acclimatised to much greater quantities, and, as a matter of fact, several milligrammes were frequently absorbed daily without any ill effect in the food which throughout France was cooked in copper vessels. Experiments made by M. Gautier upon himself had shown that no ill effects were produced by acid food that had been cooked in copper utensils. Long before the poisonous dose had been reached a liquid contaminated with copper would have acquired a harsh metallic taste which would put the consumer upon his guard, and this would be the worst that could happen in the exceptional cases where water would attack the pipes. With leaden pipes, however, a poisonous dose could be present in the water without its being detected by the taste. There was, therefore, in his opinion, only benefit to be derived from the substitution of copper for leaden pipes for the supply of water to houses.

The report of Professor Gautier, the chief points of which are summarised above, is published in the current issue of *Biologica* (1911, VI, 79). His conclusions agree with those of the American chemists and doctors who have advocated the use of copper sulphate and metallic copper for the sterilisation of drinking water. Readers of these columns will also remember that copper sulphate is now used upon a large scale in America for destroying the pond scum upon the water reservoirs.

GRECIAN BLACK ENAMEL.—The rich black lustre upon Grecian and Roman pottery has long been attributed to the presence of manganese, but according to M. L. Franchet, who has recently studied the question (*Comptes Rendus*, 1191, CLII, 1097), the proportion of manganese is altogether insufficient to produce the effect upon the ancient vases. The suggestion made by Verneuil that the Greeks made use of metallic iron obtained by the reduction of an oxide, is not in accord with the statements of ancient writers, who assert that natural products were employed.

Since the mineral magnetite was known to the Romans, who obtained it from Piedmont, M. Franchet has made experiments with that natural ferroso-ferric oxide, and, by fusing it in an oxidising flame with quartz sand and sodium, has succeeded in reproducing the black enamel.

The richness of the lustre is probably increased by the presence of a trace of manganese in the magnetite. A similar enamel is found upon the Egyptian pottery, and it is probably from Egypt that the Greeks derived their knowledge of the art.

PROPERTIES OF ALUNDUM.—A fused form of alumina is now extensively used under the name of "Alundum" in the manufacture of crucibles and other vessels for which a refractory material is needed. According to Mr. L. E. Saunders (*Amer. Electrochem. Soc.*, April, 1911), the commercial product is usually a white crystalline substance containing less than one per cent. of iron oxide and other impurities. There is also a red-brown variety containing about five to six per cent. of impurities, and melting at about 2,000 to 2,050° C., or about 50° lower than the white alundum. The specific gravity of the latter is 3·93 to 4·00, and its heat conductivity is from three to four times as great as that of fire clay. It resists the action of aqueous acids and alkalies and is only slightly attacked by fused alkali carbonates. Crucibles of alundum may be used for melting metals with as high a melting point as platinum, though they are too porous to be used for melting slags. A cement for lining furnaces is also prepared from alundum, and has the advantage of not melting or combining with carbon at temperatures below 1,950° C. Bricks of alundum have also been used instead of silica for the roofs of electric furnaces.

THE TRANSFORMATION OF RADIUM.—Professor Rutherford, to whom we owe much of our knowlege of radio-active bodies, gives a most interesting survey in the *Journal of the Society of Chemical Industry* (1911, XXX, 659), of the principal results regarded from the chemical point of view. The three types of rays emitted by radio-active substances are classified as α, β, and γ rays in accordance with their penetrative capacity and effect upon a magnetic field. The α rays possess only slight penetrative properties, and are readily stopped by a metal plate. They appear to consist of streams of particles identical with the gas helium. The β rays are more penetrating and more easily deflected by a magnetic field, and are supposed to be identical with electrons; while the γ rays are exceedingly penetrating, are not deflected by a magnetic field, and have apparently properties analagous to those of the Rontgen rays.

Uranium is to be regarded as the first parent of the radium family. It is decomposed so slowly that about five thousand years would be required for half of it to be transformed into an element termed Uranium X, with an atomic weight of 230·5. This emits β rays, and is transformed into ionium, the direct ancestor of radium. Coming to radium itself, a continuous disruption takes place with the liberation of α rays (helium) and the formation of a new element, the radium emanation, which appears to be one of the inert gases. This radium emanation, in turn, breaks up with the expulsion of an α particle or helium atom and the formation of a new very unstable element, Radium A, which is rapidly transformed into another metallic element, Radium B, decomposing in twenty-six minutes, with the expulsion of β rays, into Radium C. The latter breaks up into Radium D, which in turn yields successively Radium E and Radium F. The element polonium has been identified with Radium F, and there is some evidence that the element formed in the decomposition of polonium is lead. The atomic weights and the nature of the radiations emitted by these successive elements are summarised by Professor Rutherford in the following table:

	Radiation.	Atomic Weight.
Uranium ...	2α	238·5
Uranium X	β	230·5
Ionium ...	1α	230·5
Radium ...	1α	226·5
Emanation	1α	222·5
Radium A	1α	218·5
Radium B	β	214·5
Radium C	1α	214·5
Radium D	β	210·5
Radium E	β	210·5
Radium F	1α	210·5
End product	—	206·5 (lead ?)

Many interesting details are given of the methods of examination employed in the investigation of these bodies, but, as Professor Rutherford points out, "the process of transformation cannot be influenced to the slightest degree by any chemical or physical agency. We are only able to watch these atomic processes, but cannot control them."

GEOLOGY.

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

THE PROBLEM OF THE SCOTTISH HIGHLANDS.—A new interpretation of this classic region is put forward by Professor J. W. Gregory, in the *Transactions of the Glasgow Geological Society*, Vol. XIV (1910). The most disputed points are the age of the Dalradian System, and which is the top or bottom of its long succession of deposits. In regard to the first question, Professor Gregory believes the Dalradians to rest unconformably upon the Moine Gneiss, an extensive flaggy formation which stretches from the Central Highlands to the Pentland Firth; but from certain evidence in Islay, they are probably older than the Torridon Sandstone. Among the Dalradians themselves, the Loch Lomond Gneiss is believed to be the oldest. This is succeeded to the north by the Loch Tay, Ben Lawers, and Blair Atholl series, and the Schichallion Quartzite. All these rest unconformably upon the Moine Gneiss to the north and north-west, with the exception of the Loch Lomond Gneiss, which does not appear to come into contact with the Moine anywhere. Two further series, the Ben Ledi and the Aberfoyle, occur to the south of the Loch Lomond Gneiss, and appear to rest unconformably upon that formation. The great band of quartzite in the Central Highlands is, under this arrangement, the youngest rock in the Dalradian System, with the possible exception of the Aberfoyle Series. It rests unconformably upon the black schists of the Blair Atholl Series, and forms great cakes which have been carved into bold mountain masses such as Schichallion and Ben-y-ghlo. Two other horizons of quartzite or quartz-schist occur below the Schichallion quartzite. These separate groups have often been confounded together, and also with some portions of the Moine Gneiss, but they can usually be distinguished by their petrographical characters, as well as by their stratigraphical position. Professor Gregory concludes his paper with a series of suggestions as to useful research by Glasgow geologists on the south-western Highlands.

NEW MEMOIRS OF THE GEOLOGICAL SURVEY OF SCOTLAND.—The three interesting memoirs on Edinburgh, East Lothian, and the Glenelg district, recently issued by the Scottish Geological Survey, form very important additions to our knowledge of Scottish geology. The first two are new editions, but they are entirely new works, and their superiority to the first editions, issued forty or fifty years ago, is a measure of the advance in local geology during that period. The Edinburgh memoir is a volume of 445 pages, and contains numerous beautiful plates, as well as a geological map of Arthur's Seat. This classic hill, which renders the local geology as picturesque as Edinburgh itself, is fully described, and the description, together with the geological map, has been issued as a separate pamphlet at the price of sixpence. The oil-shale field of Central Scotland comes within the area described in this memoir. This industry has been developed since the issue of the first edition, and the new information made available by mining operations has rendered necessary great changes in the geology of the region.

The East Lothian Memoir describes rocks ranging from the Silurian of the southern uplands to the Coal measures disappearing under the Firth of Forth. The district includes the interesting area of the Garlton Hills, made up mainly of trachytes, with some mugearites and basalts, and an occurrence of the rare kulaite (hornblende-basalt), all lavas of Calciferous Sandstone age.

A little-known and rather inaccessible, but beautiful, region is described in the memoir on "The Geology of Glenelg, Lochalsh and the south-east part of Skye." The geology is extraordinarily complex, as the area contains the southern ends of some of the great thrust-planes which are a feature of the north-west of Scotland. The relation of the Moine to the Lewisian gneiss is well displayed. The Moine is shown to rest unconformably on the Lewisian, with a basal conglomerate at some localities. Variety is given to the geology of the district by the inclusion of a portion of the Tertiary volcanic rocks of Skye, and of a series of highly fossiliferous Mesozoic strata, ranging from the Trias to the Upper Cretaceous.

The maps issued with these memoirs are colour-printed, and are the first Scottish maps to be so issued. They are a great improvement on the expensive and somewhat unreliable hand-coloured maps.

METEOROLOGY.

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

THE weather of the week ended June 17th, as indicated by the Weekly Weather Reports issued by the Meteorological Office, was at first fair and dry in the South and West, but cool and showery in the North and East. Towards the end of the week rain set in very generally, and thunderstorms were experienced in many places.

Temperature was below the average in all districts except the English Channel, where it was 0°·2 above. The greatest difference from average was in Scotland E., where the mean was 4°·5 lower than the normal. The highest reading recorded was 76° at Killarney on the 11th, which was 8°·0 lower than the maximum of the previous week. At many stations the maximum did not reach 70°, and in the extreme North it was under 60°, only 54° at Lerwick. The minima ranged down to 28° at Balmoral and 30° at Llangammarch Wells. In the English Channel, however, the minimum did not fall below 46°. On the grass very low readings were recorded, 19° at Llangammarch Wells, 24° at Birmingham, and 26° at several stations.

Rainfall was generally deficient in the eastern parts of the country, and in Ireland N., but was in excess elsewhere, though not to any great extent. Sunshine was above the average in all districts and at nearly every station. The sunniest stations were Rhyl 76·4 hours (66%), and Jersey 70·5 hours (63%). At Westminster 50·8 hours (45%) were recorded, while at Glasgow only 35·7 hours (30%) were registered. The temperature of the sea water round the coasts varied from 49° at Lerwick and Pennan Bay, to 62° at Seafield.

The weather of the week ended June 24th, Coronation week, was generally cool and cloudy, though in the first part of the week there were fairly long sunny intervals. Thunderstorms were experienced on Sunday and Monday. Temperature was normal in England N.W., below it in Scotland W., England S.W. and S.E., Ireland and the English Channel, but above it elsewhere, the variations from the normal being, however, but slight. The highest temperatures recorded were 74° at Greenwich on the 23rd, and 73° at Bawtry on the 22nd. At many stations the maximum was below 70°; the lowest readings were nowhere so low as in the previous week, and no reading below 40° was recorded. In London the minimum was 52°, and no ground frost was reported.

Rainfall was in excess everywhere and some very heavy falls were reported. At Shields and at Alnwick Castle the amounts exceeded 4·0 inches, which is more than eight times the usual quantity. At Westminster the total was 1·12 inches on five days. At Bath, though rain fell on each day of the week, the total collected was only 0·58 inches.

The district values of bright sunshine ranged from twenty-six hours (22%) in England N.W., to forty-four hours (39%) in the English Channel. Strangely enough, the two sunniest places were at the extreme North and South of our Islands, Stornoway reporting 49·1 hours (39%) and Guernsey having 49·6 hours (44%). At Stonyhurst only 11·2 hours (10%) were recorded. The temperature of the sea water varied from 48° at Berwick to 62° at Margate.

The week ended July 1st, was unsettled and rainy, with occasional thunder and lightning. Temperature was below the normal in all districts, by as much as 4°·4 in Scotland, W. The highest reading reported was 73° at York, Clacton, Raunds, Yarmouth and Tottenham. In Jersey, however, the maximum was only 63°. The lowest readings were 37° at Kilmarnock and 39° at Cally and at West Linton. In Westminster the extremes were 72° and 50°. On the ground the temperature fell to 27° at Llangammarch Wells, and to 31° at Armagh. Rainfall varied a good deal, but the departures from the mean were nowhere so severe as in the previous week. In Scotland N., the fall was about half as much again as usual, but in Ireland it was only one half the usual amount. Bright sunshine was in defect in all districts, the deficiency reaching 20% in the English Channel. Falmouth had the highest record for the week, 45·6 hours (40%), while at Weymouth 43·5 hours (39%) were recorded. Westminster had 26·6 hours (23%). The temperature of the sea water varied from 49° at Ballintrae to 63° at the Shipwash light vessel off the East Coast.

The week ended July 8th, began with unsettled rainy weather over Scotland and Ireland N., but with very fine weather in all other parts. By the end of the week the fine weather had extended to the Northern districts also. The average temperature was above the normal in most districts, though not markedly so. The individual readings, however, were exceptional and exceeded 80° in all parts except Scotland N. and W., and Ireland N. The highest readings recorded were 90° at Cullompton in North Devon, on the 8th, and 88° at Greenwich, Oxford, Raunds and Wisley. The minima were as low as 36° at Balmoral, and 37° at West Linton and Fort Augustus, but as a rule the lowest readings ranged between 40° and 50°, and were in some cases over 50°. Slight frost on the grass was experienced at Crathes (30°) and at Llangammarch Wells (29°), but in most places the grass minimum was above 35°. Rainfall was slightly above the average in Scotland N., but was in defect in all other parts of the country. At many stations no rain was experienced throughout the week. At Westminster the total was 0·01 inch, while at Greenwich there was no rain. Bright sunshine was in excess in all districts except Ireland N., where it was very slightly in defect. The English Channel was the sunniest district with 93 hours (83%), but the most sunny station was Hastings, 97·5 hours (86%). In contrast with this was the North-west of Scotland, where Glasgow reported 27·5 hours (23%), and Fort Augustus only 20·9 hours (17%). The temperature of the sea water ranged from 48° at Lerwick to 65° at Margate and Eastbourne.

The week ended July 15th was exceptionally fine and dry throughout. Temperature was above the average in all districts, by as much as 6°·0 in Ireland, S. The highest readings were 89° at Crieff, and 88° at Balmoral, Cullompton and in Ireland, S. The minima varied greatly. In the English Channel the lowest reading was 54° at Scilly, giving a range of temperature for the week at this station of 21°, while at West Linton the minimum was 35° and the range for the week 49°. At Durham, Alnwick and Llangammarch readings of 36° were recorded. On the grass still lower temperatures were observed, the lowest being 23° at Llangammarch and 29° at Crathes.

The rainfall was unusually slight; indeed over the greater part of the kingdom the week was rainless. The largest amounts reported were 0·35 inches at Gordon Castle, and 0·38 at Glencarron. Bright sunshine was greatly in excess in all districts, and at many stations it was double the usual amount. The sunniest stations were Newton Rigg, 100·4 hours (86%), Aspatria 100·2 hours (86%), and Bournemouth 99·9 hours (89%). At many other stations the total duration of sunshine exceeded 90 hours. Over the country generally the week was the finest experienced since the general establishment of sunshine recorders, in 1881.

The temperature of the sea was higher than in the corresponding week of 1910, and the individual readings varied from 52° in Scotland to 67° at Margate, and 70° at Seafield.

During a kite ascent from Pyrton Hill on June 14th, the sky was overcast, but though the kite ascended to a height of over four thousand feet, the clouds were not reached. On this occasion the direction of the wind was found to be the same throughout, but its velocity steadily increased with the altitude. The humidity of the air also increased with the height from 70% at the ground to 95% at four thousand feet.

MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD.
THE REV. E. W. BOWELL, M.A.
JAMES BURTON.
CHARLES H. CAFFYN.
ARTHUR EARLAND, F.R.M.S.
RICHARD T. LEWIS, F.R.M.S.
CHAS. F. ROUSSELET, F.R.M.S.
D. J. SCOURFIELD, F.Z.S., F.R.M.S.
C. D. SOAR, F.L.S., F.R.M.S.

HYDRACARINA OF CLARE ISLAND.—The Royal Irish Academy has just published part 39i of the Clare Island survey. This paper, to any one interested in the Hydracarina of the British area, will prove most valuable. The results of the survey will be published from time to time, as the different experts who have undertaken to work at their own particular group finish their reports. These reports will not only contain the flora and fauna of the island, but the history and geology of the district, and will be published in sixty-seven parts, four only of which are ready. Mr. J. N. Halbert, of the National Museum, Dublin, undertook, and has finished, the Hydracarina, and he has done it well. It is, I think, the best paper yet published on the water mites of the British area, both as regards the text and the figures. Mr. Halbert has added four new species to science: *Eylais relicta*, *Frontipoda Carpenteri*, *Atractides brevirostris* and *Unionicola rivularis*. Besides the above he has also added twelve species previously recorded on the continent only. Altogether, Mr. Halbert records eighty species, representing thirty-one genera, which, with the sixteen additional ones now added by Mr. Halbert, gives us two hundred and thirty species of Hydracarina, representing sixty-one genera, for the British area. *Hydryphantes placationis* K. Thon, which Mr. Halbert asterisks as a new record, has been already recorded by Mr. W. Evans in 1909, for Scotland. See *Proceedings of the Royal Physical Society of Edinburgh*, Vol. XVII, page 42.

There is one mite Mr. Halbert mentions which I am not sure is correctly named on page 37; he mentions *Arrhenurus tricuspidator*, O. F. Müll., Achill Island, June. "The mite recorded here is the *A. bicuspidator* (Koenike) 12, and other references." Now Koenike, in 12, Acarina Milben Brauer, *Die Susswasserfauna Deutschlands*, Heft, XII, 13-191, Figure 1, 277, 1909, gives both *A. tricuspidator* Müll. and *A. bicuspidator* Berlese, and there is no mistaking the two mites. The petiole of Müller's Figure Plate iii, Figure 2, in his Hydrachnae, 1781, is certainly rounded on the extreme posterior margin, but in Berlese's *A. bicuspidator* the margin of the petiole is curved inwards. I have both mites myself. What I take to be the real *A. tricuspidator* Müll. was recorded by Dr. George, for Britain, in 1901, as *A. maximus* Piersig, *Science Gossip*, 1901, page 230.

One of the most interesting finds is *Frontipoda carpenteri* Halb. as previous to this we only knew one species of this genus, *F. musculus* Müll. Another is the addition to the genus *Atractides*. Mr. Halbert gives a very useful synoptical table for the determination of species. There are three plates of well-drawn and well-produced figures, giving the absolutely essential details for identification of the species. Take it all round it is a most interesting addition to the bibliography of fresh-water mites.

CHAS. D. SOAR, F.L.S., F.R.M.S.

HYDRURUS FOETIDUS VILL.—Recently I had the good fortune to come across the above, and as it is in several respects a singular and interesting plant, it may be worth while bringing it forward in a short note. The first point about it is that it is decidedly rare in this country. Professor West says, "It is of very rare occurrence in the British Islands, being known only from Yorkshire and Scotland." But "it is common in central Europe and in the Arctic regions when the snows melt in spring." I found it in great abundance in a comparatively quiet backwater, in a rapid stream of ice-cold water running down towards the Mer de Glace, at Chamonix. It was attached to the rocks and stones, and was plentiful on a rock forming the edge of a small cascade. To the naked eye it looks like a dull-coloured moss, or one of the filamentous algae; the filaments attached at the base, floating free and swaying in the stream. Its specific name *foetidus* is appropriate, as it has a most unpleasant smell, resembling that of stale fish. The "Micrographic Dictionary" styles it "a genus of Confervoid algae" but at the same time points out its obviously true relationship, which is with the very simplest of the algae, the Palmellaceae. Probably there is not more than one species. Professor West calls it *Hydrurus foetidus*; Cooke, *H. penicellatus*, and mentions a variety. The filaments vary in size from quite small ones, up to a length of several inches. They are of considerable thickness, and simple at the base, while above they are densely branched, the branches often thickly covered with minute outgrowths and fibres, giving the whole a very moss-like appearance. Dr. Cooke has a drawing—"British Freshwater Algae," Plate 10 Figure 4—which exaggerates this a good deal, unless his illustration was taken from another variety. One would naturally expect the stem and branches to consist of cells with definite walls like other plants, but they do not. The whole is formed of a more or less tough gelatinous sticky substance, without any apparent structure under the microscope, and in this are embedded numerous minute olive-green bodies. They are packed closely and are somewhat globose in the branches, with a tendency to become mis-shapen and angular owing to pressure, while in the stem they become oval and elongated, or even comma-shaped, and are arranged partially in lines. They do not seem to have a definite wall; Dr. Cooke says it is difficult to distinguish one; Professor West says there is none. It is of course, these very small bodies that give rise to the gelatinous moss-like structure, and except for the peculiar form—a chance resemblance to that of a much more highly-developed organism—the relationship to such plants as *Tetraspora*, *Sphaerocystis* and *Palmodictyon*, which we find constantly in our own waters, would be evident. Professor West tells us "the entire structure behaves almost as a multicellular plant, growth in length being entirely dependent on single apical cells." He classes it with the Phaeophyceae, but its affinities seem to me much more with the simple genera named above, than with the highly-developed and specialized brown sea-weeds. Reproduction takes place by means of peculiar-shaped zoogonidia, developed from the coloured bodies in the branches. The filamentous form and minute branches and fibres are probably only an adaptation to the circumstances under which the plant exists. Were it not attached firmly to the rocks and stones, and of a form which gives only slight resistance to the stream, it would soon be washed away in the rapid torrents in which it dwells. Cold and violent mountain streams are not favourable dwelling places for most Algae; it is hardly worth while looking for them there, and this example is remarkable on that account as well as for its singular structure.

J. B.

THE MICROLOGIST.—We have received from Messrs. Flatters, Milborne and McKechnie, Ltd., the July number (Part V.), of their little quarterly journal, *The Micrologist*. As usual it is well illustrated, there being twelve text figures and three plates of figures reproduced in half tone. The first article is by Mr. Gordon A. McKechnie, and is devoted to the Porifera (sponges). A short account is given of their structure, classification and life-history, which is followed by details for the preparation of slides illustrating the histology of the different types. The slides, six in number, sent out with this part all illustrate sponge structure. Transverse sections of *Grantia compressa*, *Euspongia officinalis*, *Halichondria* *panacea*, *Geodia gigas*, *Spongilla lacustris*, and the entire sponge (young) of *Leucosolenia botryoides*; this last slide shows the budding of a sponge. The section of *Grantia compressa* exhibits the collar-cells (*choanocytes*); the fresh-water sponge (*S. lacustris*) shows the "gemmules," vide page 59. The three plates referred to above illustrate Mr. Abraham Flatters' paper, which is devoted to the preparation of slides illustrating the histology of the wheat plant.

THE DWARF PLANKTON.—In connection with the short report in "KNOWLEDGE" (June, page 236) of my paper on "The Use of the Centrifuge in Pond-Life Work," read before the Quekett Microscopical Club in April last, I should like to call attention to a little pamphlet recently published by Professor H. Lohmann, of Kiel, entitled, "Ueber das Nannoplankton und die zentrifugierung kleinster Wasserproben zur Gewinnung desselben in lebendem zustande" (W. Klinkhardt, Leipzig, M. 1·50). The term *Nannoplankton* (*νάννος* = dwarf) has been coined by Lohmann for the extremely minute forms of life existing in water, the forms, in fact, which pass easily through the meshes of the finest silk gauze, and his paper is in the main a summary of the additional knowledge which has been gained about these organisms by the use of the centrifuge. The application of this instrument to the special purpose of collecting these very minute organisms is due to Lohmann, who was led to the conclusion that something supplemental to nets, or even filter papers was wanted as a means of collecting the smaller constituents of the plankton, by observing the rich and varied accumulations of tiny protists obtained by the extraordinarily fine filtering apparatus of some marine animals such as the Appendicularia. The method of centrifuging water in order to concentrate the contained "Nannoplankton" is undoubtedly a very powerful new means of research, and it can no longer be ignored by those interested in the life of our seas and fresh-waters. Very small quantities of water are sufficient as a rule (I often work with tubes holding only one-and-a-half cubic centimetres) and the bulk of the forms present are deposited in one or two minutes if the centrifuge be run at a fairly high speed, say two thousand to six thousand revolutions per minute. Practically no damage is done to the organisms during the process of centrifuging, and if examined immediately after, they will be found to be alive, so that even the most sensitive and fragile of the naked forms can be recognised. This, it need hardly be pointed out, is an utter impossibility with collections made by any straining method yet invented. The Nannoplankton is composed of bacteria, protophytes (schizophyceae, desmids, diatoms, chlorophyceae, phytoflagellates), and protozoa (rhizopods and zooflagellates), the bulk being usually formed by the phytoflagellates. The comparative volume of the Nannoplankton is small, but as Lohmann points out this does not prove that it is of no importance in the economy of the sea and fresh-waters. "The degree of importance in this respect depends essentially on the rapidity of the multiplication and the duration of life-time, as well as on the nutritive character of the organisms themselves. In this latter direction the Nannoplankton surpasses perhaps all the other Plankton and in the former respect it equals the other Protists at least. Should one wish to estimate the importance of the three chief groups of Plankton only according to their average life-time, one must place on a par one volume of Bacteria to about six volumes of Protists and to about three hundred volumes of Metazoa." For those who cannot read German there is an English summary appended to the paper, which is also accompanied by five plates of Nannoplankton organisms, drawn to scale, in frames representing a single opening in the silk gauze used for the finest Plankton nets.

D. J. SCOURFIELD, F.Z.S., F.R.M.S.

QUEKETT MICROSCOPICAL CLUB.—June 27th, 1911, Mr. C. F. Rousselet, F.R.M.S., Vice-President, in the chair. Mr. J. W. Ogilvy exhibited for Messrs. Leitz a recent invention, on the principle of the dark-ground illuminator, for rendering visible the particles in smoke and gases, and in liquids. Messrs. Watson exhibited a series of seven preparations, illustrating the development of the chick. The stages were twenty-four, thirty-two, forty, forty-eight, sixty, seventy-two and ninety-six hours of incubation.

A paper by Dr. E. Penard, on "Some Rhizopods from Sierra Leone" was read by Mr. Earland. The material examined was collected from a "slow, large river, containing weeds." Fourteen species had been found, of which three were new, and four at least might be considered as special forms or varieties. The genera represented were:—*Centropyxis*, two species; *Difflugia*, five species (two new); *Euglypha*, two species; *Lesquereutia*, three species (one new); and *Pontigulatia*, two species. The author expressed his indebtedness to Mr. G. H. Wailes for the material received and hoped that time and opportunity would be found for further investigations.

Mr. T. A. O'Donohoe read a note on "Dimorphism in the Spermatozoa of the Flea and the Blow Fly." Only about 70% of the specimens examined had the two forms noted, the minority having only the smaller form. The spermatozoa of the flea are very large compared with those of man, whose spermatozoa have an average length of about 0·06 millimetres. In the flea the larger form is 0·7 to 0·45 millimetres long, and the smaller form about half these lengths. Both are similar in structure and stain well with dilute carbol-fuchsin or gentian-violet. The two forms found in the Blow Fly are smaller than those of the flea. They do not differ much from each other in length, but one is very much thicker than the other. Photomicrographs of the specimens described were projected on the screen.

A paper by Mr. E. M. Nelson, F.R.M.S., on "Normal and Abnormal Vision in Microscopic work," was read by the Assistant Honorary Secretary. The experiments described showed the effects of long and short sight upon the magnifying power of the microscope. The differences are most marked with low powers. The author's sight being presbyopic, biconvex glasses are required to make it normal. When measuring the power of a microscope by means of a camera lucida, it is therefore necessary to use spectacles, otherwise, while the image of the micrometer in the microscope is sharp, that of the exterior scale, at ten inches distance, would be invisible to him. Experiment 1.—The power of a "loup" (focus about 1·6 inch) was measured, the spectacle lens being below the camera. The power was 6. Experiment 2.—As before, but with the spectacle lens above the camera; the power was 7. Experiment 3.—A double pair of spectacles of equal power were used; the presbyopic eye was therefore made myopic. A concave lens, which precisely neutralised one of the spectacles lenses, was placed below the camera. The "loup" now gave power 8. Experiment 2 shows the power of the "loup" with normal sight. The experiments on being repeated with a compound microscope giving six diameters showed similar results. It is generally understood that persons with short sight have wonderful powers of seeing minute objects, but few realize that anyone with three dioptres of myopia can with a six-power "loup" see as much as one having three dioptres of presbyopia with an eight-power "loup." Further experiments were also described.

ROYAL MICROSCOPICAL SOCIETY.—June 28th—Mr. H. L. Plimmer, F.R.S., President, in the chair.—Mr. Strachan: The structure of scales from *Thermobia domestica* Packard. The author showed that the longitudinal striae which appeared to project at the free margin of the scale were in reality the walls of a set of longitudinal tubes, and when pressure was applied to the scales the tubes might be made to collapse and disappear, and in some instances, when heat was applied, both fluid and air bubbles were observed to traverse the tubes. These tubes were on the convex side of the scales. Radial striae also crossed the longitudinal striae at various angles, and the author illustrated his paper by an ingenious model composed of two sets of parallel thin glass tubes in close contact, almost filled with fluid and sealed at the ends, one set containing oil of turpentine, the other ethyl alcohol. One set of tubes was fixed; the other set, placed in contact with them, could be rotated over a considerable angle. By illuminating this model obliquely and varying the angle at which the tubes crossed, all the appearances of beaded, exclamation and cuneate markings observed in the natural scales could be exactly reproduced. Mr. Murray: Further report on the rotifera collected by the Shackleton Antarctic Expedition of 1909. *Rotifera of New Zealand.* There were collected forty-one species of Bdelloids, and twenty-six species of other orders. Three new species were described—*Callidina microcornis, Rotifer curtipes* and *R. montanus.* A species of Pedalion (not identified) occurred as a plankton animal in a great lake (Wakatipu). The Bdelloid fauna of New Zealand appeared to be poor, considering the variety of conditions found in different regions. *Rotifera of S. Africa.* During a short stay at Cape Town nine Bdelloids were collected on the lower part of Table Mountain. There was one new species, *Dissotrocha pectinata,* related to *D. spinosa.* This small collection was noticeable for the absence of any of the species characteristic of tropical and subtropical Africa, many of which occurred in other parts of Cape Colony.

Mr. Conrad Beck gave a demonstration of the method of determining in wave-lengths the divisions of a stage-micrometer by means of an interferometer.

He said the interferometer consists of a series of mirrors which receive a beam of light from a radiant source, and divide it into two beams of light, which are afterwards re-combined and viewed by a telescope. All the portions of the instrument are fixed, except one reflecting mirror, which reflects one-half of the divided beam of light. This can be set in such a position that the two half-beams of light, during their period of division and before they re-combined into one, have travelled exactly the same distance. A movement of the reflecting mirror can then be made, so that one half-beam of light has travelled half a wave-length farther than the other; and when that is the case, interference will take place, and the light will be extinguished. As the mirror is moved further, the light will again appear, until the path is one-and-a-half wave-lengths different, when a second interference is produced; this goes on at each successive motion of the mirror through the same distance, and the wave-lengths are counted.

As a matter of practice, it will be seen, on looking through the telescope, that the effect is not a complete change from brightness to darkness, because this only takes place in the exact centre of the field, and a series of bright and dark bands are seen in the field, which travel from right to left, and are counted as they cross the centre of the field against a line in the telescope.

The apparatus was shown with a Bunsen burner and a sodium flame as being a sufficiently monochromatic light for demonstration; but as the sodium light is not a purely monochromatic light, but consists of two lines which are not in themselves quite monochromatic, sodium does not form a very good source for the illumination. Either cadmium, mercury or hydrogen, used in connexion with a prism which shall direct one only of the chief lines into the instrument, is the best for the purpose.

The micrometer is held on a bracket which projects out from the carriage on which the moving mirror is fixed in such a manner that, although it is viewed by the microscope, it is not in contact with it, and no friction is caused which could interfere with its motion.

Mr. Conrad Beck exhibited a new portable microscope suggested by Mr. Murray. He said that this instrument had been designed to meet the wishes of Mr. James Murray, the well-known explorer, who was anxious to have a microscope extremely small and portable, and which could be used in the field. Being away from the comforts of civilization, in tropical forests, he would be debarred from the luxury of chairs and tables, and the microscope was therefore so designed that it had one leg, which could be strapped to a walking-stick, which had been driven into the ground, and the observer could sit with the stick projecting from the ground between his legs, and the microscope could be inclined by means of the usual joint to a convenient position. The instrument was on the model of the Star Microscope, with an aluminium stage, and all the superfluous metal removed to make it extra light. It had a sliding coarse-adjustment, a micrometer-screw fine-adjustment, and a small substage condenser, with iris diaphragm. It was provided with two loose legs, which screwed into the single leg-base, making it into a tripod for use on a table in the usual way, when such a support was available on the return from an expedition. For the study of pond-life on the spot this instrument was especially desirable, as the naturalist on the walking-ing-stick-stand principle might spend many profitable hours in pleasant weather in conducting his microscopical examination at the side of the pond, or on the country-side in the open air.

Mr. Murray remarked that as the journey he was about to undertake had to be made without the assistance of carriers, it became important to reduce the weight to the utmost, because every ounce put into instruments to be taken must be deducted from the amount of food which could be carried. Therefore, remembering his previous experience with the Star Microscope on his journeys, he asked Mr. Beck if he could improve upon that instrument in the matter of weight. The present microscope was the result. It was true that the necessity for unscrewing the legs of the tripod introduced a structural weakness, but the instrument was intended to be primarily used on a walking stick. Its use in the ordinary way, on a table, was a secondary matter. It was not anticipated that one would be able, as Mr. Beck had said, to sit comfortably and work with the microscope; that was usually impossible in the Amazonian forest. It was proposed to have the walking-stick sufficiently long to enable the observer to work standing. Quite possibly the conditions would prevent work, but it was hoped sometimes to rig up a net to keep out insects and allow a little work to be done. Mr. Beck had not stated what the weight of the microscope was. Complete in its case, as fitted for use on the table, it weighed two pounds. But even that was far too much to take on such a journey; for, as he had said, only so much could be taken, and the heavier the instruments, the less the quantity of food which could be carried. Therefore, when the difficult journey began, the case of the microscope would be left behind, the two supplementary legs would be unscrewed, and the microscope folded up and wrapped in a spare shirt. The weight, without the case, was only one pound.

BOTRYDIUM GRANULATUM (L.)—The water at the Welsh Harp reservoir, Hendon, is very low, and it may be of interest to some to know that large stretches of mud are at present—July 20th—in many places covered with the singular little plant *Botrydium granulatum.* It is not so plentiful as it was last year, vide *Journal of the Quekett Microscopical Club,* Ser. 2, Vol. XI., No. 68, page 209, probably because, with the drought and great heat, the mud is dried too quickly for the plant to develop. *Botrydium* does not seem very common in the London district, but here it covers an immense area.

J. B.

ORNITHOLOGY.

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

DISTRIBUTION OF THE NIGHTINGALE IN GREAT BRITAIN—FIRST OCCURRENCE IN SCOTLAND.—Commenting on the note in our last number (page 282) a correspondent writes as follows:—"It appears to me that the whole body of evidence collected by Messrs. Ticehurst and Jourdain wants to be rearranged with respect to its salient features; restated to show the value or valuelessness of its component parts; and, generally, to be dealt with in as broad, critical, and philosophical a spirit as can be brought to bear upon it. I am pleased that the information has been brought together; more than that I cannot say, unless that I am dissatisfied with the want of any adequate examination of it by the authors of the paper."

Our correspondent (who writes from Scotland) further remarks that the physical difficulty of extension was overcome when the Nightingale had reached the valleys of the Dee, Weaver, and Mersey in Cheshire, and that there was consequently nothing physical to prevent extension into Lancashire; also that if the species had been in Yorkshire and Lincolnshire for a century there was nothing to hinder it following the coast line to Scotland.

These observations have received immediate point by the publication in the new number of the *Annals of Scottish Natural History* (No. 79, July, 1911, page 132) of a short paper by Misses E. V. Baxter and L. J. Rintoul announcing that they had secured a single specimen of the Nightingale on the Isle of May, Firth of Forth, on 9th May, 1911. This is an addition to the avi-fauna of Scotland, and to the rarities and valuable records which careful and continuous watching of the Isle of May has yielded to the writers above-named. Following recent nomenclature they call the bird the Southern Nightingale (*Luscinia megarhynchos megarhynchos* = *Daulias luscinia* of Saunders and other authors).

Our readers are invited to send in any observations that they may be able to make upon the distribution of the Nightingale.

ARE BLACK GAME VERMIN?—The answer to this question, like many others, depends largely upon the point of view and upon personal predilections, and sportsmen may probably not agree with the judgment given in the recently published "Forest Survey of Glen Mor" (1911), by Lord Lovat and Captain Stirling of Keir. This work contains recommendations for the treatment of grouse and low game shooting from the point of view of the forester and timber-grower, and makes the proposal to reduce Black Game from the status of game birds to that of forest vermin. With this finding, all who have had experience of the depredations of the species will, we believe, be found ready to agree, with but little reluctance.

BIRDS BREEDING IN THE LONDON ZOÖLOGICAL GARDENS.—This has been a good season and about one hundred and fifty had already bred by the beginning of July, although, for foreign species, the season was not more than half over then. The expectations and prospects were that this number would be considerably augmented. The Wigeon does not commonly breed in confinement, but of this native British species there were fifteen well-grown ducklings, and another brood was looked for. Amongst the young Gulls were three interesting hybrids, the produce of the Lesser Black-Backed and the Common Gull.

ABUNDANCE OF THE COMMON SWIFT (*CYPSELUS APUS*).—It is far from easy to compare the numbers of any of our commonly seen birds, season with season, with any approach to accuracy. In any summer the Common Swift is an abundant bird in the neighbourhood of London, but this year it seems to be present in larger numbers than usual, judging by the swarms which are now disporting themselves in the district on the Middlesex and Hertfordshire borders. In the neighbourhood of Bushey, for instance, a glance around any morning or evening shows some dozens within sight in the air. To attempt to estimate the numbers would be futile; but it may be worth remarking that, one day in the month of May three years ago, 1908, the writer spent a considerable time in attempting to count the numbers of a large gathering of Swifts, hawking over the surface of the Brent Reservoir, Middlesex, and approximately set them down as some seven hundred or eight hundred birds.

BIRDS IN THE ELEVENTH EDITION OF THE "ENCYCLOPAEDIA BRITANNICA" (1911).—This work contains reprints of the series of articles contributed by the late Professor A. Newton to the ninth edition with some small alterations. These articles are assuredly classics in ornithological literature, but it is to be regretted that the new edition does not contain the supplementary matter which Professor Newton himself included in republishing them in his great "Dictionary of Birds" (1893-6). This leaves the last-named work, and not the new edition of the "Encyclopaedia" as the final and more complete authority on the birds included. The "Encyclopaedia," however, contains fresh ornithological writings in such articles as those on the general subject "Bird," and on "Egg," "Feather," and so on.

PHOTOGRAPHY.

By C. E. Kenneth Mees, D.Sc.

TRI-COLOR PRINTING INKS.—In the *Process Photogram* for July, Mr. A. J. Bull contributes an excellent article on the rendering of greens in three-colour work, in which he directs attention to the fact that the difficulties met in reproducing greens by the three-colour process, are mainly due to the fact that even the best blue inks used for that process have but a low reflecting power for green light. In a totally different article, that by Sir Harry Johnston on the art of painting, in the *Westminster Gazette*, we find another indictment of three-colour printing inks from the point of view of the artist. He writes:—"Fortunately for painters, a stereotyped reproduction in colour is hampered at the present day by the miserable quality of the inks and pigments used by all colour printers (except here and there in Germany, Austria, and France)." This would seem to imply that Sir Harry Johnston considers that the printers are to blame for the poor quality of the inks and pigments that they select, but it would be interesting to know on what grounds he makes exception in favour of certain printers in Germany, Austria, and France. It may be true that there are printers in those countries who produce better results than those produced in England or the United States,—the present writer does not possess the necessary knowledge to give an opinion upon the subject, but he doubts very gravely whether, if the results produced are superior, the effect is to be ascribed to the use of better inks. Colour-printing inks are chiefly made in large quantities by big firms, and any ink that is on the market can be obtained by any printer who desires it, nor does the price of an ink necessarily increase with its suitability for three-colour work.

The real difficulty in the obtaining of more suitable inks for the three-colour process lies in the wide separation between the user of the inks and the original producer of the colour. The user of the ink is the printer, but the colour is largely chosen for him by the photo-engraver who makes the blocks, and he, in his turn, is limited by the inks that he can obtain from the maker, who is again limited by the lakes which the dye works can supply. It is not to be expected that these various commercial undertakings will all fully understand the theory of the three-colour process, the only one of them who actually requires the knowledge in every-day work being the block-maker, and hence, while most photo-engravers now understand what inks they require, ink makers, as a rule, will tell you frankly that they supply any colour of ink for which they can obtain satisfactory lakes, and leave the choice of the inks to the engraver. A visit some years ago to a great dye works containing a section devoted to the preparation of lakes for three-colour printing opened the writer's eyes to the fact that the scientific chemists in charge of that section, had not the least knowledge of the theory of the three-colour process, and had not taken any steps to attempt to obtain permanent colours of the right shade, the colours which the firm recommended for the production of three-colour printing inks being entirely unsuited to the purpose, and being selected simply for their printing qualities, with very little reference to theoretical requirements as to colour. It is not too much to say that there are no inks in existence which are both permanent and of the right shade for three-colour printing, and the reason for this is undoubtedly that the dye works have not yet produced permanent lakes of the right shade. There is, of course, no difficulty with the yellow ink, but the red ink always reflects far too little blue, while the blue ink reflects only a small proportion of the required amount of green. There are dyes which are nearly of the right shade; some of the acid rhodamines, for instance, are nearly the right shade of magenta, and fast green blue shade, or patent blue would make a satisfactory blue ink, but apparently the lakes which can be produced from these dyes are not fast to light, so that for improvement in colour-printing, as in so many other things, we must look to the scientific chemist at the base rather than to the ink-maker or printer who are dependent upon him for their materials.

THE DEVELOPMENT OF QUANTITIES OF NEGATIVES.—When a large number of exposed plates have accumulated one's thoughts turn to methods of handling a larger number of plates at the same time than would usually be employed and the case with which several plates can be developed in a tank is certainly one reason for the popularity of tank development. Tank development, however, introduces a number of possible difficulties which are less likely to occur during development in a dish. In the first place a tank should be selected which can be reversed or shaken so that circulation of the developer can be assured, because otherwise there is considerable danger of accumulations of oxydised developer which may produce most unexpected marks upon the plate. A photograph of a church tower against the sky, for instance, which is left quiescent in a tank with the sky downwards may show upon the prints a white mark extending up into the sky from the tower. This is owing to the fact that the developer on the face of the plate immediately over the tower does no work, and consequently remains fresher than the developer covering the rest of the sky, and this fresh developer slowly streaming over the sky immediately below the tower produces a streak of greater density in the negative, which appears light in the print.

If a very dilute developer is used for prolonged development, generally known as "stand" development, marks of obscure origin are often met with and such a developer may give rise to a considerable amount of general fog. The reason for this fogging by dilute developers has not hitherto been understood, but some recent observations would appear to show that in some cases, at any rate, it is due to the lowering of the sulphite concentration in the developer, and may be removed by addition of sulphite when the developer is diluted. A difficulty with many developers when used for stand development, is that it is impossible to calculate the time of development from the dilution, because the reducer is oxidised by the air dissolved in the water used. The dilution of one part of a metol developer, for instance, with nine parts of water, will not give a developer requiring ten times as long for development as the original solution, but a longer period will be required, the extension depending upon the air content of the water used for dilution. A reducer, which appears to be almost entirely free from this defect, and which, therefore, must be little amenable to aerial oxidation, is glycin, which is peculiarly suitable for timed development with weak solutions.

PHYSICS.

FRESH SUPPORT FOR PROFESSOR BICKERTON'S THEORY.—The conclusions of Professor Kapteyn's recent address to the Dutch Science Congress, based on his own and other observations, furnish a most remarkable case of the fulfilment of physical deductions and predictions.

For over thirty years Professor Bickerton, of New Zealand, has with increasing emphasis been making cosmic dynamical deductions and publishing papers and books, showing that every characteristic of our Galaxy can be most easily explained by assuming that it is made up of two cosmic systems, of different orders of development. Ages ago these two systems interpenetrated one another, coalesced, and swung off the double spiral of stars called the Milky Way. The idea was very clearly shown in a paper in the *Philosophical Magazine* for August, 1900. Kapteyn's conclusions are as follows:—

"The Stellar system was not originally a single system in which the two known drifts or currents have developed; but the present system is the result of the encounter of two systems which originally were entirely independent of each other."

"The primordial matter is now more abundant in the drift of less star-density, and is almost entirely absent from the opposite drift which is richer in stars."

Kapteyn's system of much primordial matter is Professor Bickerton's cosmic system of the first order, which on dynamical grounds he shows must grow up in the empty parts of space. One of these primordial systems has interpenetrated with one of a higher order. Such impacts, to quote Professor Bickerton's paper in the *Philosophical Magazine*, will produce a cosmic system of a third order, of which our Galactic system is a type.

For some years back, in Australasia, there has been growing up a belief that this new cosmogony is true, as it has anticipated in a remarkable way so many subsequent discoveries. This belief has culminated in the New Zealand Government sending Professor Bickerton to England to present it as a working hypothesis to guide astronomical research.

In our next number Professor Bickerton will tell the story of Nova Persei, the new star of the new century, that in less than two days grew from invisibility, to be actually the brightest star in the Northern Hemisphere. Had the flash of this temporary star been seen at the same distance as our Sun, this huge celestial light would have been ten thousand times as bright a blaze as the Sun itself. Professor Bickerton says that all new stars are the explosively hot third bodies, torn from grazing suns. The surprising number of phenomena that were scientifically deduced, as possessed by this vast cosmic spark, a score of years before Nova Persei appeared, and the complete way all have been demonstrated by astronomers, reads more like a fairy tale than a statement of sober fact.

SEISMOLOGY.

A SEISMOGRAPH AT A LONDON EXHIBITION.—At the Coronation Exhibition, Shepherds Bush, there is this year one very interesting sight—a seismograph actually at work. The exhibitor is Mr. J. J. Shaw, of West Bromwich, and he believes that this is the first time that a seismograph has ever been publicly exhibited under working conditions. He has been fortunate in that, during June, two large earthquakes occurred and were recorded by his instrument.

Mr. Shaw's instrument differs in several details from Professor Milne's well known pattern which has been adopted as the standard form by the Seismological Section of the British Association. The two horizontal pendulums are suspended from separate brick columns and actuate multiplying levers which by means of glass needles record the movements on a smoked paper roll carried on a revolving drum. These two records are marked side by side with the time record between them. This is, for popular demonstration purposes, a method superior to that adopted by Professor Milne, whose instruments give photographic records which require to be developed before they become visible.

A record on the Seismograph, at the exhibition, of an earthquake in Mexico on June 5th, is only the second that has been made on any instrument in London.

ZOÖLOGY.

THE FLYING APPARATUS OF THE BLOWFLY.—Dr. Wolfgang Ritter describes in *Smithsonian Miscellaneous Collections*, Volume 56, No. 12, his researches upon the flight of an insect. He finds that the downward movement of the wings is caused by the contraction of two powerful dorsal muscles, and he has repeated an old experiment illustrating this. From a recently-killed fly, whose wings are raised, the abdomen and head are removed and the thorax grasped with a broad pair of forceps, so that one part of the latter is at its anterior, and the other at its posterior end. On compressing the forceps the thorax is shortened just as it is when the dorsal muscle contracts and the wings descend. The dorsi-ventral muscles act as antagonists to the dorsal, and by compressing the thorax in a vertical direction, raise the wings. A direct muscle brings the wings back from the position of flight to that of rest. Other direct muscles, which probably act as steerers, draw the wings respectively forward and backward and depress various portions of it.

THE SPIRIT BUILDINGS AT THE BRITISH MUSEUM (Natural History).—It has been announced that an amicable settlement has been arrived at between the Trustees of the British Museum and the Office of Works with regard to the site for the Science Museum, for which the ground now occupied by the Spirit Building, with its important collections of zoölogical specimens in alcohol, was demanded. No further official information is forthcoming, but it is said that the arrangements that have been made will obviate the necessity of pulling down the building in question.

FLIGHTLESS BIRDS.

By MATTHEW DAVENPORT HILL, M.A., F.Z.S.

THE power of flight is undoubtedly one of the most marked characteristics of birds. Yet we know that time and again birds belonging to widely different orders have lost it, accompanied to a greater or less extent by atrophy of the wings and pectoral arch. It is interesting to consider, as far as possible, what changes in environment may have brought about such striking modifications. Although the absence of enemies, and abundance of food close at hand may suggest reasons for the loss of flight in such birds as the Kiwi and Owl Parrot of New Zealand, yet it is probable that here, as elsewhere, the law of correlation of structures, about which at present we know so little, has played a part in the transformation, coupled with a change in the habits and circumstances of the ancestors of flightless birds. For there can be little doubt that the reptilian forerunners of birds generally were [illegible], and probably arboreal, animals, not aquatic, as some writers have suggested. In any case the pterodactyles cannot be regarded as being in the direct line of descent of birds.

Archaeopteryx lithographica, the most ancient, as well as the most primitive bird, "created," as Huxley said, "to prove the truth of the theory of evolution," had well-developed fore-limbs, even if they were not very serviceable wings, and hence we may assume that in all cases flightless birds have descended from flying ancestors. Bearing this in mind, it is certainly remarkable that one of the most ancient known birds, *Hesperornis* (see Figure 1), found in the Cretaceous shales of Kansas, had lost the power of flight completely. In fact the wing-bones were absent, and the breast-bones and pectoral arch much reduced. The bird was a gigantic diver.

FIGURE 1.
Hesperornis regalis Marsh (restored) from the Cretaceous of North America.

FIGURE 2.
Phororhacos longissimus Ameghino (restored) from the Santa Cruz Bed (? Miocene) Patagonia.

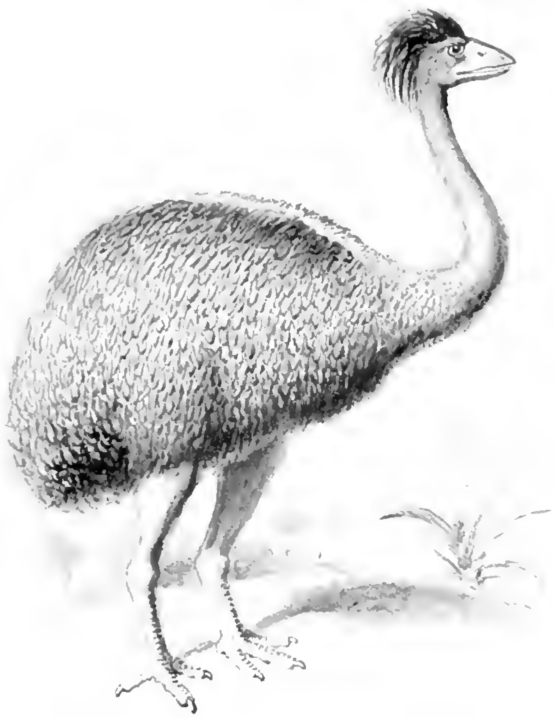


FIGURE 3.
Aepyornis maximus Geoffroy (restored) from the Pleistocene of Madagascar.

allied to the grebes of to-day, so well adapted to an aquatic habitat that it probably rarely, if ever, walked on land. The set-back of the legs, and the large knee-cap and cnemial crest seem to have rendered an erect position impossible. The mouth was well provided with teeth, set like a lizard's in a groove, not in distinct sockets. The remains of other Mesozoic birds have been found which, barring the possession of teeth, are not very different from modern forms, *e.g.*, *Icthyornis* allied to the gulls.

Unfortunately for the palaeontologist the bones of birds are rarely found fossilized. Their lightness prevents them in a great measure from sinking, and thus being covered up by some sedimentary deposit, a necessary step in the process of fossilization. Hence it is not hard to understand why, with the important exception of *Archaeopteryx*, as yet no remains of any intermediate forms between reptiles and birds have come to light.

In the Santa Cruz Bed (? Miocene) of South America we find the remains of another giant flightless bird *Phororhacos*, allied probably to the Secretary Bird of South Africa. The reason for the large size of many flightless birds is not hard to see. Among the extinct pterodactyles, as well as in birds, there is a strict limit to size when the body has to be raised into the air. Muscular tissue and general vertebrate anatomy being what it is, we may safely assume that no animal much larger than a swan ever flew through the atmosphere of our planet. But as soon as the necessity for flight is removed, so likewise is the embargo on any increase in size, and natural selection has a free hand. Size, strength, and fleetness of foot have often to make up for loss of flight. A few generations, probably, were sufficient to produce a marked increase in weight and stature in a bird that had ceased to fly. To return to *Phororhacos*. The bird had certainly a larger and more massive head and beak than any other yet discovered, and it is not improbable that it resembled Figure 2. It is portrayed killing a lizard, but there can be little doubt that it would have made short work of any living snake if its habits and mode of attack were the same as those of its smaller modern relative.

Figures 3 and 4 are those of *Aepyornis* and

FIGURE 4.
Dinornis maximus Owen (restored) from the Sand-hills of New Zealand.

Dinornis (the Moa). The first of these—the eggs and remains of which have been found in Madagascar — is generally believed to be the original of the "Roc," and certainly lived down almost to historic times. It was a flightless, ostrich-like bird that laid one enormous egg at a time. Specimens have been found measuring 13 inches by 9·5 inches. In this connection it is interesting to note that the *Apteryx*, a modern flightless bird of New Zealand, about the size of a fowl, lays, likewise, an egg entirely out of proportion to its bulk, being very nearly as large as that of a swan. Doubtless in flying birds the eggs are necessarily prevented from becoming very large, to ensure that the bird does not become too heavy, but in those that are flightless there is no such need.

(*To be continued.*)

THE TIME OF HIGH WATER.

By J. A. HARDCASTLE.

At this time of the year so many people enjoy the sands and the bathing at the seaside, that the time of High and Low Water is a subject of considerable importance, and the wise man will consult a local tide-table if he wishes to choose the best date for his visit or indeed the best seaside resort for his purpose. The Norfolk coast has long enjoyed a great popularity, yet it is more than probable that no one has noticed one great advantage that it possesses, a feature, the loss of which would be more detrimental than the disappearance of the much-vaunted sands. It consists in the particular value for that coast of what is technically called the "establishment," a list of which quantities is given in *Whitaker's Almanac* page 68. The value for Cromer is five hours—meaning that High Water occurs there five hours after High Water at London Bridge.

It is common knowledge that each day the tides occur fifty minutes later, and consequently, in the course of fourteen days they go all round the clock, and the moon also passes from new to full and full to new in fourteen days. Consequently if High Water occurs at noon on the day of new moon it will occur at noon also on the day of full, and in fact all the Spring Tides will be high at noon. It is also well known that the tides proceed round the coast and on any one day High Water occurs at a different moment at different ports. Thus, for instance, Spring Tides are high at Aberdeen at 2 o'clock, at Cromer at 8 o'clock, at Brighton at 12; these hours may be taken as both morning and afternoon since there are practically twelve hours between any two high tides.

I can well remember my disappointment as a child at hearing again and again of wonderful high tides beating on the sea-wall at Cromer, but they always happened when I was in bed because the Cromer Spring high tides occur at 8 o'clock; but then on the other hand the Spring low water laid bare the best sands and sometimes even showed us the old Church Rock, and these low waters always occurred in the middle of the day. This then is the first point of advantage conferred by the "establishment"; the lowest tides and the best sands happen in the middle of the day. Now at Ramsgate the "establishment" differs from that of Cromer by seven hours and so the Spring flood-tide is in the middle of the day and the best of the sands are bare at 7 a.m. and 7 p.m., which is far less convenient.

It will, however, be urged that the loss of that particular low tide to the visitor who stays a fortnight is not serious. A week later Cromer will be having low water at 7 or 8 o'clock and Ramsgate at about noon, and though those will indeed be Neap Tides, the difference scarcely matters much.

But that rejoinder betrays ignorance of one of the most interesting features in the run of the tides, which is called their priming and lagging.

The following Table gives the times of High Water at Cromer for September and October, 1911; the first column being drawn up on the assumption of a uniform interval of fifty minutes from day to day, the second gives the actual time of High Water—while the third gives the actual intervals.

Tide Table for Cromer.

1911.			At uniform intervals.		At true intervals.		
Sept.	21		5.46 a.m.	...	5.46 a.m.		
,,	22	New Moon	6.36	...	6.34	48	C
,,	23		7.26	...	7.13	39	C
,,	24	Springs	8.16	...	7.48	35	C
,,	25		9.6	...	8.22	34	C
,,	26		9.56	...	8.57	35	C
,,	27		10.46	...	9.28	31	C
,,	28		11 36	...	9.58	30	C
,,	29		12.26	...	10.32	34	
,,	30	1st Qr.	1.16	...	11.12	40	
Oct.	1		2.6	...	12.6	54	I
,,	2	Neaps	2.56	...	1.19	73	I
,,	3		3.46	...	2.58	99	I
,,	4		4.36	...	4.23	85	
,,	5		5.26	...	5.21	58	
,,	6		6.16	...	5.59	38	
,,	7		7.6	...	6.35	36	C
,,	8		7.56	...	7.7	32	C
,,	9		8.46	...	7.39	32	C
,,	10		9.36	...	8.15	36	C
,,	11		10.26	...	8.50	45	C

Let us suppose that the most convenient hour for the summer visitor to have low water is between 12 and 4, while the most inconvenient is between 6 and 10. Our Table gives High Water so we must state it thus:—

Convenient days High Water from 6 to 10.
Inconvenient days High Water from 12 to 4.

I have marked with a C and an I these days respectively—and one sees at once that there are seven convenient days and only three inconvenient days, while five days are indifferent. After fifteen days everything repeats itself. The reason is apparent by reference to the third column. Spring tides occur two days after new and full moon, for certain reasons that need not now concern us, and for three or four days before and after the Springs the tidal intervals are very short; the tides are said to be priming. On the other hand at Neaps the tides lag and the intervals are long.

If, therefore, the "establishment" is such that Spring tides occur at a favourable hour in the day—you will get perhaps seven very favourable days to three unfavourable—or roughly speaking it is two to one in favour of the tripper finding the sands convenient for him at Cromer. At Brighton it is precisely the opposite, seven unfavourable to three favourable days.

REVIEWS.

ARCHAEOLOGY.

The Past at our Doors. Or The Old in the New around us. By WALTER W. SKEAT, M.A. 198 pages. 52 illustrations. 4¾-in. × 7-in.

(Macmillan & Co. Price 1/6.)

The second title of this book gives perhaps the better idea of its contents for they deal with the story of our food, our dress and of our home. To a great extent the origin and use of the names comes in for attention, but those who like to trace the history of the things around them from the small vestiges and peculiarities which survive, will be charmed with the book.

We learn the meaning of the dairy where bread was originally kneaded; a hamper was once a basket to hold a particular kind of drinking cup; the hearse took its name from a framework of spikes like a harrow on which to stick candles, and for that reason was given the same name as a harrow. Even in connection with the story of our home, trade signs are considered, while the subject of clothes is one that is always attractive.

BACTERIOLOGY.

Aids to Bacteriology.—By C. G. MOOR, M.A. 240 pages. 4¾-in. × 6½-in.

(Baillière, Tindall & Cox. Price 3/6 net.)

This little book, of which we welcome a second edition, contains many useful hints both for those who are not familiar with bacteriology and those who are working at the science and want to find, easily, details as to methods of preparation, staining, collection of samples, and the general points to be borne in mind with regard to various diseases which are due to bacteria.

BIOLOGY.

The Biology of the Seasons.—By J. ARTHUR THOMSON. 384 pages. 12 coloured illustrations. 5¾-in. × 8¾-in.

(Andrew Melrose. Price 10/6 net.)

Professor Thomson's book is full of interest, because, not only does he give us facts and put them before us in his own way, but because he discusses theories and reminds us that there are still differences of opinion in many biological matters. As the name implies, the treatment in the book is seasonal, following that natural but informal sequence, which is one of the great advantages of what is known as nature study, which is scientific but not science. As may be expected, birds come in for a good share of attention, the meaning of their song for instance is discussed and the question whether they learn to build their nests or instinctively construct them is considered.

We may mention also the chapter on the migration of eels, and most particularly that dealing with adolescence. The book is illustrated by a number of reproductions of coloured sketches, which are certainly a change from the photographs from which most popular books are now illustrated, but they are mounted on paper which is so dark that it detracts from their effect.

We should like to see "The Biology of the Seasons" very widely read.

BOTANY.

Life Histories of Familiar Plants. By JOHN J. WARD. 204 pages. 120 illustrations. 5-in. × 7¾-in.

(Cassell & Co. Price 3/6.)

In natural history familiarity is far from breeding contempt, and there is so much to learn about even the commonest creatures, that it would be strange if Mr. Ward's book had not proved successful, as the call for a popular edition shows it to have been. The photographs are exceedingly good, and reproduced plainly and simply without any of the flummery or inartistic combinations which occur in many nature books.

CHEMISTRY.

Chemistry for Matriculation.—By G. H. BAILEY, D.Sc., Ph.D. and H. W. BAUSOR, M.A. 548 pages. 140 illustrations. 7-in. × 5-in.

(University Tutorial Press. Price 5/6.)

This book, as its title suggests, is intended to help students across the pitfalls of the Matriculation Examination of the University of London. It is divided into four sections, viz.:—I, dealing with the general principles of Chemistry; II, with the non-metals; III, with the more common metals and including a chapter on electrolysis; and IV, with chemical calculations.

Since the pass-list is the ultimate aim of the book, its contents are of necessity rigorously compressed and all extraneous matter is excluded, but the experiments are so well chosen as to remedy to a large extent the usual bad effects of such compression. The ground required for the examination is certainly most efficiently covered, and even students who are not working under the shadow of examination will find the book of use to crystallise their knowledge.

C. A. M.

The Chemistry and Testing of Cement.—By C. H. DESCH, D.Sc. 267 + x. pages. 9 plates. 5½-in. × 8½-in.

(Edward Arnold. Price 10/6 net.)

Dr. Desch's book is of interest to the scientific chemist mainly, owing to its able discussion of the chemistry of the setting of cement.

In confining himself to the scientific side of the question, Dr. Desch, in his book on "The Chemistry and Testing of Cement," has filled an hitherto conspicuous gap in the ranks of modern cement literature. There are many excellent works dealing with the practical aspect of the industry, but none of these deal in an exhaustive manner with the questions so efficiently discussed by Dr. Desch.

The author has gathered the results of researches dating from the time of Le Chatelier to the present day, and presented them to his readers in a concise and masterly fashion. The subject is thus shewn to be a fascinating one, and there are still many opportunities for further research. The work under review indicates the lines along which future work must proceed.

On experimental grounds the author finds himself unable to accept the crystalline theory of setting advanced by Le Chatelier. This theory supposes the setting of the cement to be due to the interlocking of crystals of hydrated silicates of calcium. Dr. Desch considers the experimental evidence in support of this view to be insufficient. Microscopical examination of a hardened cement, according to the author's own researches, does not reveal the presence of a sufficient proportion of crystalline constituent. By far the larger proportion of the constituents appear to be amorphous. From this, Dr. Desch is led to support the views of W. Michaëlis, who suggested, so far back as 1893, that "the calcareous hydraulic cements owe their hardening mainly to the formation of colloidal calcium hydro-silicate."

Dr. Desch says: "The theory (of Michaëlis) so well explains the phenomena observed, and is in such good accordance with the results of microscopical investigation of cements during and after setting, that it must be held to contain at least a greater part of the truth."

The hardening of cement Dr. Desch considers to be due to the loss of water experienced by the colloidal bodies formed.

Many interesting experimental data are given.

The mechanical and physical properties, their determination, and the mechanical analysis of cement, also receive careful attention.

The book may be represented as containing the most modern accepted views of the chemistry of cement, and is a highly important and successful addition to existing literature on the subject. It should find a place in the library of every scientific chemist.

W. A. B. W.

Modern Industrial Chemistry.—From the German of H. Blücher, translated by J. P. Millington, M.A. 779 pages. $6\frac{1}{2}$-in. × $9\frac{1}{2}$-in.

(The Gresham Publishing Company. Price 30/- net.)

This volume is really a chemical dictionary. Reference to a number of the items considered in its pages shows that the information contained in it is full, considering the amount of space there is to spare, and we have no hesitation in saying that it will prove most useful, not only to chemists but also to the mass of educated persons who often wish to know more about some substance or process of which they hear or read.

MATHEMATICS.

Orders of Infinity: the Infinitärcalcül of Paul du Bois-Reymond.—By G. H. Hardy, M.A., F.R.S. 62 pages. $8\frac{3}{4}$-in. × $5\frac{5}{8}$-in.

(Cambridge University Press. Price 2/6 net.)

This work forms No. 12 of the valuable series of short mathematical tracts entitled "The Cambridge Tracts in Mathematics and Mathematical Physics," published under the general editorship of Messrs. J. G. Leathem, M.A., and E. T. Whittaker, M.A., F.R.S.

As Mr. Hardy remarks in his preface, "with the particular system of notation that Du Bois-Reymond invented, it is, no doubt, quite possible to dispense; but it can hardly be denied that the notation is exceedingly useful, being clear, concise, and expressive in a high degree"; and mathematicians in this country will, no doubt, be grateful to Mr. Hardy for presenting them with Du Bois-Reymond's valuable ideas in an English dress. Du Bois-Reymond, unfortunately, is at times highly obscure, and many of his proofs can hardly be regarded as conclusive. Mathematicians have further to thank Mr. Hardy for largely remedying these defects, and for bringing the "Infinitärcalcül" up-to-date. It is rather a pity that lack of space has prevented him from discussing the various points that arise in the book rather more fully than is done: and it would certainly have been an addition welcomed by readers whose mathematical abilities are not of quite the highest quality had the general proofs been more freely illustrated with specific examples.

There is an interesting paragraph on pages 25–26 dealing with the attempts (which do not appear to have been altogether successful) to represent orders of infinity by means of symbols. The writer is inclined to consider this subject, in its present condition, as being merely of the nature of a mathematical curiosity; we venture to suggest, however, that with further research it may prove to be of no little importance.

An appendix containing a bibliography of the subject, as well as another containing some numerical calculations (made by Mr. Jackson, scholar of Trinity College) bearing on the subject of the work, add to the value and interest of the book.

H. S. Redgrove.

METEOROLOGY.

Hints to Meteorological Observers.—By W. Marriott, F.R.Met.Soc. 75 pages. 25 illustrations. $9\frac{1}{2}$-in. × 6-in.

(Edward Stanford. Price 1/6.)

We are glad to see that a seventh edition of this very useful little manual has been called for, and this fact is perhaps the best testimony to its worth. Mr. Marriott gives in clear and simple language just the information required by those interested in weather observation, and by following the instructions given anyone will be able to bring his local record into line with others and thus greatly increase its value.

The volume includes a set of Meteorological Tables, together with a particularly useful glossary of Meteorological terms.

MICROLOGY.

Animal Micrology.—By Michael F. Guyer, Ph.D. 240 pages. 71 illustrations. 6-in. × 9-in.

(Cambridge University Press. Price 7/- net.)

Brief, practical and definite descriptions of the most important modern methods of microscopic technique have been prepared by Dr. Guyer and combined with a simple account of the microscope and a consideration of standard reägents, to form a useful book for those who are taking up microscopical research. Methods of preparing material and of examining particular kinds of creatures are also explained.

NATURE STUDY.

Nature's Pageant.—By Margaret Cameron, LL.A. 120 pages. Numerous illustrations. $6\frac{1}{4}$-in. × $8\frac{3}{4}$-in.

(Blackie & Son. Price 1/-.)

This book, which is intended for very young children, carries out the nature study idea in so far as it deals with the seasons. It is, however, open to the objection that in it the animals are endowed with speech, and though fairy tales as fairy tales are interesting and stimulate imagination, much of the false sentiment of modern times is due to dealing with animals as if they had exactly our thoughts and feelings.

PSYCHOLOGY.

An Introduction to Experimental Psychology. By Charles S. Myers, M.D., Sc.D. 156 pages. 20 illustrations. $6\frac{3}{4}$-in. × 5-in.

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

On the scientific merit of Dr. Myers' little book the verdict of expert opinion will be favourable. The topics for treatment are well selected; the treatment itself is careful, lucid and effective. Those who are not experts will probably turn to this brief introduction to ascertain what are the claims of those who advocate the application of the methods of experiment in psychology, and how far there is some promise of these claims being made good. We fear their off-hand verdict may not be so favourable. They will turn, perhaps, to the chapter on memory, and they will find that the experimental work deals with the associative linking and subsequent revival of pairs or groups of nonsense syllables. They will wonder why such emphasis is laid on the nonsensical, and ask, perchance, whether *this*, then, is the new psychology. All suggestion of meaning seems to be regarded as a disturbing factor, which only ceases to give trouble "as the subject becomes more expert." They should remember, however, that what we glibly talk of as memory is a pretty complex business, and that the only chance of dealing scientifically with such a complex is to follow up in detail the several threads which are subtly interwoven. They should remember, too, that, in the course of experimental work, the mere fact of endeavouring resolutely to exclude meaning is a means to the realisation of how readily some significance is apt to be suggested. Dr. Myers might, perhaps, have insisted on the value of the experimental method in stimulating that introspection to which the novice in psychology is comparatively unaccustomed. The current perusal of such a book in a spare hour will not enable the reader to do justice to its merits, or to grasp how much real psychological value there is in experimental work.

C. Ll. M.

TOPOGRAPHY.

Burma: A Handbook of Practical, Commercial and Political Information.—By Sir George Scott, K.C.I.E. 520 pages. Numerous illustrations. 5½-in. × 7½-in.

(Alexander Moring. Price 10/6 net.)

Sir George Scott's readable account of Burma is well known, and in noticing the second, new and revised edition, we may say that Natural History and Geology are considered in some detail, while the hints to visitors or new residents make the book more valuable.

Ruins of Mexico. Volume I.—By C. George Richards. 153 pages. 262 illustrations. 13¼-in. × 9½-in.

(H. E. Shrimpton. Price 42/- net.)

During his wanderings amongst the ruins of Mexico, Mr. Constantine George Richards has collected a fine series of photographs, and to form the first volume of his book which is now before us, he has put together two hundred and sixty-two collotype reproductions of his pictures. In his introduction he says that there is nothing scientific, literary, or new in his work, but those who are privileged to see it will be ready to assure him of the value of his records of the ruins of the times before the Spanish Conquest.

QUERIES.

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

46. BIBLE ASTRONOMY.—What would be the effect on our planet and other of this system if the sun and moon were to stand still as stated in the book of Joshua in the Bible?

J. W. A.

47. GRAVITY.—I heard it stated in a sermon, preached in a village church a few Sundays ago, that the reason we do not tumble off the earth is because it is surrounded by the atmosphere, which keeps us from flying off into space. No allusion whatever was made to gravity. Talking it over with a friend afterwards, she informed me that gravity was now rather discredited by scientific men, and that, if the atmosphere was not the sole cause of our remaining on the earth, at all events it had a good deal to do with it.

This is such a very novel theory to me that I venture to write and ask you if there is any truth in it?

IGNORAMUS.

48. THE COOLING OF HOT WATER. There is a popular belief that boiling water freezes faster than cold: apparently it is also held that it cools more rapidly when the thermometer does not fall to 32° F., for I have heard of very hot water being put ready overnight for a bath in Jamaica in the belief that this would furnish the coolest morning tub. That the belief is false in most cases I have convinced myself by a "fool's experiment": on a night of hard frost I put out water at boiling point, water that had boiled for some time, and cool water, in similar vessels, with the result that might have been expected: the cold water was ice some hours before the others. But can you or any of your readers tell me what gives rise to such a singular and unexpected fallacy? Are there any conditions under which boiling water could freeze more rapidly than water at any lower temperature?

A. F.

NOTICES.

THE HOME OF GILBERT WHITE. In *The Country Home* for July there is a thoroughly-well illustrated article on "The Wakes at Selborne," by Miss Amy Astbury. We believe that pictures of many of the rooms have never been published before, and we are able, by the courtesy of *The Country Home*, to print below, one of the rooms in which Gilbert White wrote "The Natural History of Selborne."

WHO'S WHO IN SCIENCE.—Messrs. J. & A. Churchill are preparing a new annual book of reference which will contain the names, appointments and achievements of the foremost scientific men in the world. Schedules are now being sent out and the cooperation of all those interested in science is invited. The forms should be returned, as soon as possible, to 7, Great Marlborough Street, London, W.

The room in which Gilbert White wrote "The Natural History of Selborne" and in which he afterwards died.

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, 1911.

THE TRUE STRUCTURE OF THE DIATOM VALVE.

By T. F. SMITH.

(*Continued from page 293.*)

FIGURE 14 is from the *inner* side of another valve, the first ever seen and taken, showing the fracture through undoubted perforations. The strongest argument hitherto for "beads" in the finer forms was that the fracture always ran between them, as the weakest part. Mr. E. M. Nelson, at the discussion in the Quekett Club, gave this testimony: "The difficulty has always been felt that in *formosum* they had never been able to see the holes: but now it was shown that there was, undoubtedly, a perforated membrane; they could take it and see for themselves that it was a perfectly plain thing: indeed, if this was not real, then he could only say that all other things were hocus pocus. With their very best lenses they had tried to find out about *formosum*. Mr. Smith had found this fracture, had shown it to him, and that at any rate the fracture did run through the holes." This extract is given here not in any spirit of self-glorification on the part of the present writer; but rather that so valuable a testimony should be added to strengthen his own.

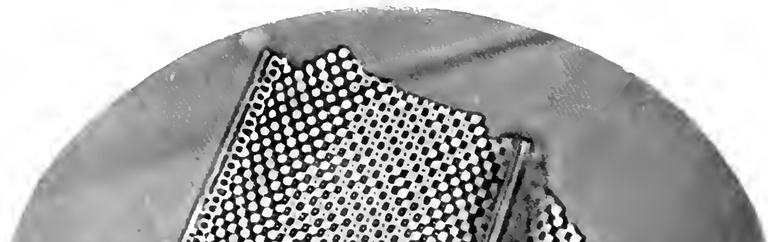


FIGURE 14. The inner side of *Pleurosigma formosum* showing the fractures through the holes, the first ever seen under these conditions, × 1750.

Particular attention is also directed to this print, as it exhibits a structure of squares instead of the customary round beads. This is in accordance with the theory of Dr. Abbe, expressed in his paper on the relationship of aperture to power. He shows there that all the optical details of an object developed with insufficient aperture to resolve them properly, whether square, lozenge-shape, or triangular, are depicted either oval or round. Figure 4, from the same side, where the valve has not been acted upon, may seem to contradict this view. The present writer, however, has already given his opinion that these appearances do not denote structure, but are only a collection of focal

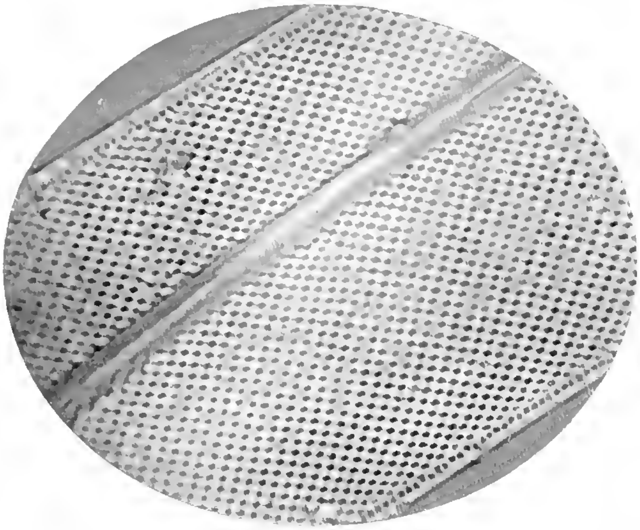


FIGURE 15. The inner side of *Pleurosigma formosum* where the valve has been acted upon in parts, leaving bare the fibrils or grating. × 1750.

images thrown from the other side of the valve, as on a screen. The structure does not seem to differ much in character from that of the outside, except in being more robust. See Figure 15 for this, taken also from the inner side.

Comparing the optical results from the same diatom, in the photographs taken both by the oil immersion and the dry lens, is there any reason for doubting the utter futility of attempting to elucidate further the structure of *P. formosum* with an objective of only 1·0 N.A.? Yet the *Transactions of the Royal Microscopical Society* show that this feat has been attempted by one of its Fellows within the last two or three years. The chief, the almost sole, advantage of the oil immersion apochromatic lens is that by its refinements of correction it can stand more light, and have more of the available aperture utilised. The almost possible limit of resolving power was reached by the old glasses with an aperture pushed to 1·50. It was proposed to carry resolution still further by an objective of only 1·0, with a top-stop as an accessory. The results are recorded and figured in the *Transactions* let the readers of "KNOWLEDGE" compare them.

When we come to *P. angulatum* we are dealing with structure of just double the fineness, where it is not so easy to get such striking examples of the torn structure to confirm the practical identity of the two. In *P. formosum* we can obtain it in long chains, as it were, here we shall find only links. Yet to those who know a chain when they see it, identical links should be sufficient for evidence. Indeed, from the various processes to which the valves are subjected it is only to be expected that the more fragile forms will get the most damage, and they do. The photographs of this species have been enlarged twice, for the better comparison; figure 16 shows the fragments of two valves, each with the opposite face outwards, forming a striking contrast. The torn structure seen just above the median line is from the *outer* side, and exhibits similar fibrils, with the same arrangement as in *P. formosum*—more especially seen at the left-hand bottom corner of the picture, where it is marked with a ×—exhibits the same focal images, projected from the other side of the valve. Above this again it will be seen that we get the normal appearance of the *outer* side when sound, and, in the uppermost division in strong contrast the characteristic hexagonal structure of the *inner* side. Figure 17 is another example from the outer side of still more torn structure; further, it is put here also to point a moral, if not to adorn a tale; for there is a tale.

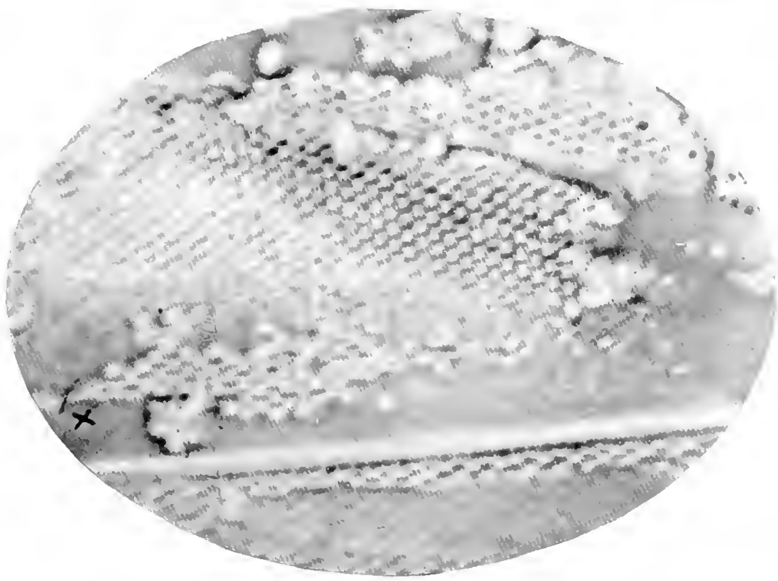


FIGURE 16. Fragments of the valve of *P. angulatum*, one showing the outer and one the inner side. × 3500.

Throughout the greater part of the period over which the history of the achromatic microscope extends, this species has been employed as a

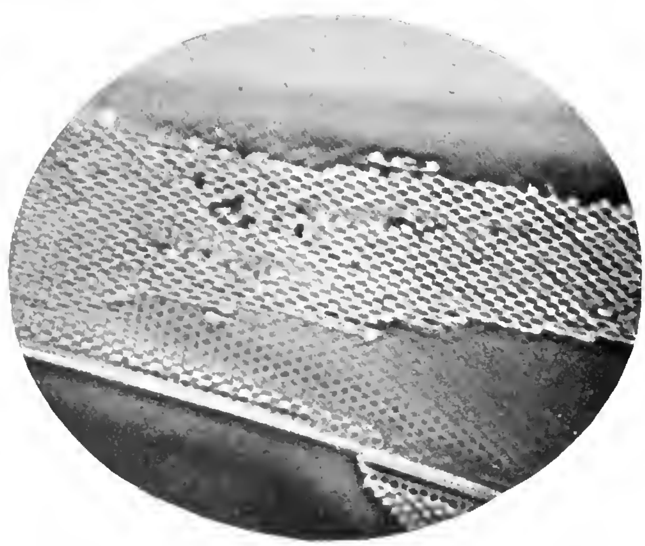


FIGURE 17. The outer side of the same, × 2500.

general test object, to illustrate different observers' theories. It has also been used to measure the advances, or the supposed advances, in the revealing of structure. Sometimes it has served as a proof that it can offer no evidence of the real structure at all—Dr. Abbe to wit. In the September number of *Harper's Magazine*, for 1907, there is an article on photo-micrography with the ultra-violet rays, under which it is claimed that the resolving power of the microscope has been recently doubled. The customary *P. angulatum* is ushered in to make valid this claim. By an ingenious and, I am afraid, a somewhat disingenuous arrangement, two photo-micrographs of this diatom are placed side by side, one taken under the ordinary illumination and the other under the ultra-violet light, to prove it.

Now, somebody, somewhere, must have been taken in at the same time, for this supposed new structure was seen, and photographed, by the present writer twenty years previously. It had not then, and has not now, any special significance for him, except in illustrating his theory of focal images. Neither is it a severe test of the resolving power of the microscope; any oil immersion of 1·30 will suffice. The statement is from Germany, which produces some of the best micro-objectives in the world, and is also the home of some of the worst micrography.

Figure 18. The inner side of *P. angulatum*. × 3770, showing the isolated slip.

Of course, one does not wish to imply that the resolving power of the microscope cannot be increased, or even doubled, by the use of the ultra-violet light, only that the example given does not prove it. As far as memory serves, the method stated as being employed did not give much promise of future great discoveries. The object was not seen at all, surely fatal to accurate and refined definition. To know one's subject thoroughly it is necessary to work out the details under the microscope while sitting down, in order to recognise what to go for, before attaching it to the camera. More practical, the late Dr. Dallinger advocated increasing the resolving power by the judicious use of coloured screens. Yet, after experiments, he recognised that the objectives should be corrected throughout for any particular ray.

Now, turning to the inner side of the valve, enlarged as before, for better comparison, Figure 18 should give us the key to the much-discussed hexagonal structure. It offers, however, this characteristic difference from the corresponding side of *P. formosum*, that the fibrils or short bars of silex instead of being placed leng[illegible]s [illegible]re set obliquely across the valve. It will be [illegible] [illegible]so that the zig-zag arrangement of the isolat[illegible], if joined to the broken edges bordering the clea[illegible]s on each side, would require no crossbars to comp[illegible]te the so-called hexagons. Another peculiarity is that this seems to be real structure in which there are no focal images to obscure it. The analogy, in fact, would be more with the hexagonal middle structure of the large discoid and other forms.

There still remains the question of the intercostals, which Mr. E. M. Nelson maintains are the products of the second order of spectra only. If these are not real entities, then why are they produced from this one side of the valve alone? The structure on both sides is of equal fineness; given the same conditions of aperture and lighting, should there not be produced the same results? However, perhaps it is not well to express too pronounced an opinion on such a matter. We are dealing here with appearances so minute that six dots are arranged around one that once taxed the whole powers of the microscope to define.

Figure 19 is from a valve of *P. balticum*, still showing fibrils and also indications of the structure underneath. The appearances here have been put down to moisture in the dry mount; but, as it happened, Mr. E. M. Nelson exhibited the same diatom under the celebrated new objective of 1·63 N.A., presented to the Royal Microscopical Society by Zeiss. The object then was of a necessity mounted in a dense medium, yet in all respects it offered the same details as are figured here. So much for moisture in the mount. It will be seen that the fibrils differ to a certain extent from the preceding examples. They appear in this print as extended bars, with swellings at regular intervals, seemingly, when together, giving the semblance to beads or squares according to the aperture employed. This difference can be ascribed to one of two causes. It may arise from the true fashion of the structure in itself, or from imperfect resolution. Some countenance is given to this last view by referring back to Figure 11[*], taken with the dry lens, where it will be seen the fibrils come out almost straight, though by no means so when under the wider aperture of an oil immersion. Every earnest student of Nature knows that often we arrive at a point where we stand groping helplessly outside the boundary of knowledge. We may hazard a guess as to the right way in; but there our efforts must end.

[*] See "Knowledge" for August, 1911, page 293.

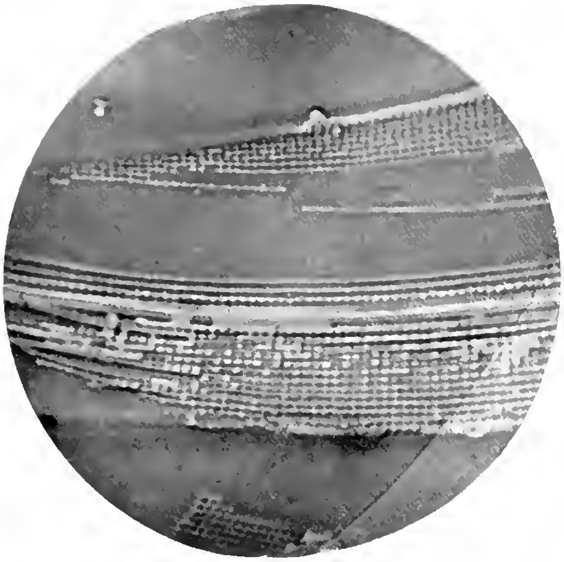


FIGURE 19. *P. balticum* showing the fibrils and the double structure of the valve, × 1750.

All the work figured here hitherto was done upon diatoms mounted dry. Later the writer was able to complete his evidence, of a unity of structure, upon other diatoms mounted in a medium. Figures 20 and 21 exhibit the same structure of fibrils upon a small *Coscinodiscus* so mounted, and being of sufficient thickness to allow the separate layers to be distinguished by an oil immersion. In one print the picture is much more crowded than appeared under the microscope, where the fine adjustment could be used. Only those who practice photo-micrography can appreciate the difference between seeing things in the microscope, and putting the same features vividly upon a plate. Visually the fibrils were unravelled, layer after layer, as one might unravel some woven material. Figure 21, taken at a slightly different level, shows two fibrils projecting into space, well separated from everything at the sides, above and below. Evidently the fibrils seen in the two prints, and not Mr. Slack's beads, form the sides of the hexagons of the middle layer of this diatom.

It is not assumed here that all diatom structure must be made up of similar fibrils. It is always dangerous to generalise from too little data. On the other hand the evidence is positive that much of the structure is, and there seems nothing to preclude the remainder from being formed of the same kinds of units. How these fibrils are deposited upon the true membrane of the lining vegetable cell is another matter.

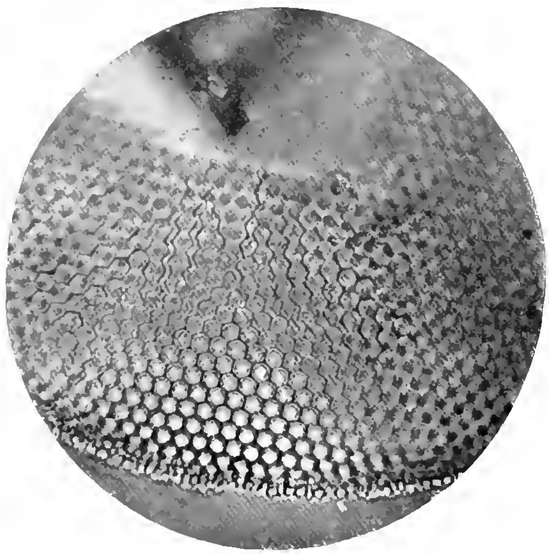


FIGURE 20. A small *Coscinodiscus* valve mounted in balsam, showing the same kind of fibrils forming the hexagons, × 1750.

This article would not be complete without reference to Dr. Henry Van Heurck's more recent work upon diatom structure, with the new apochromatic objective of 1·63 N.A. Plate 11 of the last edition of Carpenter was prepared by Dr. Van Heurck especially for that work. The description reads:—"This plate has a two-fold purpose. It is designed, first, to justify the opinions held by Dr. Van Heurck upon the structure of the valves of diatoms, and also to show how the usual microscopical tests present themselves when examined with the new objective . . . lately constructed by the firm of Zeiss."

The editor (Dr. Dallinger) thus describes Dr. Van Heurck's views. "He concludes that diatom valves consist of two membranes or thin films and an intermediate layer, the latter being pierced with openings. The outer membrane is delicate and may be easily destroyed by acids, friction, and the several processes of cleaning. When the openings or apertures of this interior portion are arranged in alternate rows, they assume the hexagonal form; when in straight rows then the openings are square or oblong."

Dr. Dallinger continues: "It is, however, due to Mr. T. F. Smith, who worked at this subject for years, to say that he long maintained this view. . . . . . In Plate 1, Figure 1, we have a photograph of his, showing the *inside* of a valve of *P. angulatum* magnified one thousand seven hundred and fifty diameters, and exhibiting the "postage stamp" fracture; while in Figure 2,

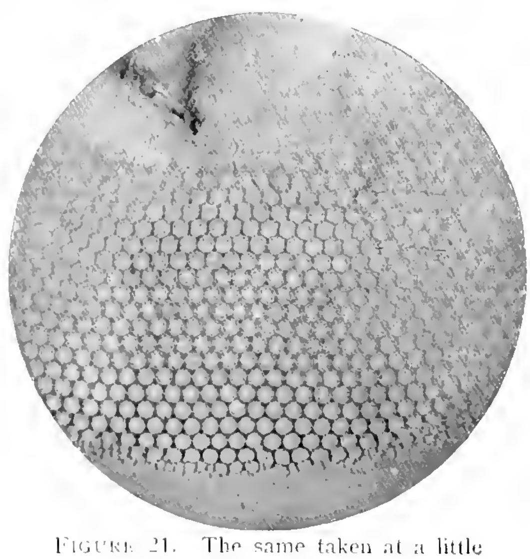


FIGURE 21. The same taken at a little different level, × 1750.

in the same plate, we have the *outside* of *P. angulatum*, showing a different structure: and Mr. Smith has abundant evidence of the existence of what he has so long maintained.

"By using the new lens of the great aperture of 1·63, Dr. Van Heurck has produced some remarkable photo-micrographs, which rather confirm these general inferences than present any new data of knowledge concerning the diatoms."

As it happens, Figure 6 of the plate of Dr. Van Heurck shows an isolated strip almost identical with that given here in Figure 18, even to the breaking across in one particular spot. It should be interesting to compare the two, not only the strip, but also the edges of the fractured valve bordering the blank spaces on each side the strip. Figure 5, of the same plate, exhibits the hexagons magnified ten thousand diameters, which Sir (then Mr.) Frank Crisp, described, on its introduction to the Royal Microscopical Society, as a remarkable photo-micrograph. It proved subsequently to be only an enlargement from the original negative.

NOTE.—In the first part of the article, on page 289, Figures 1 and 2 were inadvertently interchanged, and on page 291, "720" should read 1720.

CORRESPONDENCE.

OBSERVATION OF URANUS AND VESTA.

To the Editors of "KNOWLEDGE."

SIRS,—Mr. Leonard speaks of Uranus being probably visible to the naked eye, and in this connection I may say that the planet is often distinctly visible without telescopic aid. Many years ago, while pursuing meteoric observation, it was my habit to obtain nightly glimpses of Uranus and I found it quite possible to trace, even with unaided vision, the displacement in the position of the object relatively to small stars near. In fact I considered it an attainable feat for the ancients to have discovered the planet with the unassisted eye had they watched the zodiacal stars with great diligence and compared exact positions. Indeed Vesta, as well as Uranus, might have been recognised in this manner.

W. F. DENNING.

THE DISTRIBUTION OF THE NIGHTINGALE.

To the Editors of "KNOWLEDGE."

SIRS,—As in the August "KNOWLEDGE" you invite observations on the distribution of the Nightingale, I take the liberty of sending the following:—

In the map given in "British Birds," it is shown as numerous, or fairly so, over the greater portion of this county. Now in the Devizes and Pewsey Vale district it is *extremely* rare. My father has been in this part of the county for thirty-five years, and the first instance of its occurring here he has heard of was on May 3rd, 1910, when one came to our garden and stayed for two days and a night (*i.e.*, it was on migration).

Round Salisbury and in South Wilts generally it is a common bird.

G. B. HONY.

THE TRUE STRUCTURE OF THE DIATOM VALVE.

To the Editors of "KNOWLEDGE."

SIRS,—With reference to Mr. T. F. Smith's article on the above, it would seem a word or two is needed. At the outset let me heartily congratulate him upon his most excellent photographs of the valve. From one or other of them absolutely the whole structure is laid bare, but what at the same time is truly astounding is the fact, that having this actually before him he needs misinterpret it and head off upon a "new structure discovery" ending up with "chains of fibrils formed of short bars of silex arranged lengthwise which run in pairs parallel, and each pair having larger and narrower interspaces between, in regular succession, and so on." All of which is totally beside the mark and quite misleading to amateur microscopists.

These "chains of fibrils" in *Pleurosigma*, as well as Mr. Smith's "pins" in *Podura* scales, are as spurious to the true structure as the Man in the Moon. One is aware that kaleidoscopically they may be observed and even photographed, but taking his own example of sheets of transparent paper with markings thereon placed behind one another, although he has separated the sheets, in one photograph or the other, he ends with placing three together (at least) under a peculiar illumination and gives this as the true structure. It is disappointing that with such excellent photographs the time and patience should be expended in finally misreading their purport and sallying forth into print to further mislead mayhap other amateur microscopists. As I have only seen the first portion of Mr. Smith's article published, I am anxious to see what further discoveries he has in store for us.

F. J. W. PLASKITT.

SIRS,—By your courtesy I have received a proof of Mr. F. J. W. Plaskitt's letter printed above, which gives me the opportunity of replying, without the delay of another month. For his kind reference to the excellence of my photographs I thank him, at the same time taking exception to his strictures on some of my work. He says, for instance: These "chains of fibrils" in *Pleurosigma*, as well as Mr. Smith's "pins" in *Podura* scales, are as spurious to the true structure as the "Man in the Moon." By "spurious," I suppose he means due to diffraction effects. If so, why do they leave off in certain places, while at the same time there is an extended structure immediately underneath? Not only that, the structure I exhibit is irregular, while diffraction effects are not. Diffraction effects result also from a narrow cone of illumination, while I always work with a wide one of strictly central light.

Mr. Plaskitt says that in one or other of my photographs: "absolutely the whole structure is laid bare"—then—"but what at the same time is truly astonishing is the fact, that having this actually before him he needs misinterpret it and head off upon a new structure discovery" and so on. Further: "He ends with placing three together (at least)"—does Mr. Plaskitt mean three layers of structure, or three photographs?—"under a peculiar illumination and gives this as the true structure."

Unfortunately he does not give the numbers of the figures to be praised, and otherwise, for guidance, leaving me quite in the dark as to the work for which I am to be blessed and for which to be banned. As the other part of my article appears in this number of "KNOWLEDGE," I suppose he will now have further exceptions to take; will Mr. Plaskitt kindly supply the references I ask for, when I shall be pleased to do my best towards meeting his points. I have never run away from a discussion yet, but I naturally want to know what I am fighting.

T. F. SMITH.

MOUNTAIN BUILDING AND ORE DEPOSITION.

By J. E. W. RHODES, Assoc. Inst. M.E.

Of all physical features, mountains are among the most familiar but yet the least known. Few are ignorant of the romantic legends that cluster round them, of the poets who have sung of them, of the nations who have defended them; and to the student of History they have ever had a fascination,

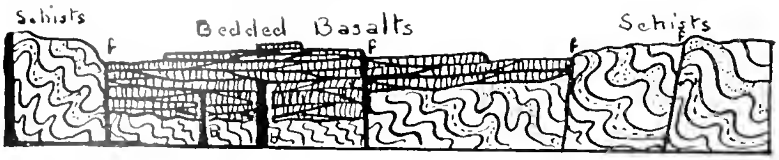


Figure 1.

as the walls that have kept race from race, and sometimes guided the destinies of nations. Again, in the hard world of to-day they are still there, the natural frontiers of the soldier, and the only partly subdued obstacles of the engineer. Yet after all this is only a superficial view—they are something more than view points, and if we enquire into their structure we shall find that every crag has its meaning in the long story that is now revealed to us.

The first characteristic of a mountain that we notice is its height above its surroundings, not merely height, but relative height. An upland plateau is not a mountain, however high it be, but all the characteristics of a true mountain range may be shewn by a low ridge. Thus the Malverns rise to little more than one thousand feet, yet in structure they are true mountains. Of almost equal importance is ruggedness, which is intimately associated with the first characteristic: for it expresses the steepness of the mountain, that is to say, the height divided by the horizontal extent.

Let us analyse these facts. Elevation requires upheaval, and so a mountain chain must have been at some time upheaved. Impressed by this truth the earlier observers neglected all others and attributed not merely the height but even the details of the form of the mountain to this cause. Von Buch, for instance, easily explained the perched blocks of the Alps in this way. When the mountain chain was thrown up, the motion was so violent that rocks were detached, and thrown up into the air, subsequently coming to rest on the sides of the mountain.

But detailed study soon shewed that things were not so simple. No violent catastrophe ever threw up a completed mountain chain and left it perfect. The moulding of its form was the work of ages and of more than one cause. And its complicated topography is but the expression of its no more simple architecture. Its hard and enduring rocks have been bent, broken, and contorted by great earth movements ere the long course of denudation sculptured its present form.

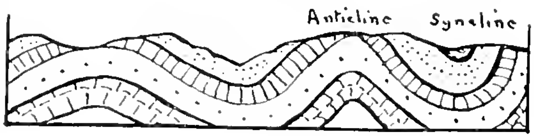


Figure 2.

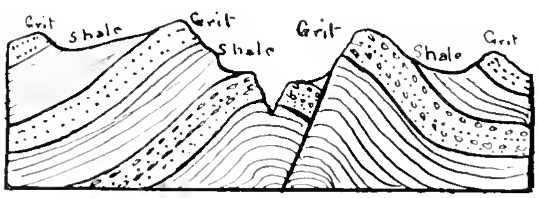


Figure 3.

So the primary origin of mountains is in movements of the earth's crust, and it becomes of importance to us to know in what ways the earth's crust can move, and what effects each kind of movement may have. Earth movements are of two kinds, viz.,

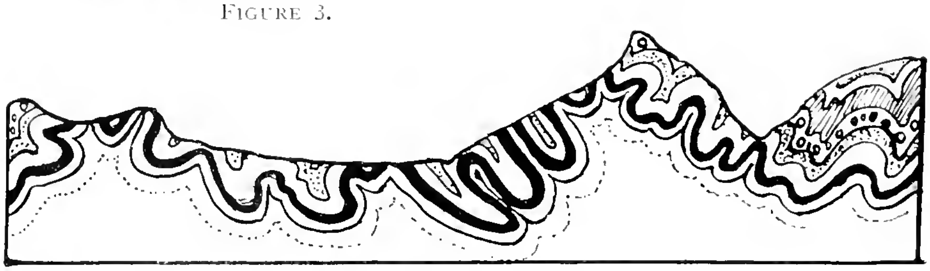


Figure 4.

1. Vertical, up-and-down, or plateau building.
2. Horizontal, tangential, or mountain building.

The plateau building movements are the result of the sinking or rising of one area relatively to another. They take place owing to the weight of the strata which tend to sink in blocks into the still fluid portion of the earth's interior, which, being molten, is probably lighter than it, and gives rise to more or less vertical faults or dislocations which bound the blocks. Thus the great basaltic plateaux of the Western Isles of Scotland have been let down by great faults between much more ancient rocks. In the deep fissures and cracks produced by this motion huge floods of basaltic lava have welled up while the sinking blocks of the crust sank into their place. The type of structure thus produced is shown in Figure 1.

The mountain-building movements are probably caused by the gradual contraction of the earth as it cools in the long course of ages. The molten interior contracts faster than the solid crust, which is kept at a more constant temperature on account of radiation, atmospheric circulation, and the heat received from the sun. From time to time, to be strictly accurate, at all times, the outer crust is being drawn inwards by gravity. One effect of this tendency has already been noticed, viz., the vertical

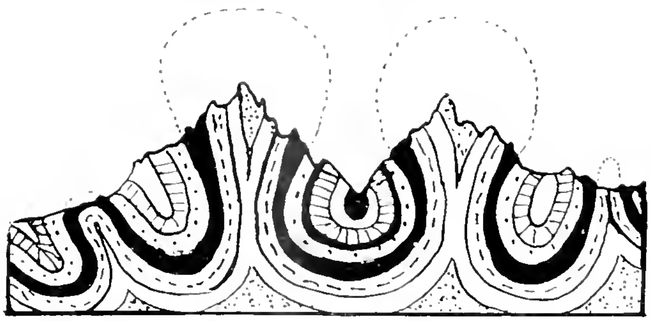


Figure 5.

movement is to originate a series of folds such as are shown in Figure 2, dipping in the direction of the movement and striking across the country, in a direction at right angles to it. As the movement intensifies the limbs of the folds become steeper and steeper, the more brittle strata snap at the crests of the folds as in the great anticlinal fault which marks the Pennine Chain in Lancashire and Yorkshire (see Figure 3). At last the folds themselves become folded, that is to say, their axes bend over and isoclinal folds are produced in which both limbs dip in the same direction, and the whole system of folds and faults is arched and crumpled up, as shown in Figure 4. In this intense crushing the limbs of folds are often so compressed as to squeeze the core of the fold

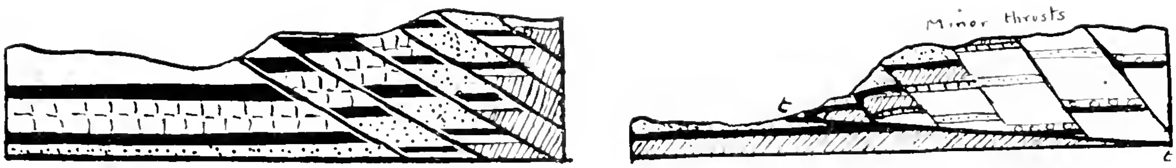


Figure 6.

slipping downwards of some areas of the earth's crust relatively to others, or plateau formation. But since a small sphere has necessarily a smaller area than a larger one, it follows that the bodily sinking of one portion of the earth's crust squeezes together other parts, and this movement or pushing aside of parts of the crust is horizontal or tangential. The pressure of this movement is so enormous and irresistible that the solid rocks of the crust are folded, crumpled, and piled on top of each other in their endeavour to occupy a less horizontal space. It is to the piled-up masses of strata raised in this way that we properly give the names of mountains, and the detailed study of the way in which their component beds have moved is of peculiar interest.

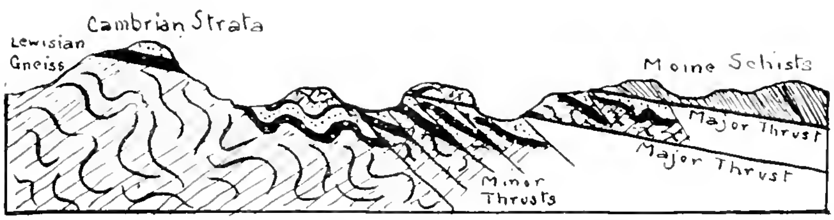


Figure 7.

The effects produced vary according to the nature of the strata. Igneous rocks and quartzites are very brittle and have a great tendency to break when folded, but soft shales can be very highly crumpled without fractures. With the less brittle rocks the first effect of a horizontal earth

bodily into the crest giving rise to fan structure (see Figure 5), and the component grains of the rocks themselves are broken and drawn into parallelism with the strike of the folds.

The extreme brittleness of many rocks gives rise to another set of features, and since both brittle and more or less flexible rocks are usually found close together these effects are usually added. According to the recent researches of Mr. Cadell, it has been shewn that when horizontal pressure is applied to a brittle mass, the parts nearest the pressure instead of folding, break off and slide upwards on somewhat inclined planes. As the block slides up the pressure is brought to bear on the next portion of the mass and another fracture or, as it is termed, minor thrust, is produced. In this way a series of thrusts is formed dipping towards the applied pressure. At last the huge mass of strata piled up between the pressure and the undisturbed rocks is driven forward bodily along a gently-inclined plane till it rests on undisturbed rocks. The part overlying this plane often crumples up on account of the extreme friction, or is crushed into powder. This major thrust, as it is called, allows the movement to affect the hitherto undisturbed rocks below, which in their turn become thrust. This is illustrated in Figure 6 and Figure 7, the latter shewing how the most ancient rocks in the Scottish Highlands have yielded to these movements.

The chief earth movements that have affected great Britain and Western Europe may be gathered into four great periods :—

1. The Pre-Cambrian, which for our present purpose is unimportant and will not be dealt with.

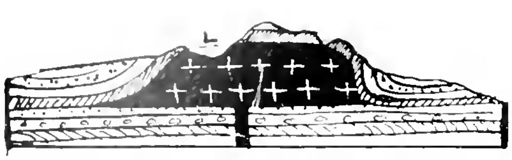


FIGURE 8.

2. The Post-Silurian or Caledonian, which folded the ancient rocks of North Wales, the Lake District, Southern Uplands and Highlands of Scotland, and whose folds generally strike W.S.W. to E.N.E., so that the movement must have come from the S.S.E.

3. The Post-Carboniferous, or Hercynian, which folded the Coal Measures and included two separate movements, one of which produced most marked effects in the South and the other in the North of England. The Armorican movement came from the South and crumpled the strata in the South and West of England into a range of mountains forming part of the great Armorican-Variscan chain, which then almost ranged across Europe. Though its effects are concealed from view in Eastern England by a mantle of newer rocks, it is well shewn in Devon, Cornwall and S. Wales.

The other Post-Carboniferous movement is called the Hercynian movement, and uplifted the Pennine Chain, forming great folds running North and South in the North of England.

4. The fourth great series of movements raised the chalk and converted it into land. These movements continued until the middle of the Tertiary period, and in Britain, especially in the Western Isles of Scotland, were of a plateau-building type. In Switzerland, however, great mountain building stresses were set up and resulted in the formation of the Alps.

It must not be imagined, however, that the highest peaks of any mountain range have received most uplift, and that the valleys necessarily lie in the troughs of the folds. Such is far from the case, for the uplift has always been so slow that the wasting action of air and water has had enormous effects, and the effects of the earth movements are only indirectly responsible for the scenery. The elevation of the Alps as a whole is due to earth movement; its individual peaks and valleys are due to the relative hardnesses of the diverse rocks of which they are composed.

In the study of mountain chains two things have long been noticed and as will now be seen have more than a practical interest. They are the abundance of mineral veins and of granitic and other igneous rocks. As has been mentioned before, igneous rocks also characterise plateaux, but they occur in a markedly different manner. If we examine the British metalliferous areas we shall find that they have all suffered from the mountain-building movements of the Caledonian and Hercynian, the great plateau regions of N.E. Ireland and the Western Isles of Scotland being devoid of mineral veins. It is also remarkable that most of the veins occupy fissures which appear to be due to the Hercynian and Armorican movements: only in a few parts do they appear to be Caledonian. To explain these phenomena it will be necessary to take a glance at the modern theories of the relationship of igneous rocks and mineral veins.

According to modern theories, beneath the solid crust of the earth lies a magma composed of fused rocks. Chemically it is composed, in the neighbourhood of the crust at any rate, of silicates and sulphides, which at the enormous temperature and pressure which there obtain are probably mixed together, although any lowering of temperature and pressure would cause them to separate into two layers.

The enormous pressure of the overlying rock tends to make this magma rise up through any cracks that may be present in the crust and dissolve large cavities in it. By so doing it draws nearer the surface and the sulphides and silicates separate into layers, the silicates at the top and the sulphides at the bottom. The fractures of the rocks caused by the great earth movements afford a ready means of escape, and in many cases the powerful uplifting

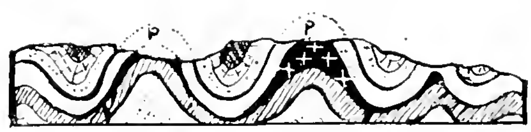


FIGURE 9.

action of the ascending rock has important effects. Thus a body of molten rock ascending a fissure may meet an impervious bed of rock and spread out as a sheet or sill, or arch up the strata to form a laccolite or occupy the core of a fold to form a phacolite. (See Figures 8 and 9.)

Since the silicate or rock-forming magma floats on the top we naturally expect that the formation of igneous rocks will precede the production of mineral veins, and when we come to examine the actual distribution of the ores we find that this is always the case. The tin veins of Cornwall are later than the granite, although certainly originally derived from the same magma, whilst the sulphide ores of copper in the same district are later still. In the same way the phosphate (apatite)) deposits of Norway represent the last stages in the consolidation of the great masses of gabbro, and wherever the gabbro is pierced by the veins a very peculiar alteration is produced in the gabbro which shows that it has been affected by heated waters containing Chlorine, a characteristic constituent of the ore apatite.

We have thus traced mountain building, the formation of igneous rocks, and the production of mineral veins, back to the same source—the great crustal movements caused by the contraction of the cooling earth. Despite their enormous effects, these movements are so slow that they would escape notice altogether but for those surface symptoms, earthquakes and volcanoes, which remind us that there are jolts in the evenness of an otherwise imperceptible movement. Movements that have begun long before historical times are still unfinished. The Himalayas are even now being folded over towards the great plain of India, and the far more ancient Highlands of Scotland are still moving feebly along the old faults.

QUERIES.

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

REPLIES.

46. BIBLE ASTRONOMY.—I do not know in what spirit J.W.A. has written this query. The sudden standing still of any of the heavenly bodies (apart from collision) is obviously of the nature of a *miracle*, *i.e.*, the operation of some special agency over and above the ordinary known forces. We clearly do not know its mode of action, so cannot introduce it into our mathematical analysis. But it would obviously be futile to leave out of account the action of this transcendent power, and yet to expect to obtain the true "effect on our planet and others of the system," on the assumption that only the known forces were acting. This is, however, the inconsistent assumption that J.W.A. appears to contemplate. Many think that the poetical and somewhat indefinite terms of the narrative can be sufficiently explained without assuming an actual change in the motions of the heavenly bodies. For example, he will find in Mr. E. W. Maunder's "The Astronomy of the Bible," the suggestion that the miracle was really the giving of unusual strength and endurance to the pursuing army, so that they made an afternoon march which would normally be deemed impossible, and inferred that the day had been lengthened.

A. C. D. Crommelin.

47. GRAVITY.—I think it is sufficient to simply say that it is gravity, and not the atmosphere, which prevents our falling off the earth.

A. C. D. Crommelin.

47. GRAVITY.—The statement made by your correspondent's friend, "That gravity is now rather discredited by scientific men" is quite incorrect.

The theory that "We do not tumble off the earth because it is surrounded by the atmosphere" is absurd on the face of it, seeing that the air, like every other substance, has weight and actually tends to buoy us up.

Humphrey Wilson.

QUESTIONS.

49. POLAR PHENOMENA.—I am thankful to the Rev. Mr. Davidson for enlightening me, in the February number of your journal, on some points of Polar Phenomena which had troubled me for some time past. May I take the liberty of troubling Mr. Davidson again, or any of your readers who may take interest in the matter, to enlighten me on the following points also.

1. An Indian author in his calendar for $86\frac{1}{2}°$ of latitude gives twenty-four to twenty-three days as the period of continuous long dawn, seventeen to eighteen days as the period of alternation of twilight and sun, and one hundred and sixty-nine to one hundred and seventy-one days as the period of continuous long day. Are these figures strictly correct, or may I assume that in actual observation they may vary slightly? I want a latitude which would give twenty-four days for the long dawn, sixteen days for the period of alternation and one hundred and seventy-one days for the long day. Will $86\frac{1}{2}°$ suffice for my purpose or shall I have to assume it to lie between $86\frac{1}{2}°$ and $87°$—say, at $86\frac{3}{4}°$?

2. What is the exact manner in which the sun's disc is rendered visible during the sixteen days-long period of alternation? I am told that the period of alternation begins when the South declination is $4° 20'$, and ends when the North declination is $4° 20'$. Shall I be wrong in imagining that the phenomena of sunrise during the alternation period occur as follows? On the first day the sunshine will last for about one-and-a-half hours only, and the maximum portion of the sun's disc visible that day (at noon) will be about one-sixteenth of the whole. On the second day about a two-sixteenths portion of the disc will rise into view, and the day will last for nearly three hours. On the third day three-sixteenths, on the fourth four-sixteenths and so on, till at noon on the sixteenth day, the whole disc will have emerged into view, standing just above the line of the horizon. Of course, the stay of the sun above the horizon will not be in the *exact* arithmetical progression as I have stated above, but practically the progression may be assumed to be so, as the daily variation will be slight. I wish to know if the phenomena occur as assumed above, or whether the *complete disc* of the sun will be visible at noon, for some days during this period of sixteen days.

3. If the first day of this alternation period falls on the eighth day of the dark half of a certain month, will not the Vernal equinoctial colure occur on the new moon day following or on the first day of the bright half of the next month? And also, may not such colure be assumed to occur at the very beginnings of a new (lunar) constellation? A certain Vedic passage says that the new year's day falls on the eighth day of the dark half of the month connected with the constellation Maghā, which has been identified with Regulus (129°). Assuming this day to be the first day of the sixteen days-long alternation period, shall I be right in taking the equinoctial colure to occur in (Delta) Leonis ($139° 58'$)?

I shall thank any one of your readers if they will kindly enlighten me on the above-mentioned points.

Baroda. R.K.P.

50. RADIO-ACTIVITY.—Would any of your readers inform me concerning the following questions for which I have not been able as yet to find an answer.

(1) Is it definitely proved that the α particles of a radio-active body are helium? Is this transformation?

(2) What is the exact nature of X rays? are they identical with and the same as the γ rays of radio-active bodies?

(3) What is the cause of the glow of the glowworm?

H. Sinclair Tait.

A NEW TABLE FOR PRACTICAL MICROSCOPY.

By The Rev. F. C. Lambert, M.A., F.R.P.S.

Sooner or later every user of a microscope experiences the inconvenience of the usual height (30 inches) of a writing table when it is required for a microscope with the tube in a vertical position. One feels the need either of a lower table, or an extra-high seated chair. To meet this difficulty, some time ago I designed a table and had it made by a local cabinet maker. One or two subsequent and trifling alterations have yielded me a perfectly satisfactory piece of furniture, which I propose to illustrate now somewhat fully, by means of photographs, so that any working carpenter should be able to repeat the apparatus in design, and modify its dimensions to suit the needs of his employer, by comparing the various illustrations one with another.

Figure 1.

The photographs had to be taken somewhat hurriedly in a quite small room, and with a hand camera without a swing back. These limitations will account for an obvious but slight distortion effect, which gives the table a tilted forward and enlarged top appearance. Some apologies are needed for the dust sheet background. Figure 1 shows a full face view of the table when in use for writing, and so on. Height from floor to top, including castors, thirty inches, length thirty-six inches, width twenty-four inches. The end flap shown hanging down on our right gives another eight inches length when it is raised on its side folding bracket. An ordinary half sheet blotting pad on the top gives one an idea of scale size. In the knee-hole part to the left is a shelf just wide enough to take a full-sized Smith-Premier typewriter which is here stored out of the way when not in use. Above this is apparently a handleless drawer, hereinafter explained. On our right is a knob by which one pulls out a flat slide which gives extra table room. Below this are two drawers, the upper, two and a quarter inches, the lower four and a half inches deep inside. The upper holds slips, dissecting tools and so on. The lower is nested with card divisions for bottles. Below, on the right, is a cupboard sixteen and a half inches high—amply tall enough to take any ordinary full-sized microscope case. At the back of this cupboard are two narrow shelves for sundries, larger bottles and so on. One of my difficulties was in obtaining sufficiently small and low castors, of which six are needed.

Figure 2.

Figure 2 shows the end flap raised and draw slide partly pulled forward.

Figure 3 shows that the table top is cut and joined by "counter hinges." The left-hand part is folded flat over the right-hand portion of the table top. This folded-over part forms an excellent rest for bottles and sundries. To our left is seen a box-like recess.

In Figure 4 we see that the front side of this box-like arrangement has been removed and is laid on the table top. Behind one end is put a post card to act as background, and show the tongued end of this piece. We here also see the groove into which this tongued end slides.

In Figure 5 we see the microscope resting on the flat top above the typewriter shelf, four inches lower than the writing table top—*i.e.*, twenty-six inches from the

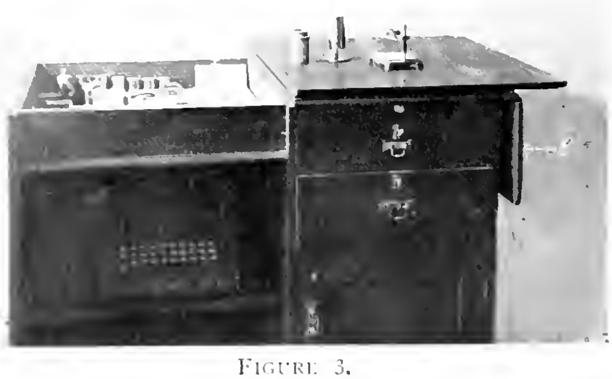


Figure 3.

ground. This I find quite high enough for vertical tube work. Indeed, perhaps twenty-five inches would be a more generally convenient height for an ordinary chair and sitter. This sliding part stows conveniently out of the way along the edge of the recess. The open cupboard shows the microscope case also out of one's way.

Before winding up, perhaps I may mention two very simple contrivances, which I have long used with great convenience.

Figure 6 shows a straight bit of wood about a foot long, two inches wide and one inch thick. In it are a number of circular holes large enough to take the immersion oil bottle, and a number of brass cases of objectives. A strip of card glued on the bottom of the wood prevents the things slipping about when it is moved. It is kept out of the way and yet conveniently at hand in the recess (Figure 3).

Figure 7. A stiff card shallow box-lid in which are cut a number of nicks for holding tools and preventing them rolling about. Here are half-a-dozen special favourites:—

(*a*) Forceps with slide clamp.

(*b*) Glass rod with drawn out slender point and tiny knob for applying reägents locally when dissecting.

FIGURE 4.

(*c*) Another glass rod with knob end for applying a larger drop.

(*d*) A handled sharp-pointed knife.

(*e*) A *curved* needle for tearing out tissues.

(*f*) A double-edged spear knife.

To save repetition the parts in all the figures are uniformly lettered.

A Typewriter shelf.
B and C left and right hand portions of hinged top.
D Draw slide.
E Hinged flap supported by hinged side bracket.
F Sliding front of depressed table top.
G and H Tongue and groove of F
J Objective holder.
K Upper drawer.
L Lower drawer.
M Cupboard.

FIGURE 5.

FIGURE 6.

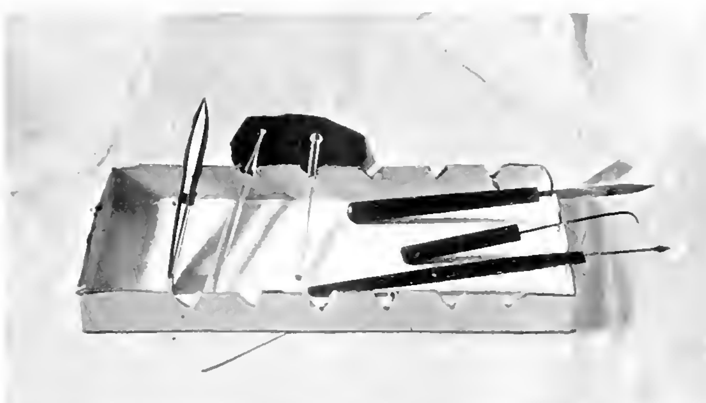


FIGURE 7.

The lower level top arrangement on which the microscope rests (Figure 5), also serves admirably to hold my typewriter at a convenient height. The folded over part B (Figure 3) is then very convenient for writing, corrections, and so on. The back ends and door are all panelled; the back and ends have also styles (Figure 2). The work throughout is in solid oak and darkened by ammonia fuming. The carpenter's cost, not including castors, locks and keys, and brass handles, was four guineas. Doubtless, he would repeat at or about the same price. The workmanship is excellent. I send the carpenter's address to the Editor.

CLUSTERS AND NEBULAE.

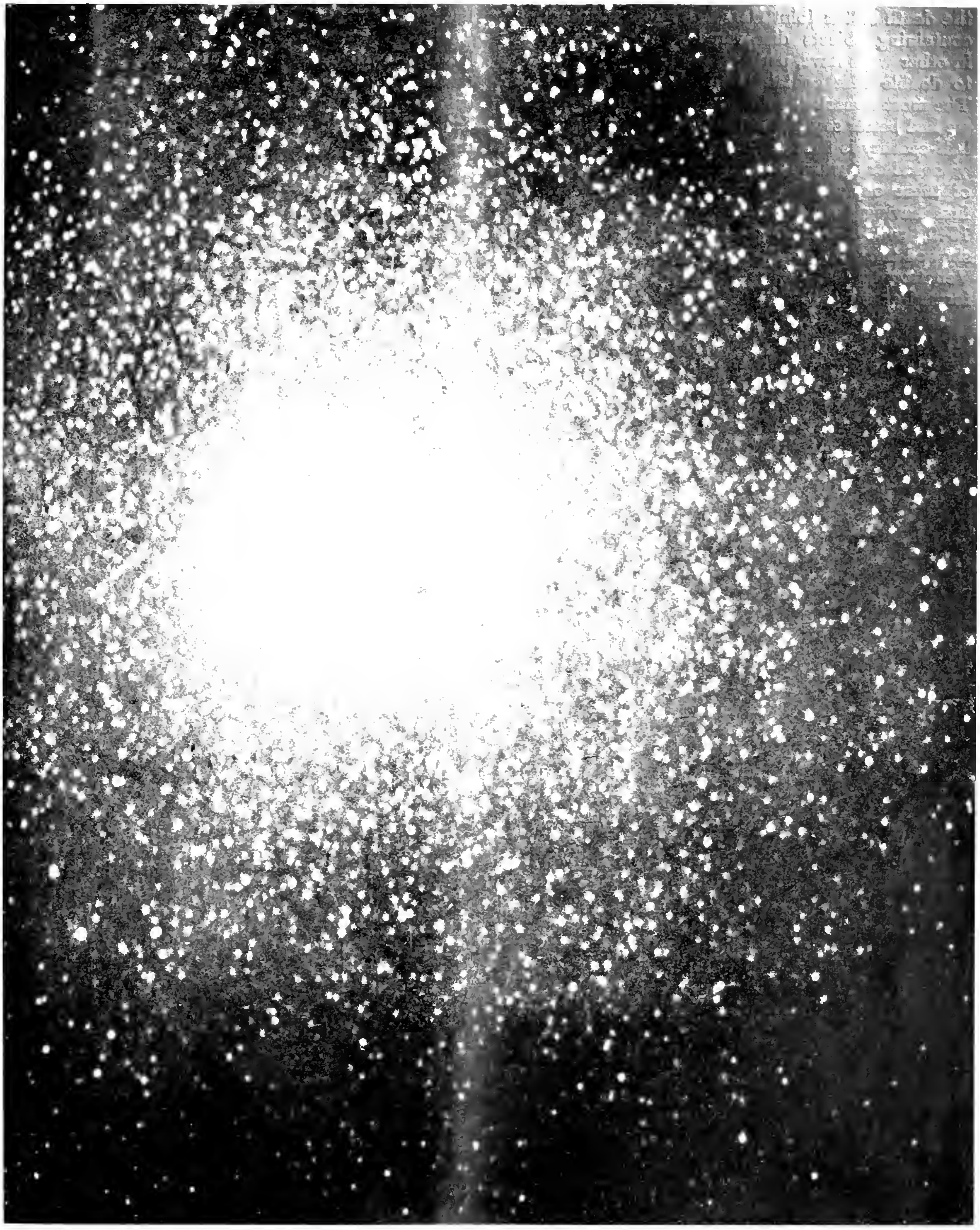
By F. W. HENKEL, B.A., F.R.A.S.

More than two thousand years ago the Greek philosophers, Democritus and Anaxagoras assured their countrymen that the luminous circle of the Milky Way consisted of nothing but dense masses of stars too small and too close together to be seen separately. The former, sometimes known as the "Laughing Philosopher" of Greece, also entertained some equally remarkable views on other subjects: the atomic theory, the nature of the sun and stars, and so on, many of which have been verified by later investigation. In addition to the Milky Way itself there are to be found, scattered all over the sky, luminous patches of cloud-like material, stellar groups or "nebulae," as some of them are called. Many of these are known to consist, like the Milky Way itself, of numbers of stars too near together to be separately visible to the unaided eye except in a few cases. The well-known Pleiades group in Taurus is an example. There are to be seen by the eye from seven to twelve stars close together, the number varying according to the keenness of sight of the observer and the state of the sky. With the help of the smallest telescope this number is increased to about one hundred, whilst the large telescopes and photographic appliances of modern astronomy have enabled us to detect the presence of a yet greater number of stars as well as streaks and wisps of nebulosity surrounding and enveloping most of the region. The Hyades cluster is situated close by in the sky, and not far off is the "Praesepe" in Cancer, which seen as a cloudy patch, becomes resolved into a swarm of stars, whence the name Praesepe (Beehive).

Other well-known clusters are those known as 13 M Herculis, not very far from the "apex" of the Sun's way, often considered the finest in the Northern Hemisphere, the cluster surrounding the star ω Centauri (see plate), the group in the "sword handle" of Perseus, the beautiful cluster M Canum Venaticorum (the Hunting Dogs), the cluster M 14 Ophiuchi, and so on. Some of these clusters are shown to be such by the help of very moderate telescopes, though they are better seen with larger instruments, others require more powerful optical aid, whilst yet others have never been resolved into stars, though on other grounds we have reasons for suspecting their "resolvability," as distinct from what are now known as "true" nebulae. Since, as we have said, most clusters, if visible at all to the unaided eye, appear to it as cloud-like misty objects or "nebulae," and are resolved into separate stars by a greater or less application of telescopic power, it was at one time thought that all such objects were of a similar nature, the difference between different clusters arising from the varying size of their members or their differing distances from our system. Whenever a new or more powerful telescope was applied numbers of these nebulae or cloud-like objects (Latin—*nubes*, a cloud) were "resolved" into separate stars, though some, such as the nebula of Orion and the great nebula of Andromeda, showed no signs of such resolvability. However, the great reflector of Lord Rosse being applied to the former, it was reported that this instrument had at last resolved the nebula, but this was a mistake, for as we shall see, no telescope ever can or will resolve it, since it is not composed of stars, but is of an entirely distinct and different nature. Fifty or sixty years ago, however, this idea of the resolvability of all nebulae into clusters was generally entertained. It was thought that they were remote clusters or "island universes," lying far beyond the system to which our own Sun belongs (the great Milky Way, or Galaxy), so inconceivably remote that light, though travelling at the enormous speed of over 186,000 miles per second, requires many thousands of years to reach us from them, and many may have ceased to exist ages ago, and yet it will be many ages hence before we become aware of their extinction. The work of Herschel and later investigators, showing the intimate connection between the distribution of the clusters and nebulae and the position of the Milky Way generally, has thrown doubt upon the validity of such views, though many popular writers have made these ideas generally known to the non-scientific public.

The memorable and systematic exploration of the heavens, with instruments constructed by himself and of far greater power than any previously used by astronomers, has immortalized the name of Sir William Herschel, and it is this, perhaps, more than the discovery of a new planet in the Solar system, which was his greatest contribution to our Science. Previously to his day the number of clusters and nebulae known did not exceed about one hundred and fifty or so, many of which were detected by the famous French astronomer Messier,* known as the "comet ferret" from his diligent search for those bodies, whose ill-defined and often misty appearance is not unlike that of a nebula, and indeed a comet has been not inaptly termed "a wandering nebula" for more than one reason. Sir John Herschel extended his father's work into the Southern hemisphere, staying for several years at Feldhausen, near Cape Town, and completely surveying the whole sky. In 1864, he published a catalogue of five thousand and seventy-nine nebulae and clusters, a great part of which had not been previously located by other observers. A supplement containing about a thousand more

* The letter M before the name of a nebula or cluster indicates that it is one which was included in Messier's catalogue.



The Cluster in Centauri.

of these objects was published by Dr. Dreyer after the death of Sir John Herschel, and additional lists containing objects discovered by photography and in other ways have, perhaps, brought up the number to double that contained in Herschel's catalogue. The most remarkable discovery in stellar, or perhaps we had better say sidereal, astronomy during the last half-century is that of the existence of *vast* numbers of spiral or "whirlpool" nebulae. Only a very few of these objects had been previously known, the first having been detected by Lord Rosse, about 1840, with the help of his great reflector, which showed the spiral form of the great nebula in Canum Venaticorum and others previously regarded as ring formed or annular.

Sir William Herschel divided these objects into—(1) Clusters of stars in which the stars are easily distinguishable: these are again subdivided into *globular* and irregular clusters. (2) Resolvable nebulae or such as excite the suspicion that they consist of stars, and which any increase of optical power may be expected to resolve into distinct stars. (3) Nebulae, properly so called, in which there is no appearance whatever of resolvability; these again were subdivided into subordinate classes according to their brightness and size, and so on. (4) Planetary Nebulae, (5) Stellar Nebulae, and (6) Nebulous stars.

Long previously to Herschel's day, Halley and other earlier discoverers of nebulae had followed the speculations of some philosophical writers in postulating the existence of a primitive elementary form of luminous sidereal matter, (Halley, *Philosophical Transactions*, Vol. XXIX, page 390, *et seq.*), but it was mainly as a result of his extensive observations that Sir William Herschel himself was led to consider the consequences of a gradual subsidence and condensation of such matter into more or less regular spherical or spheroidal forms denser towards the centre than at the circumference. Laplace's well-known nebular hypothesis, worked up by him from the previous suggestions of Kant, Wright, Swedenborg, and others, also brought into prominence this idea of "nebulous matter" of a nature distinct from ordinary solid or fluid substance such as we are familiar with on our planet.

The application of the spectroscope to Astronomy, about the year 1860, threw a flood of light upon subjects which had been thought to be beyond the power of the mind of man to discover, such as the chemical nature and physical condition of the heavenly bodies and enabled us to draw the real distinction between true nebulae and apparent nebulae, or remote and condensed clusters. Newton in his "Optics" relates that he once decided to "try the celebrated experiment of the colours." Admitting sunlight through a small opening into a darkened room, if allowed to fall normally on a white screen it produces a round white spot, which is an image of the sun. If now we introduce a prism or triangular piece of glass, with its edge downwards, in the path of the beam, the latter will be deflected upwards, and the image on the screen will be no longer white but coloured, a many hued band, showing the "colours of the rainbow." The prism, in fact, will have effected an analysis of the light. White light (sunlight) is composed of a mixture of different colours, and these on passing through the prism are deviated to a greater or less degree, the violet rays most *refracted* and the red least so. By employing a very narrow *slit* and a number of prisms (or a diffraction grating) a pure spectrum or coloured band of considerable length, in which the colours are well separated, is obtained. By such means Wollaston, and after him Frauenhofer, showed that the "spectrum" given by sunlight is not quite continuous, but crossed by a number of fine dark lines or vacant spaces. If the slit is illuminated by a gas flame or lamp such lines are not seen, but a continuous spectrum is obtained, giving the colours red, orange, yellow, green, blue (indigo) and violet, the so-called seven colours of the rainbow. Thus the dark lines are not characteristic of light in general, but only of sunlight. By special means it was shown that the brighter stars, too, gave spectra containing systems of dark lines somewhat similar to those given by sunlight, but with differences for different stars.

Passing over various stages in which the meaning of these lines, known universally as the Frauenhofer lines, was gradually unfolded, we come to the work of Kirchhoff and Bunsen. They showed that a continuous spectrum is given by every incandescent body whose molecules are so entangled as to be unable to vibrate freely; in other words, by solids, liquids and gases under high pressure. A gaseous substance, under low pressure, gives a discontinuous spectrum, containing only a few bright lines, and these lines are characteristic for each elementary substance, and also for some compounds. A gaseous substance, when cooler, absorbs from white light passing through it, precisely those rays which itself emits when hot. Thus the spectrum of white light, after passing through sodium vapour, exhibits two distinctive dark lines in the yellow, whilst *incandescent* sodium emits a yellow light, which, when examined by the spectroscope, is found to be of just that refrangibility. Thus it was discovered that somewhere between the Sun's luminous surface and the earth, there are a number of vapours of well-known elements, which form the "dark" Frauenhofer lines. Applying the spectroscope to the nebulae and clusters, a matter of some difficulty owing to the faintness of their light, the late Sir William Huggins, aptly named by Proctor the "Herschel of Spectroscopy," found that many of the former bodies gave spectra consisting of five or six bright lines, indicating the presence of hydrogen, magnesium, and nebulium (?) under low pressure, in a state of great rarefaction.

Some, such as the great nebula of Andromeda, give a continuous spectrum unmarked by lines or bands whether bright or dark. It is possible these may consist of more condensed gases, but this is by no means certain. Clusters and resolvable nebulae give spectra similar to those given by the stars showing their starlike nature, whilst the irresolvable nebulae, as we have just said, give either bright lines or continuous characterless spectra. Thus a real distinction of a physical nature may be drawn between the different classes of these objects. (Dr. Fath, however, is of opinion that, notwithstanding what has been just stated, "no spiral nebula has a really continuous spectrum," that the continuous spectrum of the Andromeda nebula, or at least that of its central portions, is given by "an unresolved star cluster consisting of stars mainly of the solar type.") Of late years photography has been successfully applied to spectroscopic purposes and spectrograms of many of the brighter stars and clusters, and nebulae, have been obtained. Amongst remarkable clusters and groups of stars with community of proper motion, which seem to be connected, in some as yet unknown way, by a force acting far more powerfully and at greater distances than gravitation, in addition to the Pleiades which we have already discussed (see also a paper by the present writer in "KNOWLEDGE" for July, 1907), may be mentioned the "five stars" in Ursa Major, which were pointed out by the late Mr. Proctor about forty years ago, as well as by Flammarion and others[*] and also the Taurus cluster investigated by Professor Lewis Boss. Drs. Ludendorff and Hertzsprung have shown that Sirius, the brightest star in our sky, is a member of a family which includes (besides the five stars, β, γ, δ, ϵ and ζ Ursae Majoris), also β Aurigae, 37 Ursae Majoris, δ Leonis and α Coronae Borealis. These ten stars appear to drift together, lying approximately in one plane and nearly in a right line. In the *Astronomical Journal*, Number 604, Professor Lewis Boss has discussed a moving cluster in Taurus, consisting of many of the Hyades. For more than twenty-five years he has been investigating their motions and found these "nearly identical," at least forty whose directions of motion converge towards a common though very distant point, "at which their apparent velocities will enable them to arrive almost simultaneously after the lapse of some sixty-five million years!" At present this "cluster" is spread over a total area of 15° but is somewhat condensed towards the centre.

It has been estimated that the average velocity of the entire cluster is about forty-six kilometres (say under thirty miles) per second, and the "average" parallax 0″·025 (Küstner) giving a corresponding distance from our system of eight hundred billions of miles, thirty times that of the nearest star, Alpha Centauri. As a result of Professor Boss's work in another direction, Mr. Eddington, of Greenwich, has given an account of a "Moving Cluster of Stars of the Orion Type in Perseus." Sixteen stars, lying between R.A. $3^h\,11^m$ and $5^h\,15^m$ Dec. +42° to +58°, share very nearly the same proper motion both as regards magnitude and direction. They thus form a group similar in character to those above mentioned. Their magnitudes range from 2·9 (α Persei) to 6·4, and the mean "proper motion" is about 4″ per century.

On clusters of stars in general, and especially on the regular globular clusters it may not be without interest to notice the remarks of the late Sir John Herschel, who was the highest authority on such matters, and who had himself observed more of these objects than any other astronomer of his day. "We can hardly look upon such a group . . . as not forming a system of a peculiar and definite character. Their round figure clearly indicates the existence of some general bond of union in the nature of an attractive force; and in many of them there is an evident acceleration in the rate of condensation as we approach the centre, which is not referable to a merely uniform distribution of equi-distant stars through a globular space, but marks an intrinsic *density* in their state of aggregation, greater in the centre than at the surface of the mass." The stability of such a system "without a rotatory motion and centrifugal force," is scarcely conceivable, but if we suppose a globular space filled with equal, and very numerous stars, attracting one another according to the gravitation law, any one of these will be urged by a resultant force directed towards the centre of the sphere and proportional to its distance therefrom (law of direct distance, Newton). Under such a resultant force each individual star would describe a perfect ellipse about the centre of the system, no matter in what plane it might lie, or in what direction it might be moving. Thus it would not be necessary that the cluster should rotate as a mass around a single axis. Each ellipse described by the separate members would remain unchanged in form and dimensions, and all would be described in one common period, so that at the end of each such period every member of the system would be in exactly the same position with regard to every other, and would run the same round for an indefinite succession of ages. Such a system, whose members were sufficiently distant from one another so that their orbits did not intersect, might exist and realise a state of abstract and ideal harmony, transcending even the harmonious and stable conditions of our own Solar system, without any preponderating "Central Sun." However, it is probable that such a condition of affairs is but rare in the sidereal spaces; though many almost perfectly globular clusters are known, others are of a more or less oval outline, and yet others of irregular figure. These latter are also less definite in outline, so that it is not always easy to say where they terminate, and they are not often condensed towards a centre. By far the greater proportion are situated

[*] This community of proper motion was named by Proctor "stardrift." The stars appear not only to be moving together, but their chemical constitution as revealed by the spectroscope is similar.

in or near the Milky Way, a fact which led Sir W. Herschel, quite early in his career, to infer the existence of a clustering power, akin to gravitation, which is gradually breaking up the Galaxy, and has already given that "great arch of light, the aspect of a series of clusters rather than that of a uniform band of milky light." Professor See, in his great work "Researches on the Evolution of Stellar Systems" (Vol. II.), has however, pointed out the important effect of the universally diffused cosmical dust, which acts everywhere as a resisting medium, so that "the Milky Way may have been always more or less aggregated into clusters, which have simply grown denser or become more dispersed with the flight of ages." If these clusters arose from the condensation of nebulous material, and this diffused "cosmical dust" acts everywhere, it follows necessarily that all clusters will, in course of time, become more dense and more nearly globular, unless the aggregations thus going on are dispersed by the action of external forces due to other clusters. Space will not permit our pursuing this interesting subject further, but it must be fairly evident that the study of the nature and conditions of formation, growth and decay of these objects is one of the grandest with which the human mind can be employed. We owe much to the patient labours of "self denying men of science" but more lies for the future to unravel, and as there appears to be neither end nor beginning to the Universe of God, so also must we believe that its complete comprehension will for ever transcend the finite mind of man.

SOLAR DISTURBANCES DURING JULY, 1911.

By FRANK C. DENNETT.

THERE has been a very slight increase in the amount of solar disturbance during July, but on four days (6th, 11th, 25th and 26th) no trace of activity was visible, bright nor dark, and on sixteen days (5th, 7th—10th, 17th—24th, 27th, 28th and 31st) only faculae could be seen. The longitude of the central meridian at noon on July 1st was 65° 41'.

No. 27.—When first seen on the afternoon of July 1st it was a single pore, but next day there were three forming a long triangle 25,000 miles in length. It was not seen on the 3rd, but a pore showed on the 4th.

No. 28.—A solitary spotlet only seen on the 2nd and 3rd.

No. 28a.—A group of four pores 23,000 miles in length, forming two pairs, only seen on the 4th.

No. 29.—Two spotlets, the western largest and accompanied by two pores, were visible on the 12th. During the next day considerable alteration took place in the group, by the afternoon the rear spot had enlarged considerably and thrown forward a sort of tail which broke into a line of small umbrae, having in front of them a small triangle of pores. On the 14th the rear spot was about 5,000 miles in diameter, with a curve of pores on the northern side and line of pores in front, having a total length of 52,000 miles. On the 15th its length was unchanged but its members were shrinking, and on the 16th only the hindermost spot was seen cut in halves by a bridge, with a tiny pore to the south. Not seen after, except its faculic remains near the western limb on the 19th, 20th and 21st.

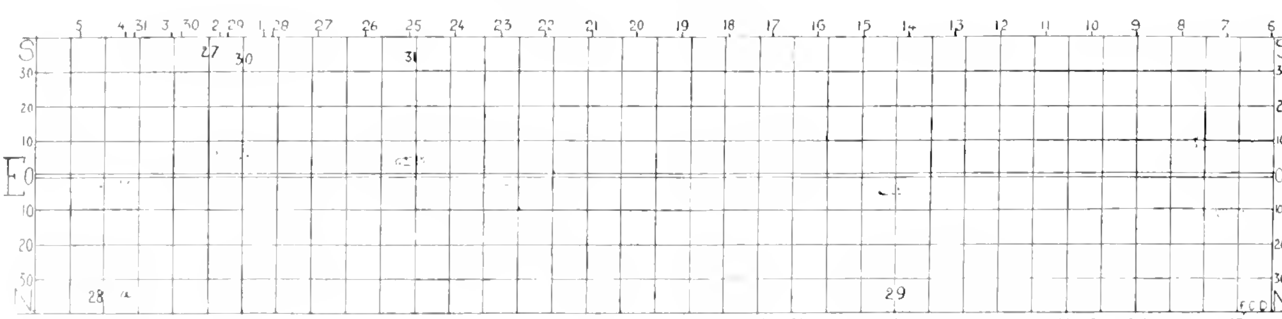
No. 30.—A group of three pores, one very tiny, 18,000 miles in length, on the afternoon of the 29th, but on the 30th only two minute pores seen close together, and not seen after.

No. 31.—A pore visible on the northern border of a bright faculic disturbance on the 30th, but not observed after.

On the afternoon of July 8th, a very pretty prominence eruption was witnessed, though on a very small scale. In adjusting the position circle of the spectroscope, a bright little bead was noticed only 3° west of the north pole. Within a very few minutes it threw up a fine needle of light which slightly expanded, then bent over polewards and began drifting off as clouds. The positions of the other prominences around the limb were measured, then on returning to the same point only a little bead of light remained. The position of the bead was measured at 5.45 p.m., and the observation was completed at 6.10, so that the eruption could only have occupied a few minutes.

Our chart is constructed from the combined observations of Messrs. John McHarg, E. E. Peacock, and F. C. Dennett.

DAY OF JULY, 1911.



NOTES.

ASTRONOMY.

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

Being at the seaside and away from all sources of astronomical information or reference my notes this month are very brief.

ENCKE'S COMET was found on the last day of July, by M. Gonnessiat, at Algiers. Owing to its unfavourable position there were some apprehensions that it might escape detection at this return, and thereby break a remarkable record of visibility at every return since 1819. Perihelion is passed about August 20th. After the observations of this return have been discussed, it will be possible to discriminate between Professor Backlund's two hypotheses to explain its recent movements, viz.: (1) that it suffered a sudden change in its rate of acceleration about 1905, (2) that the mass of Mercury which he had previously derived is sensibly in error. Encke's comet affords the best way of determining the mass of Mercury, since the two bodies are periodically very near together. None of the planets are sufficiently perturbed by Mercury to give its mass with any accuracy.

BROOKS' COMET.—After last month's notes were written, the veteran comet discoverer, Mr. W. Brooks, of Geneva, U.S.A., discovered a faint comet, which is likely to brighten into naked eye visibility before next November, when it makes a fairly near approach to the earth. The earth, about September 3rd, will pass through the point occupied by Kiess' comet four weeks earlier. There is a possibility of a meteor shower at that date, if the comet has a meteoric appendage following in its wake, as some comets are known to have.

SOLUTIONS TO MR. BARTRUM'S QUERIES (page 311).—The answer to the first query, *re* the illumination of Venus, is that his law of illumination, varying as the cosine of the angle of incidence, only holds for smooth spheres, which the planets are not. Even tiny inequalities on the surface, far too small to be discerned from other planets, suffice to give an altogether different law of illumination.

The most casual glance at the Moon suffices to show that the illumination at the terminator is very different from zero, which it would be on his hypothesis. The actual law is doubtless a very complicated one, but empirical formulae have been given for representing observed facts with fair approximation. The formula used in the *Nautical Almanac* for finding when Venus is brightest is avowedly only a rough approximation, and does not profess to accurately represent the facts of nature. It is only used because the phenomenon is not considered a sufficiently important one to call for a refined investigation; indeed it would be practically impossible to determine by observation the average slope of the small inequalities on its surface, which would be one of the necessary data of an accurate solution. *Re* his second query, the phrase "mean distance," if used without further qualification, is always taken to mean the semi-major axis of the elliptical orbit. If any one desires to use the phrase in one of the other meanings which he indicates, it is necessary to specially state the fact.

I prefer to postpone his third query till next month. I think I see the fallacy involved, but it is easy to make mistakes in such problems. In any case, he has succeeded in finding a neat little astronomical catch.

BOTANY.

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

PRE-GLACIAL FLORA OF BRITAIN.—In a recent paper on the plant remains found in the Pre-glacial deposits of Norfolk and Suffolk, Clement Reid (*Journ. Linn. Soc.*) gives a list, with notes, of the Pre-glacial species of British flowering plants now known, numbering one hundred and fifty. The plants described grew in the small stream channels of a large river, probably the Rhine, and in the adjoining wet meadows or in moist woods close at hand. The flora of Norfolk and Suffolk as a whole has altered very little in the many thousands of years since these beds were formed, although it was driven out by the cold of the Glacial Period and returned later. A certain number of exotic species are recorded, however, these including three species of *Ranunculus*, a water lily, the water-nut (*Trapa natans*), the spruce fir (*Picea excelsa*), and *Naias minor*. The southern element in the Cromer flora is therefore greater than was formerly supposed, and it apparently includes several extinct species. These pre-glacial plants suggest climatic conditions almost identical with those now existing, but slightly warmer—a difference doubtless owing to the fact that Britain was then united with the Continent.

THE FUNCTIONS OF LATEX.—In a very large number of flowering plants, there are special sacs and tubes containing the juice called latex, which is commonly milk-like in appearance (e.g. in dandelion, spurge, sow-thistle), but may be colourless, or red, or orange in colour. Latex contains a great variety of substances (e.g. proteins, starch, rubber, alkaloids), and its uses to the plant have been much discussed. Some writers state that latex is mainly, if not entirely, composed of waste substances, which do not enter again into the metabolism of the plant, though useful in guarding against the attacks of animals, on account of the bitter and poisonous substances they contain. Others contend that latex is largely made up of reserve food materials, which are eventually used up in the nutrition of the plant.

The most recent contribution to the controversy is a paper by Bernard (*Annales du jard. bot. de Buitenzorg*, 1910), in which some interesting new facts are given. This writer supports the view that latex functions largely as a depository of reserve food materials. He finds that the fruits of various latex-containing and rubber-yielding plants have abundant thick latex when young, whereas the ripe fruits contain very scanty and thin latex. This he regards as proof that the substances present in latex are used up in the formation of the fruits and seeds, after being converted into other food materials. He also shows that when spurges are cultivated in air deprived of carbon dioxide, so that they cannot manufacture carbohydrate foods from external sources, the starch grains in the latex are corroded and are apparently changed into sugar for the nutrition of the plant.

ACIDITY OF BOGS.—As is well known, the peat-moss (*Sphagnum*) rarely grows on limestone soils. Some years ago, it was shown by Paul that calcium carbonate is very injurious to *Sphagnum*, even in small quantities. He grew various species in water containing lime and found that the plants soon perished. He found that not all salts of lime have an equally injurious effect, and that alkaline salts of potassium and sodium are as deleterious as those of lime. Various other writers have found that peat-mosses give an acid reaction; hence it has been suggested that the injurious effects of lime may be due to the neutralising of the acidity of the moss: that forms growing on high moors contain more acid than those found on low heaths, and that the former are more sensitive to lime; that on high moors there is less mineral food available for the Sphagna in the substratum, and that the amount of acidity and the sensitiveness to its neutralisation decrease as the amount of available mineral food increases; also that high moor Sphagna usually absorb more water than those growing on low heaths.

Baumann and Gully (*Mitt. d. K. Bayr. Moorkultursnatalt*, 1910) have confirmed Paul's statement that living *Sphagnum* plants give the same free acid reaction as does peat derived from the dead remains of *Sphagnum*. They also show that living or dried *Sphagnum* plants dissolve calcium phosphate in the same way as peat. From numerous experiments, they conclude that the acidity of peat and of *Sphagnum* is due to the presence of colloidal substances of acid character in the cell-walls.

Czapek showed, some years ago, that *Sphagnum* contains various interesting chemical substances. One of these, "sphagnol," is injurious to Bacteria and thus acts as an antiseptic, preserving the dead *Sphagnum* tissue from destruction and helping in the formation of peat. The walls of the clear water-holding cells of the leaves also yield on treatment with alkali large quantities of jelly-like substance, probably identical with Baumann's "*Sphagnum* colloids."

SENSITIVE STIGMAS.—As is well known, the flowers of various species of *Mimulus* (monkey-flower, musk) have a stigma with two flat diverging lobes, which when irritated shut together so that one stigmatic (inner) surface meets and presses against the other. The inner surface is the sensitive part, a touch on the outside of the lobes producing no effect. The closing movement is instantaneous; after from five to eight minutes the lobes begin to diverge again, and in ten to fifteen minutes have regained the position of rest.

These movements, which occur in some other plants, *e.g.* species of *Torenia* and *Martynia*, were first described about a century ago, but the only detailed account, until quite recently, was that given in 1902 by Bruk. According to Bruk, in *Mimulus* the lobes remain closed only if the stimulus has been caused by placing on them specific pollen (*i.e.*, pollen from the same flower or from a flower of the same species), and soon open and remain open if foreign pollen (*i.e.* pollen from a different species of plant) is used. He also stated that in *Torenia fournieri* the lobes will open again and remain open if pollen from the two shorter stamens of the same flower has been placed on them; this point is referred to below.

Oliver, in 1887, showed that the stimulus is transmitted from one lobe to the other; if one lobe is prevented from moving (*e.g.* by cementing it to the corolla), a touch on its inner face still provokes movement in the other lobe. He also showed that the transmission takes place through the ground tissue of the lobes, probably by means of intercellular protoplasmic connexions, since transmission occurs when the vascular bundle is cut through.

Lutz has made a thorough investigation of irritable stigmas (*Zeitschrift für Botanik*, 1911). The ground tissue of each stigma lobe is sharply divided into two zones, the inner zone forming the conducting tissue (down which the pollen tubes pass) and the outer consisting of compact parenchyma; the epidermis of the outer side is strongly cutinised and has no papillae, that of the inner side has very thin cuticle and is produced into long hairs which receive the stimulus of contact. The movement of the lobes is brought about by a sudden lowering of the osmotic pressure, and diminution in volume of the whole ground tissue. The diminution in volume is not uniform, but very different on opposite faces of the stigma lobes, being in fact about twice as great on the inner face as on the outer face. By artificially withdrawing water by osmosis there can be produced a closing together of the lobes similar to that resulting from stimulation.

Lutz carefully investigated the results of pollinating the stigma of *Mimulus cardinalis*, and so on, with pollen of the same species and also with foreign pollen. He tried the effect of placing pollen in different quantities on the inner surface of the stigma lobes—on one small area, on about half of the inner surface, on the entire inner surface. If little pollen is used, whether of the same species or not, the lobes at once close, then open again in about ten minutes. With more pollen, enough to cover about half the inner face of the stigma lobe, the lobes open again after about ten minutes; but if the pollen used is of the same species, a second closing movement begins after from two to three hours and lasts for about twenty minutes. If, however, the pollen is carefully placed on the stigma to avoid mechanical shock, the second closing movement occurs as usual after between two and three hours, although the first (contact irritability) movement is not made. When a large amount of pollen is used, the whole inner face of the stigma being covered, the first instantaneous movement occurs as usual, owing to the mechanical shock stimulus in applying the pollen, but the lobes remain closed, never diverging again. If the stigma is loaded with foreign pollen, it closes at once as usual, and remains closed for two or three hours, but then opens again.

In these interesting experiments with small, medium, and large quantities of pollen, Lutz worked chiefly with *Mimulus cardinalis*, and used in each case (1) pollen from long stamens of same species, (2) pollen from short stamens of same species, and (3) pollen from various foreign species—Snapdragon, Plantain, and others. His results show that the permanent closure or the reopening of the stigma lobes is determined in the first instance by the *quantity* of the pollen applied—a large quantity causes permanent closure, a smaller quantity does not; and, secondly, by the *origin* of the pollen used—a full load of pollen of the same species results in prolonged closure, foreign pollen in closure for a few hours at most. In opposition to Bruk's results, Lutz finds that in *Torenia* the anthers of the short stamens dehisce later than those of the long stamens; that pollen from undehisced anthers is not capable of germinating; and that when such pollen is placed on the stigma, the latter opens in ten to fifteen minutes after the usual closure.

Lutz proceeds to analyse the two closing movements which result on the placing of suitable pollen on the stigma. The instantaneous first movement is purely the result of the mechanical stimulus. Bruk explained the permanent closing of a pollinated stigma as being due in part to the pollen grains abstracting water from the stigma tissue, and thus preventing this tissue from returning to its original state of turgescence. This explanation is supported by the observation of Lutz that the stigma only remains closed when a large amount of pollen has been placed on it. Lutz also noted that sometimes, even with a full load of pollen, the stigma lobes after from one to three hours opened again, doubtless recovering turgescence by being supplied with water from the ovary and style—but this re-opening would not, of course, interfere with fertilisation, since the pollen had had ample time to germinate and send the pollen-tubes into the conducting tissue.

Lutz found that not only specific and foreign pollen, but also such substances as dry sand and powdered starch could cause prolonged closure of the stigma lobes. On the other hand, wet pollen caused only temporary closure (for ten to fifteen minutes); only *dry* pollen could produce prolonged closure. The permanent closure, resulting simply from the prevention of the automatic re-opening movement, is due to (1) the absorption of water by the pollen grains and their germinating tubes, and (2) the chemical effects of the growing pollen-tubes on the conducting tissue of the stigma lobes. If either of these conditions be absent, the stigma lobes open again after a shorter or longer time. Both conditions are fulfilled by the germination on the stigma of the pollen of the same species. This portion of Lutz's results may be summarised by stating that the stigma remains closed only if the pollen grains and the germinating pollen-tubes can, by abstraction of water, prevent the return of the original osmotic pressure in the stigmatic tissue, and the consequent reversal of the primary closing movement, until a sufficient number of pollen-tubes have penetrated the conducting tissue and so disorganised it that re-opening of the lobes is made impossible.

The next question is, *how* do the entering pollen-tubes cause this remarkable disorganisation of the stigmatic tissue? The entering tubes will resorb the very thin cuticle between the stigmatic papillae, and they will, after some time, absorb sufficient water to prevent a return to the original turgescence in the stigmatic tissue, but the disorganisation of the stigma is not entirely explained in this way. Evidently some chemical substance or substances contained in the pollen grains and tubes must diffuse into the conducting tissue, and there cause disorganisation of the cells. Lutz tried the effect of watery extracts of the pollen-grains. On placing a drop of this extract on the stigma, the latter closed as the result of the mechanical stimulus, and remained closed, also showing, after a few minutes, a yellow discoloration, while the microscope showed exactly the same kind of disorganisation of the conducting tissue as is caused by the pollen tubes. The extract did not act as a chemical closing stimulus on the stigma, however. On putting a stigma into the extract it began to close gradually after a few seconds, whether the stigma were irritable or not; this closing occurred in insensitive stigmas—old stigmas, and stigmas made insensible by treatment with ether, for instance. That is, the closing movement was due to chemical *action* of the extract, but not to a chemical *stimulus*; the extract injured the stigma cells but did not act as a stimulus to movement. Beyond ascertaining that the active substances extracted from the pollen were not destroyed by heating to 100°C., Lutz made no attempt to isolate and identify them, because exactly the same result was brought about by extract of pollen of all kinds of other plants, and by solutions of various organic and inorganic substances.

Clearly, then, the permanent closure of the stigma lobes in *Mimulus* and so on, is brought about by abundant pollination with pollen of the same species, while with foreign pollen (the tubes of which either do not penetrate the stigma or only do so occasionally and imperfectly) the stigmas open again after a time. When killed pollen-grains of the same species are applied to the stigma, the latter opens again in an hour or so; the dead pollen can absorb water from the stigma tissue, and of course it still contains the chemical substances which injure the stigma tissue, but it cannot produce pollen-tubes which are required to conduct the chemical agent to the conducting tissue.

Of what advantage to the plant are the movements of the stigma-lobes? Bruk's answer was that the closing up of the stigma-lobes is a protection against the germination of foreign pollen. Lutz finds, however, that the pollen of some foreign plants germinates almost as well on the stigmas of *Mimulus* and so on, as the plant's own pollen, though the foreign grains do not seem able to send their tubes into the conducting tissue. Hence it is not the irritability of the stigma that prevents the growth of foreign pollen, but rather the specific chemical characters of the pollen-grains, pollen-tubes, and conducting tissue. Gärtner suggested that the irritability of the stigmas was necessary for the proper fertilisation of the ovules in the ovary, but Lutz shows that fertilisation occurs even when the stigma has become insensitive by age or rendered so artificially. Of course, the germination of the pollen is favoured by the closing process, which shuts the pollen grains into a moist chamber, and Lutz concludes that this is the sole advantage of the closing movement. When pollen is placed on the stigma carefully, so that no movement results and the lobes remain open, the grains germinate much more slowly than in the normal case where the lobes become closed. Lutz watched insects at work pollinating the flowers of *Mimulus*, *Torenia* sp., and others, and found that only very rarely did they place sufficient pollen upon the stigma to make it close permanently at once.

RECENT WORK ON EXPERIMENTAL MORPHOLOGY.—In 1908, Goebel gave an account of the interesting results already gained by experimental researches on alterations in structure induced by the action of external stimuli, or environment, and on the regeneration processes that occur when parts are injured or removed. In this work ("Einleitung in die experimentelle Morphologie der Pflanzen"), Goebel emphasised the necessity of studying a plant throughout its development as a condition for the understanding of its structure, pointing out examples that show great diversity between the corresponding parts of the young and the adult plant, and tracing these differences to causes whose action could be tested by experiment. Such experiments show that the action of the environment depends largely upon the period of growth during which it has acted, and that the characters of the earliest period may be retained in the normally later stages, or may be reproduced in these stages by the influence of an environment suitable to the earlier period. For instance, the common harebell (the "bluebell" of Scotland) shows rapid changes in the forms of its leaves as the result of changes in environment, these changes resulting from very different causes such as diminished light, lessened supply of water, increase in salts dissolved in water, and so on.

Goebel made the generalisation that these external influences act indirectly by altering the amount and kind of the food formed by the plant and needed to allow of the normal course of development, the external form being conditioned by the vital activity of the plant and by the food supply to each part of it. Goebel holds that the quality of the food supply explains the nature of the parts formed. For instance, the formation of stolons in the enchanter's nightshade (*Circaea lutetiana*) is attributable to the amount of organised food relatively to the inorganic ash constituents supplied to the growing-point of the stolon, being greater than that supplied to the leafy shoot. Again, if potato tubers are kept at a temperature not above 7°C., few roots or leafy shoots are formed, but new tubers develop rapidly, though remaining small; if the parent tuber is then cultivated at about 25°C., leafy shoots are freely formed, the younger tubers of the new growth often being changed into leafy shoots.

Dostál (*Flora*, 1911) has made a large number of experiments with *Circaea* and some other plants, and the results obtained by cultivating isolated pieces of stem, each piece with a single leaf and bud, are of great interest. He finds that axillary buds thus treated develop into either stolons (underground runners) or flowering shoots, or transitions between these two kinds of shoot, according to the position of the leaf and bud—whether taken from the base, apex, or middle of the plant. On the other hand, if the leaf is detached from the piece of stem, the bud always produces a sterile leafy shoot, no matter from what region of the stem it has been taken. Again, if, in experiments with a leaf and bud portion, the leaf is excluded from the light, the buds always grow into sterile leafy shoots. Dostál also finds that the development of a sterile leafy shoot depends upon the food supply; to produce a flowering shoot the proportion of organic to inorganic food must be greater than that required for the formation of a stolon. On the same material (food supply) conditions depend also the various characters of the kinds of shoot produced—their geotropic reactions (whether the shoot will grow upwards or horizontally when laid flat), the lengths of the internodes ("joints") of the vegetative stems and the inflorescences, the size and form and number of the leaves, the number of flowers, and so on.

Dostál's paper is of value as a careful and detailed working out of the experimental morphology of a single plant, on the lines indicated by Klebs and by Goebel. From the work of Klebs, we know that the normal course of development in any plant is only a special type of many developmental possibilities; that this normal sequence and no other is usually met with must be attributed to a normal sequence in the external factors. From Goebel's work, we gain further generalisations, some of which have already been mentioned.

In dealing with the production of buds in abnormal situations on various plants, Goebel shows that this is closely akin to regeneration, both being specially active at the growing-points of axes (stem or root) and of leaves; that adult tissue in various places may, however, revert to the embryonic state, these areas being along the veins; and that the impulse to development, apart from external stimuli, is conditioned by the presence of the necessary constituents of the food, brought about in leaves—when the leaf-stalk is cut—by the retention of the leaf's products within itself.

The phenomena of regeneration in plants have been much studied, and the results obtained by experimental researches, in which the plant is injured or has various organs removed, depend primarily for their interpretation on the fact that the various parts are correlated and influence each other. That is, we may assume that every organ arising from growing cells may develop in a variety of ways, and the direction of development which it takes depends upon its relations to other parts. When a stem or root is amputated, as in making cuttings, the new organ arising may be already present as a rudiment near the wound, or it may be formed from the healing tissue (callus). As a rule, leaves or parts of leaves cannot be replaced, but this does happen in some plants; as, for instance, in *Cyclamen persicum*, where new leaf-blades arise on the leaf-stalk when the blade of a young leaf has been cut off. Goebel states that in this case there is no real renovation of the leaf-blade, but simply a continued growth of the leaf-base, which was previously inhibited owing to correlation.

A remarkable feature in regeneration is the polarity of the organs and of the individual cells. If the tip of a shoot is removed, the bud nearest the wound develops; if the tip of a root is cut off, the nearest lateral root takes its place. A cut willow branch, bearing buds, will, if kept in moist air, produce at its upper end shoots only, and at its lower end roots only, whether it is placed right way up or inverted. The branch has an inherent polarity of its own, which was for long regarded as fixed; but Klebs showed that if the cork is removed from the upper end of a cut willow branch, and this end placed in water, roots will then develop from this end—by allowing enough water to enter, owing to the removal of the cork, the internal polarity of the branch is upset.

Doposcheg-Uhlár (*Flora*, 1911) has investigated the regeneration and polarity in various plants, and has obtained some remarkable results. He finds that the new shoots which arise from a very young fern-plant, still attached to the prothallus, when the growing-point of the plant is removed, strongly resemble the young fern produced from the fertilised egg; there arises first a "cotyledon" independent of the growing-point of the shoot. In some cases, moreover, the shoots arising from cut pieces of fern rhizome (underground stem) showed a curious leaf-like structure which protected the young growing-point, in much the same way as the cotyledon of the young fern plant protects the stem apex in its early stages of growth.

Many other interesting experiments are described by Doposcheg-Uhlár, whose paper is a model of patient and ingenious work directed towards the establishment of new facts, and the solution of the many problems arising from the stimulus given by Goebel in his invaluable *Einleitung*.

It is much to be hoped that Goebel's book will be translated into English. The earlier work on experimental morphology, regeneration, polarity, and allied topics is well summarised in Jost's "Plant Physiology" (Oxford Press).

SPORE DISPERSAL IN SELAGINELLA. — Various recent contributions to our knowledge of the genus *Selaginella* have been noted in these columns. This time we have to note an interesting paper by a German worker, F. W. Neger, who has described the shedding of the spores in *Selaginella helvetica* and *S. spinulosa*, in a recent number of *Flora* (N.F., Band 3, 1911).

In 1901, Goebel (*Flora*, Band 88) showed that in various species of *Selaginella* examined by him the megaspores are shed spontaneously, owing to a curious mechanism in the structure of the sporangium wall. The structure of the microsporangium is much simpler, the dehiscence mechanism being less highly developed, so that the microspores, despite their much smaller size, are scattered less widely than the large megaspores. He also showed that the cones or "flowers" of *Selaginella* are usually protogynous, that is, the megaspores are shed before the microspores, though the latter germinate much more rapidly. These arrangements tend to prevent self-fertilisation, or the fertilisation of the eggs, produced on germination of the megaspores, by the male gametes produced on germination of the microspores of the same plant.

Neger has investigated the dorsiventral creeping species *S. helvetica*, and the radially symmetrical erect species *S. spinulosa*. On each cone there occur at the apex microsporangia, at the middle both kinds of sporangia, and at the base microsporangia again. The apical microsporangia open first, then the two kinds of sporangia in the middle region, and finally the basal microsporangia. That is, in these two species the cones are at first protandrous, but after the emptying of the whole of the megasporangia there are always present undehisced microsporangia; there are two crops of microspores, some shed before the megaspores, and the rest afterwards. Hence during the whole of the period of shedding of megaspores there are ripe microspores ready to germinate.

In *S. helvetica*, Neger finds that the cones as well as the creeping vegetative shoots show dorsiventral symmetry, the upper leaves being small and the lower ones large. This species grows chiefly on vertical rock faces. In the middle region of the cone, which grows upwards from the creeping shoot, the megasporangia are chiefly found on the ventral side, the microsporangia chiefly on the dorsal side. This arrangement, which does not appear to have been previously noted, is attributed by Neger to the better nourishment of the ventral side owing to the larger leaves. Moreover, the ventral side is turned towards the light, and its leaves are, therefore, in a more favourable position for assimilation. Much more food is, of course, required by the megaspores, the tissue of which has to nourish the developing embryo, than by the minute microspores which merely have to produce a few antherozoids. Since *S. helvetica* grows in sheltered clefts and crannies, wind can only play a small part in the dispersal of the spores. The dehiscence mechanism of the megasporangium is well developed, but this mechanism would be of little use were the megasporangia on the shaded dorsal side of the cone—the liberated megaspores would then strike the vertical rock face close to the plant and roll off or become entangled in the vegetative shoots. The minute microspores, however, are easily carried away by the lightest breeze, and the dehiscence mechanism in the microsporangium wall is so feeble that the spores on being set free hardly reach the substratum close by. In *S. spinulosa*, which forms horizontal patches with the shoots orthotropous (erect), the cone shows no differentiation into light and shade sides; the megasporangia are found all round the axis of the cone, and the megaspores on being set free have a clear path in all directions.

CHEMISTRY.

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

BIOLOGICAL ACTION OF RADIUM.—Dr. Loewenthal writing in the *Zeit. angewandt. Chem.*, 1911, XXIV, 1130, points out that the therapeutic action of certain mineral water springs must be attributed, partially at all events, to their containing a considerable proportion of radium. It is well known that radium emanation has a pronounced stimulative effect upon the enzymes (pepsin, trypsin, diastase) present in the body, and the beneficial effects of these springs are probably due to this cause. Young plants and mould-fungi are also favourably influenced by the action of a small quantity of radium emanation, but they are injured by larger amounts. The action of the radium emanation has also a marked effect upon the white corpuscles of the blood, and it has been proved by Gudzent that the same body increases the solubility of sodium urate. This effect, however, is attributed to the action of the product of decomposition of the emanation termed "radium D." On this fact has been based a method of treating gout by the application of radium emanation, and it is claimed that the treatment has given good results.

RADIUM IN URANIUM ORES.—An estimation of the amount of radium present in various uranium ores has been made by Messrs. Marckwald and Russell (*Chem. News*, 1911, CIII, 277), who have taken the ionising power as a measure of the radium. Comparing the ratio of the radium to uranium with that of Joachimsthal pitchblende (taken as 100), they have obtained a value of 98·1 for thorianite, and 101.5 for African pitchblende, but for autunite values ranging from 20·7 to 68·0, although the ratio of ionium to uranium was much more uniform in this mineral. Since the life of ionium is not less than thirty thousand years, the conclusion is drawn that autunite must be at least one hundred thousand years old, and that, therefore, the relatively low values for the radium ratio are not due to the radium being of recent formation. It seems more probable that the physical structure of autunite is responsible for the difference, and that owing to its possessing a much more spongy texture than pitchblende and thorianite, the radium and lead have been partially extracted by water from the mineral. This view is supported by the fact that there is only a slight occlusion of helium in autunite, and by analogous results obtained in the examination of the mineral rutherfordite.

PROPERTIES OF METALLIC TITANIUM.—It is not an easy matter to obtain the element titanium in a pure condition, as is shown by the account given by Messrs. Hunter and Jones (*Rensselaer Polyt. Inst.*, No. 1, February 11th, 1911), of their attempts to prepare it. The products obtained by reducing sodium, potassium, and barium titanifluorides with potassium in no instance contained more than 73·2 per cent. of titanium, while reduction of titanium oxide by means of carbon invariably yielded products containing upwards of five per cent. of carbon. Finally pure titanium was prepared by heating together in a closed bomb a mixture of titanium tetrachloride and metallic sodium, with the greatest precaution to exclude all air. The reduction took place almost instantaneously at a dull red heat, and products, which on analysis showed from 99·9 to 100 per cent. of titanium, were obtained.

As thus prepared titanium was a hard brittle metal resembling polished steel in appearance. It melted between 1800° and 1850° C., and had a specific gravity of 4·50. It could readily be forged.

CHEMICALLY ACTIVE NITROGEN.—Pure nitrogen that has been subjected to an electric discharge from a Leyden jar undergoes a remarkable change, an account of which is given by the Hon. R. J. Strutt, in a recent issue of the *Proceedings of the Royal Society* (1911, LXXXV, 219). The gas after being removed from the region of the discharge continues to glow during the process of returning to its normal state. The glow is intensified by cold but diminished by heat, and it is suggested that it may be due to the dissociated atoms entering into combination again.

In this chemically active condition, nitrogen forms a compound with ordinary yellow phosphorus, while a large amount of the phosphorus is transformed into the red modification during the reaction. It also enters into combination with sodium and with mercury at relatively low temperatures, the mercury product being an unstable explosive body; while there is spectroscopic evidence that similar compounds with other metals, such as cadmium and magnesium, are produced.

When brought in contact with nitric oxide glowing nitrogen reacts to form nitrogen peroxide, the reaction probably taking place in accordance with the equation—

$$2\,NO + N = NO_2 + N_2$$

It also effects the decomposition of acetylene and of chlorine and bromine derivatives of hydrocarbons, with the liberation of the halogen and formation of cyanogen.

MINERAL CONSTITUENTS OF A DUSTY ATMOSPHERE.—A spectroscopic method of determining the nature of the dust in the atmosphere has been devised by Professor Hartley (*Proceedings of the Royal Society*, 1911, LXXXV, A, 271). A series of photographs of spark spectra was taken upon one plate, and compared with a similar series taken in an atmosphere of hydrogen, the differences showing which of the lines were due to impurities in the metal electrodes and which to the dust in the atmosphere.

It was found that the calcium and copper lines were intensified as the proportion of dust in the air increased, with the continuance of dry weather. With regard to the source of the copper it is pointed out that this element is present in coal-ash, and in the dust from the flues of chemical and gas works, and that it is also introduced into the atmosphere by the flashes of overhead cables; while the amount of calcium is increased by tram and motor car traffic. In fact the possibility of the copper or calcium in the atmosphere acting as reagents, must be taken into account in all cases of apparently spontaneous changes such as might have been set up by traces of basic substances. They may also produce alterations in solutions that would not be affected by exposure to a pure atmosphere.

GEOLOGY.

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

NEW THEORIES OF VULCANISM. — R. A. Daly (*Proc. Amer. Acad. of Arts and Sciences*, Vol. XLVII, No. 3, 1911, pp. 45–122) bases a paper on "The Nature of Volcanic Action" on his well-known theory of abyssal injection. He believes that the world-wide granitic terrane underlying the interrupted sedimentary shell is itself underlain by a shell of eruptible basalt, which is the source and "heat-bringer" of all igneous action. He points to the fact that all the great lava-floods of the world are of basalt, and have welled out from great fissures which are supposed to have tapped this basaltic substratum, although it is not supposed that simple openings extend to this depth.

Other igneous rocks are believed to be due to the absorption of the overlying acid shell, as abyssal injections of basalt, caused by crustal deformation, work their way upwards by a method known as "stoping." This involves the constant wedging away of blocks from the roof of the resulting batholith, and their solution in depth. The resulting mixed magmas are called "syntectics," and with or without subsequent differentiation, are held to give rise to the known variety of igneous rocks.

Daly holds that vulcanism is a subsidiary effect of abyssal intrusion. He distinguishes three phases of volcanic action—fissure eruptions, in which lava rises with great rapidity through relatively thin cracks in the crust; eruptions through local foundering of the roof of a batholithic intrusion; and central eruptions of the common cone and crater type. Fissure eruptions are well known, and beside the recent Iceland examples, there are numerous others belonging to past ages. The Yellowstone Park rhyolite is believed to be an example of the second type of volcanic action. This huge mass of lava, cut by canyons to a depth of six hundred meters without revealing its base, lacking horizontal division-planes indicating successive flows, is without parallel amongst lava-flows. Daly believes that it passes gradually downwards into a batholithic mass of granite, and is due to the foundering of part of the roof of this batholith, whereby the molten rock was solidified under surface conditions.

Central eruptions are supposed to originate in a cupola-like extension of the roof of a batholithic intrusion, where "stoping" action would be intensified by a concentration of the hot volatile magmatic fluids. On reaching the surface the "cupola" would originate a volcanic focus, and a cone would be formed. At this stage the problem of the continuance of the volcano becomes the problem of the continuance of heat within the funnel.

There are five conceivable methods whereby heat may be transferred from the magma to the vent:—

i. Explosive removal of material from the upper part of the vent, followed by uprise of magma.

ii. Simple outflow of magma at the crater-lip.

iii. Thermal convection in the lava column.

iv. "Two-phase convection."

v. The uprise of super-heated juvenile gas through the lava column.

At Kilauea, on the observation of which this theory is partly based, the first and second methods are inoperative; the third is known to be inefficient in heat-transfer; but the fourth, a process conceived to be due to the uprise of comparatively-light, hot, gas-permeated magma in the lava-column, and its return along the margins of the vent as comparatively heavy, cooled, gas-free magma,—may bring a considerable quantity of heat to the surface. This process is believed to be the cause of the lava-currents in the crater of Kilauea. The fifth method may be efficient as a heat-bringer at some vents, but not at Kilauea.

A largely overlooked source of heat, according to Daly, is that set free by chemical reaction between the constituents of the hot and active magmatic fluids. Many striking figures are given illustrating the great amount of heat evolved by the reactions between the common elements of these fluids.

The process outlined above is known as the "gas-fluxing hypothesis," and is considered analogous to that of a gas-blowpipe.

Some explosive types, such as the Ries cauldron and Bandaisan, are considered due to the contact of hot magmatic material with vadose waters circulating within the rocks. The explosions here are non-volcanic: but there may be all gradations between this type, and those, such as the Hawaiian volcanos, characterised by quiet magmatic extrusion without explosion. In ordinary volcanoes, there are great variations in the proportions of magmatic and vadose fluids involved, and consequently great variety in modes of eruption.

With regard to the now much-discussed rôle of steam in volcanic action, Daly says: "Though the rise of hot magma into rocks charged with vadose or connate water does often cause explosion, the steam pressure produced by such volatilised water can no more be regarded as the cause of vulcanism than is the boiling of a kettle the cause of the heat in the stove."

A. BRUN.—Whilst Daly emphasises the adventitious nature of the intervention of water in volcanic action, it is to Brun, of Geneva, that we are indebted for what appears to be the overthrow of the old axiom that paroxysmal eruption is due to the explosive violence of steam. In the *Geological Magazine* for June and July, Mr. E. B. Bailey, of the Geological Survey, gives an illuminating review of the new book, "Recherches sur l' Exhalaison Volcanique" by this original and courageous worker. One of the most valuable features of Brun's work is the mass of new and exact experimental data he has accumulated in respect to vulcanicity. Not only has he measured the temperature constants of many minerals found in lavas, but new work has been done in the methods of collection, extraction, and analysis of the various volcanic gases, both in the field and in the laboratory. Experimental work on the behaviour of rocks during heating has resulted in their classification as "active" or "dead." Active rocks, typified by recent lavas, expand and liberate gas at such a rate when heated that the molten material fumes over the edge of the crucible, like a miniature lava flow. Active acid rocks are more violent than basic and give rise to veritable explosions. Dead rocks, among which are schist, granite and gabbro, give off gas during heating, but at a higher temperature melt quietly without much expansion or violence. The temperature at which gas is emitted in active rocks so rapidly as to cause sudden expansion and explosion is called the "explosion temperature." The maximum temperature possible at a volcano is fixed by the explosion temperature of its magma.

The principal gases liberated at the explosion temperature are chlorine, hydrochloric acid, and oxides of carbon; the solids evolved are chlorides of the alkali metals and ammonium; sulphur occurs but is always in small quantity. Such water as is contained in the rock is always given off before the explosion temperature is reached. These constituents, with the exception of carbon monoxide, are the same as those actually emitted at volcanoes.

Brun's main thesis is that paroxysmal eruptions are anhydrous, and that the aqueous character of fumaroles is due to the contact of volcanic heat with superficial waters. This view is supported by many striking observations. It is shown, for example, that near the crater of Vesuvius, the ashes fall quite dry, but are extremely hygroscopic, owing to the presence of chlorides of iron and magnesium. Morever, the ash which falls is white; whereas if it had been exposed to the action of water vapour at a high temperature, it would redden immediately, owing to its content of ferrous chloride. In the crater itself, such deliquescing salts as $Fe_2 Cl_6$, $Fe Cl_2$, $Mg Cl_2$ and $Al_2 Cl_6$ may be collected dry and undecomposed, whilst hot water-vapour would immediately reduce them to oxides.

Further evidence is adduced from the study of the white clouds which hang over volcanoes. These are generally regarded as water-vapour; but Brun shows that they are persistent, and insoluble in the atmosphere as they drift away from the volcanic focus, and are therefore composed of solid particles. At Kilauea, Brun took a series of dew point readings in the great white cloud as it drifted across the crater-lip. His results show in every case a lower dewpoint for the air within than for the air outside the cloud. The lowered dewpoint is believed to be caused by the dilution of the air with anhydrous gases carrying hygroscopic solids in suspension. On the contrary, a markedly elevated dewpoint was obtained at the peripheral fumaroles, as was, indeed, to be expected.

It seems, therefore, that Brun has, at least, established the anhydricity of volcanic exhalations; and great probability attaches to his view that water is not the agent to which paroxysmal eruptions must be attributed.

METEOROLOGY.

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

The weather of the week ended July 22nd, as summarised in the Weekly Weather Reports of the Meteorological Office, was very fine over the greater part of England, but slight rain fell in the North and West and in Ireland. In Scotland there was frequent rain, though it was seldom heavy. Thunderstorms were reported during the middle of the week.

Temperature was again above the average, except in Scotland, where it was either normal or very slightly below. Very high maxima were recorded in the South and East of England and in the Midlands, the highest being 96° at Greenwich, on the 22nd, with 94° at Margate and 93° at Raunds. In Ireland the highest reading reported was 79°, while in Scotland North and West the temperature did not rise above 71°. At individual stations in Scotland and Ireland the maximum did not reach 70°, and at Balta Sound, Shetlands, it was only 59°.

The minima were above 40° everywhere except in Scotland, where, at Balmoral, the temperature in the screen fell to 32°, and on the grass to 30°. In the English Channel the minimum was 55°.

Rainfall was below the average except in Scotland N. and E. The defect was very great in places, and the drought began to be severely felt. In England S.E. the week was rainless.

In Scotland, however, there was much rain, the total for the week exceeding 2·0 inches at Glencarron and Fort William.

Bright sunshine varied a good deal. In most parts of England it was again above the average, but in Ireland, Scotland and the Northern parts of England it was in defect. In Ireland N. the average daily duration was less than three hours, while in England S.E. it was over eleven hours. The percentage of possible duration varied from eighteen per cent. in Ireland N. to seventy per cent. in England S.E. and in the English Channel.

The temperature of the sea water was generally high, the means varying from 52°·5 at Lerwick to 65°·9 at Margate.

The weather of the week ended July 29th, was more variable than that of the preceding week. In Ireland it was unsettled, with frequent rain. Many thunderstorms were reported, that in London, on the 28th, being very severe. Temperature was above the average in all parts, the excess exceeding 7° in England E. and S.E. The maxima were again unusually high, though not quite equal to those of the preceding week. The highest readings were 93° on the 29th, at Bath, 92° at Tunbridge Wells, and 91° at Fulbeck, Oxford, Raunds, Cardiff and Clifton.

The minima for the week ranged from 37° at Balmoral to 57° at Scilly. On several nights the minima over a large part of England were as high as 60°. On the grass the readings did not, as a rule, fall below 40°, but at Burnley, Balmoral and Crathes, readings of 34° were observed, and at Llangammarch the exposed thermometer registered 29° or 3° of frost.

Rainfall was much less than the average in most parts of England, but was more than usual in Scotland N. and W., in Ireland and the English Channel. In Ireland S. the total was two and a-half times as much as usual.

During the thunderstorm in London on the 28th 1·1 inches of rain fell in South Kensington in fifteen minutes. On the next day 1·21 inches fell in Dublin in forty-five minutes, and 2·14 inches at Kilkenny in two and a-half hours.

Bright sunshine was again in excess in England, but was deficient in Scotland and Ireland N., and just normal in Ireland S. The sunniest stations were Weymouth with 83·5 hours (77%) and Salcombe 82·6 hours (77%). On the other hand, at Fort Augustus only 11·9 hours (10%) were recorded, and at Nairn only 14 hours (12%).

The mean temperature of the sea water round our coasts varied from 52°·7 at Lerwick to 67°·6 at Eastbourne.

The week ended August 5th was unsettled, but the rainfall over England E. and S.E. was again very slight. Thunderstorms were experienced in most parts, and in some cases these were accompanied with very heavy showers. Temperature was above the normal in all districts, by as much as 7°·1 in England E. The highest maxima reported were 88° at Cambridge on the 30th July, with 87° at Cromer and Hillington, and 86° at Greenwich. In Jersey the highest reading was 76°. The lowest readings varied much. At West Linton the minimum was 42°, and readings below 50° were reported at many stations. The lowest reading reported at Jersey was 57°. No frost on the grass was reported during the week.

Rainfall was largely in excess in most of the western districts, but over the rest of the country it was still in defect, and in England S.E. it was less than one-fourth the usual amount.

Sunshine was in excess in all Districts except the English Channel where it was slightly in defect. The district values ranged from 63 hours (59%) in England E., to 35 hours (32%) in Ireland N. The sunniest stations were Felixstowe 72·8 hours (68%) and Clacton 71·7 hours (67%). At Westminster the total duration was 55·9 hours (52%).

The temperature of the sea water varied from 53° at Lerwick to 71° at Margate.

The week ended August 12th, was very fine and dry, though with slight rain in Ireland and Scotland, and some thunderstorms. Temperature was remarkably high and in England E. the district mean was as much as 9·2 above the average. In most parts the hottest day was the 9th, when temperatures higher than any previously recorded in the United Kingdom were reported. The highest reading was 100° at Greenwich, which is the highest reported since precise observations were begun there in 1841. The previous highest was 97°1 in July, 1881. Other very high readings were 98° at Raunds, Epsom and Canterbury, and 97° in London, and Hillington, Norfolk.

Dr. H. R. Mill, the head of the British Rainfall Organization, writing in *Symons's Meteorological Magazine* says that the maximum temperature at Camden Square was 97°·1 at 2.15 p.m. on August 9th, the previous highest, since the record began in 1858, being 95°·2 in July, 1900. On the same day at Mill Hill, 380 feet above sea level, while the maximum in the Stevenson screen was 95°·8, Mrs. H. R. Mill noted the reading of a black bulb thermometer *in vacuo* as 142°·4. On July 22nd this year, however, with a screen reading of 90°·0, the black bulb was as high as 146°·8.

The lowest readings ranged down to 41° at Wick and to 42° at Gordon Castle. In Jersey the minimum for the week was 59°, and on several nights over a large part of England the temperature did not fall below 60°. No ground frost was reported, but at Crathes the exposed thermometer fell to 33°.

Rainfall was largely in defect in all districts, and over the greatest part of England it was very slight indeed. At many stations the week was rainless.

Sunshine exceeded the average in all districts, the values in England S.E., being 79 hours (76%). The sunniest stations were Felixstowe, 88·2 hours (84%), Brighton, 86·9 hours (84%), and Hastings, 86·2 hours (83%). The mean temperature of the sea water ranged from 55°·0 at Lerwick to 68°·3 at Margate.

An unmanned balloon sent up at Mungret College, Limerick, on July 6th, reached a height of thirteen miles. The lowest temperature met with on this ascent was −57° C., at about seven and three-quarter miles above the ground.

MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD. ARTHUR EARLAND, F.R.M.S.
THE REV. E. W. BOWELL, M.A. RICHARD T. LEWIS, F.R.M.S.
JAMES BURTON. CHAS. F. ROUSSELET, F.R.M.S.
CHARLES H. CAFFYN. D. J. SCOURFIELD, F.Z.S., F.R.M.S.
C. D. SOAR, F.L.S., F.R.M.S.

MICRO-FAUNA OF A SEWAGE FILTER BED.—This short note is the result of isolated observations I have made from time to time, over a number of years, as occasion or necessity arose for paying a visit to the works where the process of sewage purification is carried out. The large variety of bacterial fauna present in such a nidus will not be touched upon, but only that part of the life which can be readily observed by the average microscopist. The bulk of the organisms herein noted, can be examined in a cursory way with a good pocket lens.

A sewage bed, as most of my readers are probably aware, is a specially constructed area for dealing with liquid sewage. The particular type to which this note relates is circular in plan, and is filled to a depth of about six feet, with a specially prepared material or "media," as it is termed, which forms a "nidus" or breeding ground for the bacteria responsible for the process of purification. The "media" is prepared from what is known locally as "Blast Furnace Slag" broken to varying degrees of fineness, ranging from a quarter of an inch to two inches in gauge. The sewage is applied to the surface of the bed by a travelling form of distributing apparatus similar to an elongated water wheel, which has a circumferential together with a rotary motion on its own axis, and so sprinkles the sewage evenly and regularly over the whole area of the bed.

On taking up into the hand a piece of the "media" one is struck with the gelatinous covering, which forms as it were a sort of blanket enveloping the whole piece under examination. This covering consists largely of bacterial life which is outside the scope of this note.

The first form of active life noticeable consists of a large number of small black bodies which, on a closer inspection, reveal themselves as a sort of "fly." They are very different from the fly as the ordinary individual observes them, and if a piece of "media" is taken in the hand and the "flies" shaken off on to a piece of white paper, they will be seen to move about by a series of sudden sharp jumps, sometimes covering a considerable distance in comparison with their own length. They belong to the Order Collembola and are referred to by microscopists in popular language as "Springtails." To give the reader some idea of the immense number found on a bed I have on many occasions observed an area of four to six feet (superficial) covered to a depth of one quarter of an inch. These insects are not confined solely to the surface of the bed. On digging out the "media" they will be found to a considerable depth, but in much smaller numbers.

The next dwellers in this odorous habitation are, strange to say, our very interesting friends, the spiders. My friend, Mr. F. P. Smith, some little time ago, identified a collection for me as consisting of two species, viz., *Porrhomma microphthalum* and *Tmeticus simplex*, the latter by no means a common species. Both sexes of each were taken. While on the subject of spiders it may be interesting to mention that during certain months of the year it is a common spectacle to find in the early hours of the morning the whole surface of the bed covered with a network of webs. It is an extremely pretty sight, and I have several times endeavoured to take photographic records, but without any satisfactory measure of success. The spiders, like the "Springtails," appear to be equally at home in the depths of the bed. In fact, they are much more evenly distributed.

On the bottom of the outlet channels there is usually a layer of finely divided mud, or "humus" as it is termed, and on skimming this layer one can generally obtain the Desmid *Closterium ensis*, but not in very large numbers. Amongst the Protozoa there are specimens of *Arcella*, *Actinophrys sol*, and *Difflugia*. Coming to the Infusorians there are found *Coleps*, *Stentor* and *Vorticella*, the latter forms sometimes being taken in large numbers. The slipper animalcule *Paramoecium*, it is almost needless to say, can always be found.

Amongst the Entomostraca specimens of *Cyclops* are plentiful, together with *Daphnia pulex*.

A few Rotifers are sometimes taken, and the same remark applies to *Volvox globator* and the freshwater polype *Hydra viridis*.

The variety of microscopic life would probably be larger, but owing to the method of working, and the constantly changing character of the sewage, it is somewhat surprising to find the variety herein enumerated.

A peculiarity which can perhaps be easily accounted for is that whilst it is possible to keep specimens of the forms mentioned in captivity for considerable periods of time, when the collection has been taken from a freshwater pool, this is not the case with those collected from this particular gathering ground. Vorticella and the larval forms of *Cyclops* die very quickly unless the collection is poured out into a shallow dish. In this way I have kept the several forms of life in an active condition for a considerable time.

GEO. P. DUDLEY.

ANABAENA CIRCINALIS.—The water in one of the ponds near Totteridge Common, visited by the Quekett Microscopical Club on their Saturday afternoon excursion late in June, was of a decided green colour, almost like green pea soup. The appearance was caused by the presence of many different species of minute algae, most of them of an indefinite character, such as would be classed with the Protococcaceae and Palmellaceae, with some *Scenedesmus* and zoöspores of various kinds. But the greatest effect was produced by a less doubtful plant. It was so plentiful that it was not necessary to concentrate the take with the net; it could be obtained abundantly for examination by merely dipping a bottle into the water. It obviously belonged to the not very easily discriminated family —the Nostocaceae—and was probably *Anabaena circinalis* (Figure 1). It consisted of free-swimming short filaments, composed of roundish cells averaging about 4μ in diameter, with bluish-green coarsely granular contents. The filaments were twisted into helical coils of from two to six turns, or occasionally even more, often very symmetrically arranged. Most of the coils had intercalated in them a rather larger quite spherical cell with clear contents—the heterocyst. Sometimes a spore also was present: these are oval, granular and larger than the ordinary cells. Vegetative cells undergoing division were not uncommon; in this case they were larger than usual and more or less constricted in the middle, according to the stage the process had reached. A singular feature was, that the direction of the spiral in most cases changed at the heterocyst; this is shown in the top and bottom examples in the figure. When the filament was a short one, this gave rise to a peculiar M-shaped form with turned up ends, as shown in the extreme left hand example. This form was very plentiful. Various species of *Anabaena* are not at all infrequent in the freshwater plankton but the present variety is certainly not very common.

FIGURE 1. *Anabaena circinalis.*

The specific determination of many of the lower algae is very difficult with the text books at present accessible to the ordinary microscopist, and everyone desiring to study this interesting class must be anxiously awaiting the appearance of Professor West's anticipated work, with fuller details than were possible in his "British Freshwater Algae" published in 1904.

J. B.

HYDRURUS FOETIDUS (VILL).—In the August number of "KNOWLEDGE" (page 320), a note was published on the above, but the subject proved too difficult for photography; we are, however, now able to reproduce drawings of the plant (Figure 2). The lower drawing represents a small, sparsely-branched plant; usually the branches are much closer together and of a more filamentous character. Above, on the left, such a branch is figured, and shows the small coloured bodies embedded in the gelatinous matrix. On the right is a small piece of a thicker stem, showing the same bodies and their arrangement in that part, where they become more elongated and less frequent than in the thinner portions of the plant. The magnifications are approximately × 25, × 70, and × 180 respectively.

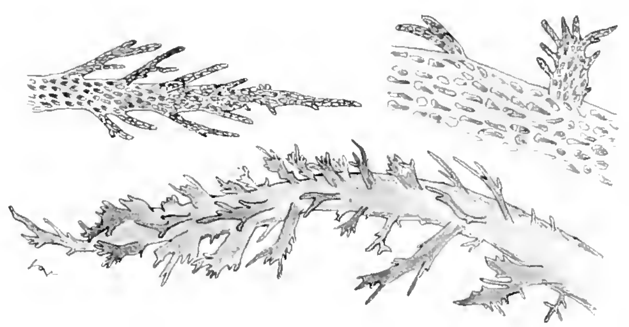


FIGURE 2. *Hydrurus foetidus* Vill.

J.B.

ENTAMOEBA COLI.—In the *Annals of Tropical Medicine and Parasitology*, Vol. V., page 111, appears a paper by Dr. H. B. Fantham, "On the amoebae parasitic in the human intestine, with remarks on the life-cycle of *Entamoeba coli* in cultures." The amoebae begin to encyst on the culture-media which the author has been using, in about four days, the cyst wall of each being formed by differentiation at the periphery of the now rounded amoeba, The cyst at first contains a centrally-placed nucleus, with a karyosome. Inside some of the cysts division occurs, and eight daughter forms are produced.

The author tried the effect on *Entamoeba coli* of "auxetics," substances such as tyrosin and leucin, occurring naturally in the human body and capable of inducing division in living cells. The substances are best used in a jelly with agar, sodium chloride and an alkali (sodium bicarbonate), forming a slightly alkaline culture medium. When such a medium containing about 0·2 per cent. of tyrosin is inoculated with cysts of *Entamoeba coli*, the period of the life-cycle is shortened and the amoebae in the culture reproduce for several generations. The author mentions a culture which had gone through five generations. One interesting and novel result on tyrosin-containing media is that a complete life-cycle of *Entamoeba coli* is passed through in about three days (at 20° to 25° C.), when all the amoebae of a given generation have encysted. Then a large number of the cysts produce eight daughter forms inside them, and the amoebulae come out of the cysts and start a new generation in the same medium. The process of binary fission which also frequently occurs in such media involves a primitive mitosis (or promitosis) of the nucleus, caps of chromatin derived from the karyosome being formed at the ends of the rudimentary spindle.

The subject of this research, *Entamoeba coli*, is usually considered to be non-pathogenic; it lives in the lumen of the large intestine and on the contents thereof; it is incapable of penetrating the mucosa. The size is slightly variable from 12 to 25 μ in diameter.

G. PLANT DEELEY.

ORNITHOLOGY.

By HUGH BOYD WATT, M.B.O.U.

A NEW BRITISH BIRD—THE ALPINE RING-OUZEL.—The occurrence of this form of the Ring-Ouzel (*Turdus torquatus alpestris*) is recorded for the first time in Great Britain by Mr. M. J. Nicoll, in *British Birds* (V, August, 1911, pages 72–73), on the strength of an adult male shot at Guestling, Sussex, on 23rd May, 1911. The illustration given shows the form to be generally whiter in appearance than the common Ring-Ouzel. The Alpine bird has a wide range, extending in the breeding season throughout middle and south Europe to the Balkans.

THE IRISH COAL-TITMOUSE—(*PARUS HIBERNICUS*).—In the current number of *The Ibis* (9th Series V, July, 1911, pages 548-552), Mr. W. R. Ogilvie-Grant gives what may be taken to be a definite finding on this bird (see "KNOWLEDGE" for March, 1911). He modifies his earlier claim for its full specific rank, and, as the British Coal-Titmouse also occurs in Ireland, and the two forms to some extent intergrade, he now regards the Irish bird (*P. hibernicus*) as a sub-species only, though a very distinct one.

Mr. Ogilvie-Grant makes the suggestion that some characters of the Irish bird indicate that its origin is much more ancient than its British representative, and that it is a pre-glacial type which has survived in the western and southern parts of Ireland. He points out that the form most closely allied to the Irish bird is, in many respects, another Coal-Titmouse (*Parus ledoucii* Malh.,) peculiar to Algeria and that the Lusitanian element in the fauna of Ireland is illustrated by this. He remarks that the distribution of the Strawberry tree (*Arbutus unedo*), which has a wide range in the Mediterranean region and is found in the neighbourhood of Killarney as well as in Algeria, is most interesting, as bearing on the question of the Irish and Algerian Titmice. What bearing the interest exactly has on the case of the Irish Coal-Titmouse is not stated.

GROUSE AND DISEASE.—"No disease" is the prevailing report from grouse moors this season, and in addition to the healthy state of [illegible] their numbers in Scotland are believed to be gre[illegible] any past year. This exceptionally good season co[illegible]th the publication of the elaborate report of the Comm[illegible]on Grouse Disease, the result of some six years investi[illegible], under the Chairmanship of Lord Lovat, the general [illegible]stions being treated by Mr. A. S. Leslie and Dr. E. A. Wil[illegible] and the scientific by Dr. A. E. Shipley.

According to the experts, who hav[illegible] into the whole matter with a thoroughness that entitles them to utter the last authoritative word on the subject, the one disease among grouse that spreads havoc and desolation among the birds is caused by what Lord Lovat—turning the expert's highly technical nomenclature into the plainest possible language—terms an over-infection of the Strongyle worm—a worm that is found in practically every grouse on a moor; that is to say (to quote Lord Lovat), "that almost every bird (grouse) contains in its body, under normal conditions, the immediate cause of "grouse disease," and is to a greater or less extent an agent for the dissemination of that scourge." This means that the Strongyle worm will be found to-day in practically every one of the unusually numerous and healthy grouse on practically every moor in Scotland. And the Strongyle worm has always been there, but where and when the grouse—so to speak—are stronger than the worm there is no "disease." The "disease" breaks out when and where the worm is stronger—so to speak—than the bird, although of course the strength of the worm has nothing to do with its name. It follows, therefore, that in the present year, with grouse so healthy everywhere, the conditions must have been such that the birds have been able to keep their worms under proper check, and if that be so it is evident that to those in any way skilled in moorcraft—with the Committee's two sumptuous volumes in their hands, and by a study of the conditions—there should now be little difficulty in so managing grounds and grouse alike that the largest possible stocks of the healthiest possible birds should be the result.—*The Glasgow Herald*, 12th August, 1911.

There is every likelihood that the sport will be so managed during the present season that 1912 should prove as healthy a grouse year as 1911—if the weather also help as it has undoubtedly done during this and last year. According to Lord Lovat, in his admirable chapter on moor management in the Committee's final report, "the immediate objective of the moor owner (who wants good stocks of healthy grouse) stands out clearly—to keep the Strongyle infection at its lowest, to keep the power of resistance of the stock at its highest, and at the same time to maintain the greatest number of birds that the moor is capable of supplying with suitable food." To put it briefly and in practical language, his Lordship sums up the whole matter in these further words—"Moor management is the science of distributing the stock of birds over the moor so that at no period of the year can any area be so infected by the Strongyle worm as to make it a source of danger to the least well-nourished bird on that area."

MARKING BIRDS AND MIGRATION.—There are some reasons for looking with dubiety on the various bird-marking schemes now in operation. Their partial and limited scope, and the danger of making general deductions from the meagre returns obtained, are fair points for consideration, and also the destruction of bird-life which may be entailed in procuring these returns, although such destruction is not approved of by the inquirers. Those who share such apprehensions are recommended to study Mr. A. Landsborough Thomson's recent paper on "The Possibilities of Bird-Marking, with special reference to the Aberdeen University Bird-Migration Inquiry" (*Proceedings Royal Physical Society, Edinburgh*, XVIII, 3, 1911, pages 204-218), which gives, in admirable terms, a well-considered and reasoned statement of the subject. Apart from general and historical and other results, of which a good and valuable account is given, covering Great Britain, the Continent and the U.S.A., the paper tells of the particular investigation now in hand at Aberdeen. This has the advantage of being a piece of research work organised under a responsible body, viz., the Natural History Department of the niversity of Aberdeen. Properly controlled methods and results should accordingly be assured, and, while Mr. Thomson writes as an enthusiast, he does so judiciously, and does not overlook the difficulties nor exaggerate the possibilities of the subject.

For some of the Aberdeen returns already reported see "Knowledge" for May, 1911 (page 198).

We wonder why so few or no returns seem to be forthcoming from one class of birds, viz., the game-birds which, owing to the numbers meeting death from the hands of man, would seem to be likely to yield a larger percentage of returns to the numbers marked than any other class of birds. We do not overlook the returns regarding Woodcock, but refer more particularly to Grouse, Partridge and Pheasant.

ACCLIMATIZING PARADISE-BIRDS.—As stated in "Knowledge" for June, 1911 (page 237), Sir William Ingram has bought the uninhabited island of Little Tobago, West Indies, and is attempting to acclimatize the Greater Bird of Paradise (*Paradisea apoda*) there. In the *Avicultural Magazine* (II. 5. 1911) he reports that he has turned out forty-eight birds and that two others were to be sent later. The island consists of four hundred acres of forest jungle and the birds have spread over the whole area. They eat fruit, insects and young birds and eggs of other species. Four are known to have died, and none have yet mated.

PHOTOGRAPHY.

By C. E. Kenneth Mees, D.Sc.

LATITUDE OF EXPOSURE IN LANDSCAPE PHOTOGRAPHY.—It is well-known that in landscape photography there is very considerable latitude in the exposure which may be given, a range which is sometimes ascribed to the latitude of gradation which the photographic dry plate is capable of accurately rendering. Experimental investigation, however, shows that the range of light intensities which can be reproduced accurately by an ordinary photographic dry plate is only about one to twelve or one to sixteen, that is to say, this is the range of intensities which are included in the straight line portion of the characteristic curve of a plate, or is the range of intensities comprised within the period of correct exposure of a plate.

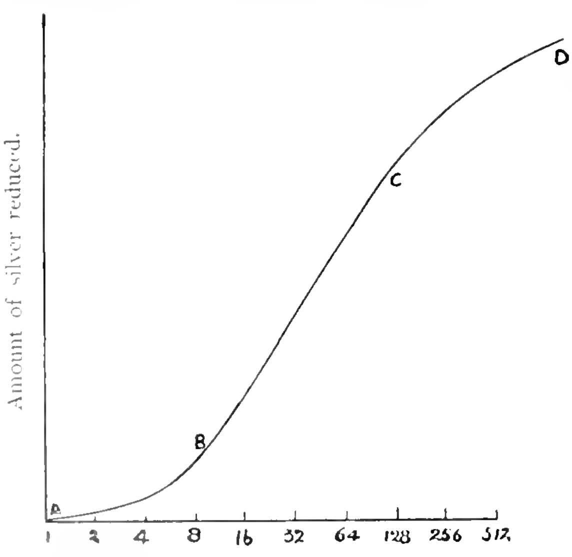


Figure 1.

The figure shows the "characteristic curve" of a plate, that is, the relation between the light intensity acting on the plate during exposure and the amount of metallic silver reduced by development.

It will be seen that this curve may be divided into three portions:—A portion, AB, where the reducible silver increases more rapidly than the geometrical increase of the intensities, a portion, BC, where the increase rates are proportional, and a portion, CD, where the increase of silver with increasing exposure diminishes.

These three portions are known:

AB, as the period of under-exposure,

BC, the period of correct exposure, and

CD, the period of over-exposure.

For the curve shown the range of intensities in the period of under-exposure is about one to eight, the range in the period of correct exposure eight to one hundred and twenty-eight, or one to sixteen.

Since one to fifteen is about an average range of intensities for an ordinary landscape subject, it is obvious that, strictly speaking, a plate has no latitude at all, that is, any deviation from one fixed exposure, which we may call correct exposure, will cause one end or other of the intensity scale to fall out of the period of correct exposure of the plate, so that, except for one particular exposure, an average landscape must have some of its intensity scale rendered either within the under- or over-exposed periods of the plate curve.

In practice a plate is not considered under exposed provided that any deposit at all is obtained in the deepest shadows, which implies that instead of the effective range of light intensities starting at the beginning of the period of correct exposure, in practical photography the range of light intensities starts at the beginning of the period of under-exposure, and the rule that the exposure should be given for the shadows—the safest of all rules in landscape photography—means that the range of intensities on the resulting negative will be represented in both the under-exposure and correct exposure periods of the plate curve. An increase of four times this exposure will merely serve to shift the shadow exposure from the beginning of the under-exposure region to the beginning of the correct exposure region of the curve, and we may therefore expect an apparent latitude of at least one to four in the direction of over-exposure. If we again increase the exposure, we may shift the upper part of the scale of gradation into the over-exposed portion of the curve, but for some considerable distance the effect will not be appreciable to the eye, and it may, therefore, be taken as a practical working rule that if a given exposure is the least which can be given to get the deepest shadow detail represented by the smallest possible deposit on the plate, eight times that exposure will still give a perfectly satisfactory negative.

It is a matter of considerable interest to measure the amount of light reflected from the shadows of landscapes by means of such an instrument as the "Lumeter" referred to in the May number of "Knowledge." Experiments showed that in order to get a negative in which shadow detail was rendered by a minimum deposit on a plate of one hundred Watkins, it was necessary to give one-tenth of a second exposure at F8, if the light reflected from the shadows of the subject was of one hundred foot-candles intensity, and measurement of a number of subjects showed that in bright sunlight in the summer, the illumination in the shadows varied from about three hundred to fifty foot-candles, according to the depth of the shadow. The deduction drawn from such measurements appears to lead to a complete confirmation of the rule made by most experienced photographers, namely, that it is difficult, with a hand camera at any rate, to over-expose landscape subjects, and that a general rule when dealing with a landscape in which there is a considerable degree of contrast, is to give as much exposure as possible. It may be said, indeed, that one-tenth of a second at F8 will rarely be found too long for a landscape subject with a close foreground.

When, however, there is no close foreground in the subject and little deep shadow, the range of contrast becomes very much less, it is quite possible for the intensity ratio between the darkest and lightest parts of an open landscape to be only one to three, and in this case it is absolutely necessary that care should be taken to keep on the side of under- rather than over-exposure, because, whereas with contrasty subjects the aim of the photographer must be to compress his scale in order to get it within the scale of the printing paper, with flat subjects having little range of contrast the object of the photographer must be to increase the contrast in order to get an effect pleasing to the eye, even though not necessarily a perfect rendering of the original. One effect of this desirability of increased exposure for increased contrast is found when such unusual subjects as tropical or alpine landscapes are photographed. In the tropics, with vertical sun and the absence of cloud, there is very little sky light to illuminate the shadows, and the shadows are consequently extremely deep and show much contrast with objects illuminated by the direct rays of the sun. This increase of contrast compensates almost completely for the greater intensity of illumination, and it is probable that a plate in the tropics should be given quite as much exposure for the same type of subject as would be required in England. Such photographs of the tropics as have come before my notice seem to bear this out very fully; they are nearly all under-exposed, in spite of the great intensity of illumination available. In the same way, the intensity of the light in the high alps is largely counter-balanced by the increased contrast due to the lack of sky illumination in the shadows, so that skilled alpine photographers almost always advise that plates in the high alps should be as fully exposed as if the camera were being used in England.

The relation between contrast and exposure does not seem at present to have been fully worked out; but there is no doubt in my mind that it is a subject which will well repay investigation, and that a discussion of practical photography, based on a number of experiments checked by direct measurement of contrast and intensity, would be of very considerable educational value for all classes of photographers.

PLATINOTYPE PRINTING. — Of all photographic printing processes, the Platinotype process is recognised to be that which gives results of the greatest beauty and the most absolute permanency. It is also an extremely quick process, requiring little time for manipulation, and, provided the exposure is correct, producing results of unvarying excellence. Unfortunately, however, it is not a printing-out process, and it is necessary to judge the depth of the printing from the appearance of the faint image produced by exposure to light, a matter which, while it presents no difficulties to the experienced worker who is continually doing it, is not so easily undertaken by one who only prints in Platinotype at rare intervals, and who is likely in the meantime to lose his sense of the necessary printing depth.

The use of mercury vapour lamps, however, both for lighting purposes and, as quartz lamps, for experimental work in scientific laboratories, puts within the reach of every possessor of such a lamp an almost perfect method of making platinotype prints. Mercury vapour lamps are almost always regulated either by hand resistances controlled by an ammeter or by iron wire ballast resistances enclosed in hydrogen, and consequently the intensity of illumination is very uniform and the prints can be exposed entirely by time. At twelve inches distance from a single Cooper-Hewitt tube taking three and a half amperes, the exposure for an ordinary negative will be about ten minutes, and a number of negatives can, of course, be placed side by side under the long tube at one time. A quartz lamp taking the same current at one hundred and ten volts would require about five minutes' exposure at twelve inches. This suggestion may be found useful by those workers who have a mercury vapour lamp available.

PHYSICS

By ALFRED C. G. E[illegible], B.Sc.

"SPHEROIDAL STATE." — W[illegible] little water is allowed to drop on to a hot plate of [illegible] heated to 300 C about, it is well known that small sph[illegible] are formed which run about on the surface of th[illegible] these finally either diminish in bulk owing to formation of steam or collapse, produce a considerable quantity of steam and spread out on the hot surface if the latter cools to a sufficiently low temperature. The water is said to have gone into the "spheroidal state." The phenomena are well demonstrated in a lecture by means of a silver dish perforated with a hole in the bottom. The dish is heated by a burner, which is removed; a drop or two of water shaken on to the dish continues to move rapidly about on it until the metal has cooled sufficiently when the drop resumes its ordinary condition and can fall out through the small hole in the bottom of the dish. The phenomena can be shown very distinctly by an experiment of Sir James Dewar's. A drop of liquid air is allowed to fall on to small flat bottomed dishes containing such liquids as sulphuric acid, ethyl alcohol, or carbon tetrachloride. In each case the drop of liquid air assumes the spheroidal state and moves rapidly about on the surface of the liquid; but in the case of the more volatile liquids, such as ethyl alcohol and carbon tetrachloride, the drop is surrounded by a cloud of the condensed vapours of these liquids and, as it moves about, is followed by a cloudy tail. The drop impinging on to the walls of the vessel shoots off again as if possessed of perfect elasticity.

When the drop of water or liquid air first touches the hot surface there is considerable production of vapour, which acts as a cushion and prevents the liquid from coming into actual contact with the hot surface. The liquid is then free to assume the spherical drop form, which is due to the attraction of the inner molecules upon the molecules residing upon the outer skin of the liquid; the drop then tends to become spherical, so as to make the ratio of the surface to the volume as small as possible. Imagine a little water to have been allowed to fall on a hot plate; there will be a sudden production of steam, the water will disrupt into several distinct drops which, since they are not actually touching the metallic plate, will retain a spherical form, being buoyed up from the plate by the cushion of steam. Since the under surface of the liquid is heated most there will be more steam formed here, and more molecules will leave the drop at the point nearest the plate; there will be then a continual disturbance of the surface tension equilibrium along the surface of the drop, tending to cause a rotation within the drop. The vapour produced will tend to shoot out from under one side more than another, and so cause an initial movement in some particular direction, and give a definite direction to the rotation of the drop, which is maintained until some other disturbing influence is met with.

The motion of a particle of potassium or sodium when thrown on to water is very similar to that of a liquid dropped on to a sufficiently hot surface. The potassium causes a production of hydrogen and also a considerable quantity of heat; some of the water is vaporised and no doubt the action is carried on between the potassium and a thin jacket of steam, the hydrogen produced acting as the supporting jacket for the pea of potassium.

The motion of the drop, its rotation, its collapse and the curious palpitations it undergoes when rather too much is added to form the true spheroidal state, are very prettily illustrated by Sir James Dewar's experiment. The collapse of the drop is no doubt due to the actual contact of the drop with the hot surface, the surface tension equilibrium being then completely upset, causing the drop to wet the surface; a certain amount of heat is required to vaporise the liquid and the hot surface may be cooled locally to such an extent that insufficient steam is produced to support the drop and isolate it from the plate. The palpitation of a drop spread on the surface of a liquid is due to curious complicated changes in the surface tension due to gradual solution or to local cooling as the case may be. It is well shown by a drop of orthotoluidine containing paratoluidine.

Spherical drops of a liquid are sometimes formed during a distillation on the surface of the liquid which is being evaporated. This, however, is a different affair, the retention of the spherical form being probably due to some difference in composition and hence surface tension of the liquid and the drop.

Mr. Darling's experiments which have been recently described in "KNOWLEDGE" show most beautifully the gradual formation of a drop, which Professor Worthington has studied on a smaller scale photographically. Mr. Darling has devised a method of preserving a sphere of one liquid in another of equal density. A beaker is filled to two-thirds of its height with water at 22° C.; one hundred centimetres of a three per cent. solution of common salt are discharged at the bottom of the beaker, making thereby the lower layers of liquid slightly denser. A large tap funnel containing orthotoluidine at about 20° is inserted so that the stem of the funnel is seven centimetres or so from the bottom of the beaker. By slowly opening the tap the orthotoluidine will form a sphere of quite eight centimetres in diameter suspended within the water and can be shaken free from the stem.

Sulphur when heated on a glass slip, gathers itself into a flat bottomed drop and does not wet the glass, residing on it like a drop of mercury though not quite such a spherical drop could be formed. The drop will solidify in the same shape as it forms as a drop, but above 256° it begins to flatten and "wet" the surface of the glass. The description of these phenomena is due to Mr. W. A. D. Rudge.

In Mr. Darling's experiments on the formation of drops, as the large sphere of aniline hits the bottom of the beaker it flattens out into a disc-like form with rounded edges, in fact the aniline at the bottom of the beaker takes up a shape something like the small drop of sulphur in Mr. Rudge's experiment.

There are many phenomena of a curious and interesting nature connected with surface tension which it is well to call attention to from time to time as their explanations are as yet incompletely worked out.

ALLOTROPY.—Many substances can exist in more than one form; there are at least three distinct "allotropic" forms in which sulphur can occur, or two in which phosphorus exists, to take well-known examples. Thus sulphur exists in a rhombic crystalline form melting at 112·8° C., and in a monoclinic form melting somewhat higher, and being of a browner hue and insoluble in carbon bisulphide. Further there are other less distinct forms, such as colloidal sulphur formed by precipitation of sulphur from thiosulphates by strong acids, and so on, or plastic sulphur which is an extensible gummy brownish-yellow mass formed by suddenly cooling liquid sulphur, and is the latter in a supercooled state, which changes fairly rapidly into rhombic sulphur. A peculiar gummy sticky variety of plastic sulphur rather different in many respects to the other variety can be made by suddenly cooling liquid sulphur by pouring it into liquid air. This variety changes very rapidly, especially on touching it, into very yellow rhombic sulphur.

Much work on allotropy and the equilibrium between the different forms of substances under different conditions of temperature and pressure, has been done by Professor Cohen, of Leyden, and his collaborators. Smits has recently published a theory to explain the phenomenon of allotropy. In the liquid state a substance showing allotropy consists of two kinds of molecules; the number of one kind existing in presence of the other depends on the temperature, and, at any particular temperature, there exists an equilibrium between the two kinds. On rapid cooling, all of the one form does not change as the temperature falls, into the simpler form which is stable at the lower temperatures, because the equilibrium cannot keep pace with the change in temperature; solidification then occurs at a temperature differing from the solidification point of one of the molecular forms. Thus if rhombic sulphur be melted and allowed to cool to 90° C. so that equilibrium sets in at this temperature and then is *suddenly* cooled, the resulting sulphur melts at 110·9° C., or, if equilibrium occurs at 65° C. the melting point is 111·4° C. This points to the existence of two kinds of molecules. In the case of phosphorus which in the pure crystalline state, melts at 44° C. ± ·02° C., the melting point is considerably affected by previous heating at different temperatures, pointing to at least two different forms of molecules being present; the violet form, which is stable below 460° C., can be best accounted for by a discontinuity of the series of mixed crystals of the yellow and red forms. Mercury exists in only one modification, which is in agreement with its single molecular condition adduced from other considerations. Tin and many other elements exist in more than one form. The theory explains readily the phenomena of undercooling and superheating such as occur during rapid cooling and heating. Having mentioned superheating it is interesting to note that the vapour pressure curve of solid bromine, obtained recently by Cuthbertson by optical means, shows evidence of superheating of this solid, the vapour pressure being greater than that of the liquid above the real melting point of the solid.

LIQUID HELIUM.—Kamerlingh Onnes has been making further experiments with liquid helium; he finds the density at 4·29° from the absolute zero (−273·12 C.) to be 0·122 and the liquid appears to possess a maximum density at 2·2°. He has also found that mercury when exposed to a temperature of 3° absolute, such as is produced by liquid helium boiling under reduced pressure, has an exceedingly great electrical conductivity: ten million times greater than at 0° C.; which is rather a surprising result, considering that from the temperature coefficient one would expect a resistance of 40 ohms, instead of $3 \cdot 10^{-6}$ ohms! Other properties, such as magnetic susceptibility, are considerably altered by these very low temperatures, though the electrical resistance of other metals, such as silver, lead, eureka, and so on, is not modified to anything like the same amount as that of mercury. Further experiments to elicit the cause of the phenomena will be awaited with interest.

URANIUM.—The name of Becquerel has been associated with the study of phosphorescence for generations. M. J. Becquerel has been studying for some time the effect of low temperatures on phosphorescence which, in general, causes an increase in the duration of the phosphorescence. However, he finds that the low temperature does not affect the duration of the phosphorescence of uranium nitrate and sulphate—the most phosphorescent of uranium salts; while the acetate, tartate, and so on, show much longer persistence of phosphorescence at low temperatures. Uranium nitrate exhibits marked "triboluminescence"; if a bottle of the nitrate be shaken in the dark, flashes of light will be seen; this is due to cleavage of the crystals accompanied probably by minute electrical discharges which excite the crystals to phosphoresce. It is a very different phenomenon to the sparks of uranium obtained by shaking a bottle of metallic uranium. The latter is a "pyrophoric" property; the uranium particles which are struck off in the shaking actually burn in the air, owing to the avidity with which uranium combines with oxygen; the same phenomenon is found with cerium and iron. I have been able to run a petrol engine using these sparks as the igniting agent for the explosive mixture, but I do not think the method a practical one owing to the injury to the cylinder walls. The triboluminescence of uranium salts is a very different affair from the pyrophoric property of the metal; the triboluminescence is unaffected by an atmosphere of hydrogen, while the pyrophory no longer occurs.

Pitchblende is the main ore from which uranium is obtained; it is also the chief source of radium. It is noteworthy that H. Poole has found that the evolution of heat by a mass of pitchblende is greater than would be expected from its radium content, and the fact that radium generates one hundred and ten calories per hour. The difference between the observed heat generation and the calculated appears greater than would be accounted for by the presence of other radio-active substances such as uranium, thorium and actinium, and might perhaps be due to the more complete absorption of the radium rays in the mass of the pitchblende, than occurs when a measurement of the heat production of pure radium is made.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

THE AWAKENING HEDGEHOG.—When a hibernating hedgehog awakens it rapidly warms itself up. Whether this comes about automatically, or whether it is due to the awakening animal "pulling itself together" seems to be a moot point. The fact is that the animal rapidly warms itself up. The chemistry of this, according to Tanzo Yoshida and Ernst Weinland, is a rapid combustion of glycogen along with a small or moderate quantity of fat. There seems no doubt that the important fuel that so rapidly makes the fire of life burn up is glycogen: the fat is only subsidiary. It must be noticed that in the hedgehog the awakening and the warming-up are two distinct, though associated, processes; for the animal may be wide awake at a lower temperature.

VARIATIONS IN FOWLS' COMBS.—Poultry-breeders know when a hen is going to begin to lay by a rapid and marked increase in the size of the comb. Mr. Geoffrey Smith has shown that this correspondence is exact both in young and adult hens. There may be an increase of 130 per cent. within three weeks, and this does not correspond with a general increase in weight, though the latter usually precedes it. After the laying period, there is a decrease in the comb. The cock's comb does not exhibit these marked fluctuations.

The increase is due to a fatty infiltration of the central connective-tissue core of the comb, and the explanation of the infiltration is to be found in the fact that at the egg-laying periods the blood becomes charged with fatty material which is conveyed to the ovary for the formation of yolk, the excess being deposited in the comb, and probably in other situations. Mr. Geoffrey Smith compares this with what occurs in a spider-crab parasitised by *Sacculina*; the *Sacculina* "forces the crabs to elaborate yolk-material;" this circulates in the blood; it should be stored in the ovaries, but there are none, because of the inhibiting influence of the *Sacculina*, the yolk material; it nevertheless acts as the stimulus for the development of the adult female secondary sexual characters.

HORNBILL'S STOMACH.—Everyone knows of the strange bag of indigestible debris which hornbills periodically eject, but there is a lack of precision in the statements that have been made. An interesting recent contribution by H. C. Curl shows that the deciduous membrane in the great Philippine hornbill, *Hydrocorax hydrocorax*, studied outside the breeding season, is a tough, homogeneous sac formed of colloid material secreted by the glands of the stomach wall.

MOSQUITO SUCKED BY MIDGE.—F. H. Gravely reports finding in the Sunderbunds a small Chironomid fly (*Culicoides*) with its proboscis well-embedded in the abdomen of a mosquito (*Myzomyia rossii*) and evidently imbibing nourishment from it. Probably the *Culicoides* sucks mammalian blood, and was taking it second-hand from the mosquito.

A FRESHWATER RHIZOCEPHALON.—Dr. Nelson Annandale, Superintendent of the Indian Museum, describes a very interesting animal, which he calls *Sesarmaxenos monticola* g. et sp. n. It is somewhat like the well-known *Sacculina* that occurs beneath the abdomen in shore crabs, and it occurred in a similar position on a fresh water crab, *Sesarma thelxinoe*, in a jungle stream in the Andamans, seven hundred feet above sea level. This is the only known freshwater Rhizocephalon, and only the one specimen has been found.

CAMBRIAN SEA-CUCUMBERS.—From the Middle Cambrian, British Columbia, Charles D. Walcott describes the first Holothuroids found as fossils. Some isolated calcareous plates have been previously recorded, but now we have entire animals,—unluckily without any calcareous plates. The most remarkable type, which the discoverer calls *Eldonia*, and describes as free-swimming, has some suggestion of a medusa about it, but Dr. Walcott has given careful consideration to that possibility. Trilobites, Phyllopods, and Medusae were found in the near vicinity. Again, we have striking evidence that there must have been great steps in animal evolution in Pre-Cambrian and early Cambrian ages.

NOTES ON THE AFRICAN FRESHWATER MEDUSOID *LIMNOCNIDA*.—Charles L. Boulenger has some interesting notes on this medusoid from Lake Tanganyika. The stinging-cells of the tentacles are not developed *in situ*, but in the ectoderm of the "nettle-ring," a thickening along the margin of the umbrella. This ring is a factory and a storage-place of the stinging-cells and they migrate thence to the tentacular batteries. There is a well-developed double nerve-ring at the base of the velum, similar in most respects to that of *Limnocodium*, and of other medusoids. Mr. Boulenger shows that the manubrium is undoubtedly functional as a digestive organ. The development of the medusoid buds presents several interesting features, some of which are undoubtedly primitive.

A REMARKABLE SPONGE.—Mr. R. Kirkpatrick, of the British Museum, gives a full and finely illustrated account of *Merlia normani*, a sponge with a siliceous and calcareous skeleton. It was found by Canon Norman, and subsequently by Mr. Kirkpatrick, in sixty to ninety fathoms, off Madeira and Porto Santo. The sponge character of the organism has been called in question mainly, if not wholly, on *a priori* grounds, but the author has examined five hundred specimens. Dr. Weltner supposes that the calcareous structure is that of an unknown organism in which a siliceous sponge has settled. "If this be so," Mr. Kirkpatrick answers, "the said organism has preserved its incognito in a marvellous manner." But we do not follow his reasoning when he says: "If, as I believe, *Merlia* is a siliceous sponge which has taken to forming a calcareous skeleton, then this sponge furnishes a good example of the hereditary transmission of an acquired character." Taking to forming lime is not an "acquired character" in the technical sense; it was probably a constitutional variation.

THE BRITISH ASSOCIATION.

THIS year's meeting will open on Wednesday, August 30th, at Portsmouth, under the presidency of Professor Sir William Ramsay, who will give his address in the Town Hall at 8.30 p.m. *The Hampshire Post* estimates that between fifteen hundred and two thousand members will be present. On Friday, September 1st, at 8.30 p.m., the first Evening Discourse will be delivered by Dr. Leonard Hill, F.R.S., on "The Physiology of Submarine Work." On Monday, September 4th, at 8.30 p.m., the second Evening Discourse will be delivered by Professor A. C. Seward, M.A., F.R.S., on "Links with the Past in the Plant World." Of recent years there has been an outcry against the papers being made so technical that local members, who are not specialists, cannot appreciate them. It has been customary for Section D (Zoölogy) to arrange a popular lecture, and this year two appear in the programme, namely, one on "Fairy Flies," by Mr. Fred Enock, and the other on "Fossil Reptiles," by Dr. Andrews. "Rain" will be considered by Dr. H. R. Mill in his lecture to the operative classes, and some very attractive excursions have been arranged to Arundel Castle, to the New Forest, and to the Isle of Wight.

THE FACE OF THE SKY FOR SEPTEMBER.

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

THE SUN.—On the 1st the Sun rises at 5.13 and sets at 6.48; on the 30th he rises at 5.58 and sets at 5.43. The Sun enters the sign of Libra on the 24th at 4 a.m., when autumn commences. The equation of time is negligible on the 1st and 2nd, hence these dates are convenient for the adjustment of sun-dials, as only the longitude correction is needed. Sunspots and faculae are very sparse, although occasionally a spotlet or a few faculic markings may be seen. The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre of Disc N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Sept. 3 ...	21° 34'E	7° 14'	299° 20'
„ 8	22° 44'E	7° 15'	233° 18'
„ 13 ...	23° 44'E	7° 13'	167° 17'
„ 18 ...	24° 37'E	7° 8'	101° 16'
„ 23 ...	25° 19'E	7° 1'	35° 17'
„ 28 ...	25° 51'E	6° 49'	329° 17'
Oct. 3	26° 13'E	6° 35'	263° 19'
„ 8 ...	26° 25'E	6° 18'	197° 20'

A suitable diagram, for this period, for the projection of the solar disc is shown on page 310 of last month's issue.

THE MOON:—

Date.	Phases.	H. M.
Sept. 8 ...	Full Moon ...	3 57 p.m.
„ 15 .	Last Quarter ...	5 51 p.m.
„ 22	● New Moon ...	2 37 p.m.
„ 30	First Quarter	11 8 a.m.
Oct. 8	Full Moon ...	4 11 a.m.
Sept. 2	Apogee	7 18 a.m.
„ 17	Perigee	6 0 a.m.
„ 30	Apogee	2 30 a.m.

OCCULTATIONS.—The only naked eye star occulted during the present month and visible from Greenwich, is the 5½ magnitude star 43 Ophiuchi. The occultation occurs on September 1st, disappearance being at 7.58 p.m., and re-appearance at 8.4 p.m.

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
Aug. 30	11 30	S 1° 28'
Sept. 9	11 3	N 2° 14'
„ 19 ...	10 46	7° 16'
„ 29 ...	11 19	N 6° 6'
Oct. 9 ...	12 29	S 0° 7'

Mercury is in inferior conjunction with the Sun on the 9th. After this date the planet is a morning star in Leo and is at greatest westerly elongation of 17° 52′ on the 25th, on which date he rises at 4 a.m., or nearly two hours in advance of the Sun. The elongation is thus a somewhat favourable one for seeing the planet.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
Aug. 30	11 45	S 6° 14'
Sept. 9	11 28	5° 53'
„ 19	11 7	3° 30'
„ 29	10 52	S 0° 26'
Oct. 9 ...	10 52	N 1° 50'

Venus is in inferior conjunction with the Sun on September 15th, and throughout the month is unobservable, as she appears too near the Sun.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
Aug. 30 ...	3 41	N 17° 42'
Sept. 9 .	4 0	18° 49'
„ 19 ...	4 16	19° 44'
„ 29 ...	4 28	20° 28'
Oct. 9 .	4 36	N 21° 3'

Mars is an evening star, rising N.E. by East at 9.30 p.m., on the 1st, and at 8 p.m. on the 30th. The planet appears between Aldebaran and the Pleiades, somewhat nearer the former.

The planet is becoming more favourably placed for observation and is increasing in brightness, the apparent diameter of the disc increasing from 11″·4 to 14″·0 during September.

As seen in the telescope the planet appears gibbous, 1″·6 of the disc being unilluminated. The south polar cap is visible and appears fairly bright; but other markings are difficult to delineate in telescopes of three or four inches aperture, even if powers of two hundred or three hundred be used.

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
Aug. 30 ...	14 29	S 13° 44'
Sept. 9	14 35	14° 15'
„ 19 .	14 42	14° 48'
„ 29 .	14 49	15° 23'
Oct. 9 ...	14 57	S 15° 59'

Jupiter is an evening star setting W.S.W. at 8.45 p.m., on the 1st and at 7 p.m. on the 30th. The planet is very little observable as he is rather low down at sunset, and is soon lost to view in the evening haze.

No satellite phenomena are observable, as the planet appears in too bright a portion of the sky when any of the transits or eclipses occur.

The configurations of the Satellites as seen in an inverting telescope and observing at 7 p.m. are as follows:—

Day.	West.	East.		Day.	West.		East.	
1	2	134		16	231		4	
2	32	4	● 1	17	3	⊙	24	
3	31	42		18	3		124	
4	34	21		19	213		4	
5	421	3		20	2		13	
6	4	13	● 2	21	41		23	
7	41	23		22	42		13	
8	42	13		23	4213			
9	4 $\frac{3}{2}$ 1			24	43		12	
10	$\frac{4}{3}$ 1	2		25	43		2	● 1
11	34	$\frac{1}{2}$		26	4231			
12	213	4		27	42		13	
13		134	● 2	28	14		23	
14	1	234		29		⊙	$\frac{1}{2}$ 3	
15	2	134		30	21	⊙	4	

The circle (○) represents Jupiter; ⊙ signifies that the Satellite is on the disc; ● signifies that the Satellite is behind the disc or in the shadow. The numbers are the numbers of the Satellites.

SATURN:—

Date.	Right Ascension.	Declination.
	h. m.	
Sept. 1	3 14	N 15° 20′
„ 16	3 13	15° 23′
Oct. 1	3 11	N 15° 12′

Saturn rises in the E.N.E. at 9.10 p.m. on September 1st, and at 7.10 p.m. October 1st. The planet appears as a conspicuous object in the evening sky looking East, and is situated about midway between Aldebaran and α Arietis, where he may be observed shining as a bright star free from scintillation, but with a peculiar lustre which has given it the name of the Leaden Planet. The telescope view of the planet with his rings is superb, and even when other objects are difficult to define, Saturn exhibits crisp detail, well repaying observation. The ring is visible in quite small telescopes, such as an ordinary good deer-stalker, with a high power eyepiece, and in a good three-inch telescope the ring is visible with a power of about fifty, and the belts on the planet's surface with a power of about eighty; using higher powers the division in the ring may be seen. The diameter of the outer major and minor axes of the ring system are respectively 45″ and 17″, so that the ring appears well open, being inclined to our line of vision at an angle of 22°, the southern surface being visible.

The planet has eight satellites: of these, Titan, (mag. 8·5) can be observed with a good objective of two inches aperture, Iapetus (mag. 9·12) may be seen at his westerly elongations with a telescope of three inches aperture, which is also sufficent to show Rhea (mag. 9·5) and Tethys (mag. 10) whilst Dione (mag. 10·5) requires an aperture of four inches. The three other satellites require larger telescopes, since their magnitude is less than twelve.

URANUS:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Sept. 1 ...	19 51 55	S 21° 32′ 6″
Oct. 1 ...	19 49 57	S 21° 36′ 39″

Uranus though rather low down in the sky, is fairly well placed for observation during the early evening, and is due South shortly after dusk. The planet is situated in Capricorn in a part of the sky devoid of good reference stars, though the star σ Capricorni is about 2° to the N.E. The planet is at the stationary point on the 6th October, after which his motion is direct or Easterly.

Uranus can just be discerned with the naked eye on clear nights, but the slightest optical aid is sufficient to make the planet clearly visible.

The planet is in conjunction with the moon at 4.37 p.m. on the 4th, Uranus being 4½° to the north.

NEPTUNE:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Sept. 1 ...	7 38 40	N 20° 56′ 10″
Oct. 1	7 41 20	N 20° 49′ 23″

Neptune does not rise till midnight on the 12th; thus for all practical purposes the planet is unobservable.

METEORS:—

Date.	Radiant.		—
	R.A.	Dec.	
Sept. 3-8	353	N. 30	α Andromedids. Very swift.
„ 5-15	62°	N. 37°	ε Perseids. Swift, bright streaks.
„ 21-27 ..	87°	N. 43	β Aurigids. Very swift.

Minima of Algol occur on the 2nd at 7 p.m., and on the 22nd at 8.30 p.m.

The period is $2^{d}\ 20^{h}\ 49^{m}$, from which other minima may be calculated.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—ζ Ursae Majoris XIII.^{h} 20^{m}, N. 55° 23′, mags. 2, 4; separation, 14″·4.

ζ Aquarii XXII.^{h} 24^{m}, S. 0° 32′, mags. 4, 4; separation, 2″·9. Both components are yellowish.

β Cygni XIX.^{h} 27^{m}, N. 27° 46′, mags. 3, 5; separation, 34″. The brighter component is yellow, the other blue; very easy double in small telescopes with a power of 20.

Cluster (M 11) in Aquila or Antinous. R.A. $18^{h}\ 46^{m}$; Dec. S. 6° 23′. Very pretty object for three or four-inch telescopes; it is an easily resolvable fan-shaped cluster, with an eighth magnitude star in apex and an open pair of the same magnitude just outside it.

THE BRENT VALLEY BIRD SANCTUARY.

A MOST successful season has been experienced in the Bird Sanctuary, and even now there is still (August 28th) a bullfinch's nest containing eggs. It has been suggested by Mr. Robert Read, M.B.O.U., that it may have been built by a pair of this year's birds, and should they prove to be poorly coloured it will be additional evidence in favour of the supposition being correct. The nesting boxes made from logs similar to those illustrated and described in the April number of "KNOWLEDGE," which were tested, were with very few exceptions tenanted, though many were put in quite exposed situations. A large number of these boxes which were sold were also used to good effect in the majority of cases, and the profits have been applied to the upkeep of the Sanctuary. The wood is interesting at all times of the year, and during the past week the following birds have been seen: Kestrels, green and greater spotted woodpeckers, nightjar, kingfisher and turtle dove. The Honorary Secretary of the Committee is Mrs. Wilfred Mark Webb, and her address is "Odstock," Hanwell, London, W.

THE NEW ASTRONOMY.

I. THE STORY OF NOVA PERSEI.

By PROFESSOR A. W. BICKERTON.

As the twentieth century dawned, an astronomical event occurred that had not had its equal in the history of celestial observation for some three hundred years. A brilliant temporary star suddenly blazed out in the Northern hemisphere, and as these evanescent flashes are called Nova or New Stars, this star was called the New Star of the New Century, and because it was in the constellation of Perseus, it was called Nova Persei.

Nothing in the whole realm of Nature is so wonderful as this event, the bursting out of a giant sun, its then increasing with amazing rapidity, until it is sometimes many scores of thousands of times the brilliancy of the magnificent luminary that keeps the earth in its orbit.

And no other celestial event has so fascinated the minds of men, and drawn them to study the heavens, as these exploding suns. It was one of these brilliant portents that caused Hipparchus to draw up his historic list of the stars. It was another that caused Tycho Brahé to leave the lamps and furnaces of his laboratory, and come out into the open to study the celestial vault and make his wonderful measurement of the places of the planets. It was a temporary star that drew Galileo into that war of words and wonder of achievement and ideas that cost him so much, and also made him teach the Copernican doctrine of the moving earth.

And again this year, the new star in the constellation Lacerta, discovered by Mr. Espin, has caused an immense amount of discussion not merely amongst the learned societies, but even in the popular newspapers all over the world. It is commonly thought that the star of Bethlehem was a new one.

Speaking of these flashing bodies the late Professor Newcomb says:—"The so-called new stars which blaze forth from time to time, offer to our sight the most astounding phenomena ever presented to the physical philosopher." Carl Snyder says:—"Could they be closely regarded, the blazing up of these novae would doubtless be, in mere extent, the most impressive spectacle the realms of Nature afford." That very able astronomer, the late Miss Agnes Clarke says:—"What they were, what they are, what they become, are all difficult questions to answer. But the crux of the whole problem concerns the manner of their vivification. A body previously inert is transformed wellnigh instantaneously into a radiative centre of immeasurable intensity. How is the change effected?"

No human being is capable of conceiving the vastness of this phenomena. To us, the earth is an immense body; we know it weighs more than six thousand million of million of million of tons. Our Sun is more than a million times the size of the Earth, and those vast globes of fire must often be many scores of thousands of times the volume of the Sun. Yet Nova Persei rose from invisibility to its maximum in less than forty-eight hours, and in a few months was again invisible to the naked eye. The stupendous nature of the phenomena and their evanescent character constitutes their chief wonder. Newcombe speaks of their impenetrable mystery. He says:—"The cause of these outbursts is a question of transcendent interest, the answer to which science has not up to the present time been able to offer any suggestions not open to question." Miss Agnes Clarke says:—"That even the most promising explanation is not merely unscientific, but outrageous to common sense."

There are an immense number of explanatory suggestions in various books on astronomy, all of which are absolutely puerile when we regard the insufficiency of energy to explain the phenomena. The question then occurs, Can any solution to their mystery be suggested? Is there any storehouse of energy that can be laid under contribution to supply fuel for so stupendous a conflagration? And the answer is clear and explicit. There is.

In the collisions of suns, we have a sufficiency of energy to account for the whole phenomena. Hence a detailed study of the phenomena of solar collisions offers the most promising ground for the solution of the mystery of these immeasurable conflagrations.

Impact, a Law of Nature.

A very superficial study shows us that solar collisions cannot be looked upon as accidental, chance, or mere random occurrences. Mutual attraction, and many other agencies, something like a dozen in all, have been investigated, and the conclusion is forced upon us that the number of solar impacts that must be produced by these many agents are hundreds of thousands of times more numerous than mere random encounters. The next thing that shows itself in our investigations is, that not one of all these collisions that are brought about by attraction, and so on, can be a direct centre-to-centre impact. The bodies must move in curved orbits, and hence the collisions so produced must be of a tangential or grazing character.

It was also shown that the extreme velocities produced by attraction in all cases of colliding suns must be of the order of hundreds of miles a second.

That is, if trains possessed this velocity, their collision would have an energy hundreds of millions of times greater than that of colliding express trains. It cannot be imagined that a slight graze of suns passing one another with these speeds will stop them. The portion actually in one another's paths will be shorn away, and the torn suns will proceed on their journey with orbits modified by the attraction of the newly-formed third star. The phenomena of these torn suns may be of the most varied character. They explain many of the characteristics of the wonder stars and double stars of the heavens. In telling the story of Nova Persei they do not greatly concern us, but must be referred to when we study the wonderful spread of light that flashed through the previously existing nebula, at whose centre Nova Persei appeared.

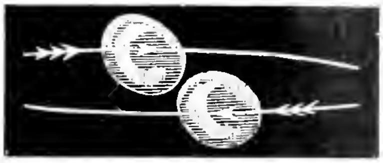


Figure 1.

A pair of Stars distorted and coming into impact.

Figure 2.

A pair of Stars in impact.

Figure 3.

The Stars passing out of impact, and the formation of a third body.

The Theory of the Third Body.

It is the properties of the coalesced portion torn from the two passing suns, that correspond with, and explain in the minutest detail, every one of the multifarious observations that astronomers have made of Nova Persei. The deductions that explain these observations were published fully a score of years before the wondrous star appeared.

The accompanying Figures (1–5) have been photographed from diagrams made and published more than thirty years ago, and show kinematically the progress of an impact during its first few hours. Figure 4 is probably the most instructive of the whole, because it shows not merely the form and motion of the third body, but also the distribution of the adherent heated matter, clinging to the two retreating suns.

The most important characteristic of this third body is its stupendous, its absolutely abnormal and explosive energy. Ritter and myself have shown that the energy of the critical velocity of a pair of similar completely colliding gaseous suns, is exactly one half of that necessary to produce an infinitely diffused nebula. It must be remembered that similar chemical elements, colliding with similar velocities, produce the same temperature, and hence, however small the portion torn away, if it be of the same composition, whether small or large, it will have the same temperature as though there were a complete collision. Thus, contrasting a complete collision with a graze of one-tenth, in the one case we have the whole matter heated to a certain temperature and in the other case, one-tenth is heated to the same temperature. In the third body there is one tenth the mass, and one tenth the heat; hence the temperature is the same as with complete collision. The speed of a particle possessing sufficient power to enable it to escape completely from a body, is called the critical velocity. Now the critical velocity depends to a large extent on the mass of the attracting body. Thus a body having a velocity of one-and-a-half-miles a second could escape the moon, a particle with a speed of seven miles a second could escape the earth: whilst an asteroid requires to have a velocity much over three hundred miles a second to entirely escape the sun. Consequently with two bodies of the same temperature and different mass the molecules may move fast enough to get entirely free from the body of small mass, and be retained by the body of large mass. The third body is a small mass at an exceedingly high temperature, as high as if the whole of the two suns had collided, and hence, if it be only one-tenth of the mass of a sun formed by complete collision, this third star possesses many times more energy than is necessary to make it explode.

The new star formed by a grazing collision of suns, being explosively hot, at once begins to expand at something like a million miles an hour. When first formed it is a body of astonishing brilliancy, and as this vast bonfire grows it becomes more and more brilliant. The maximum of brilliancy is quickly reached, but the velocity of the particles has scarcely diminished at all, and so they go diffusing in space, until the mass forms a rare nebula; the luminosity gradually diminishing from maximum until the star becomes invisible to the naked eye. The great energy of the molecules is not equally distributed amongst the elements, for it is a property of molecules that when at the same temperature each

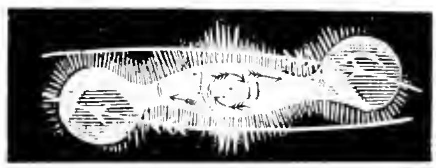


Figure 4.

Showing entanglement of matter in each body.

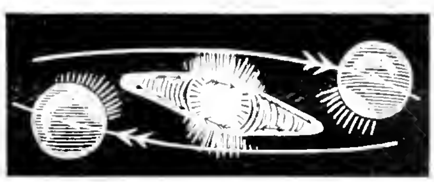


Figure 5.

Two variables and a temporary Star.

atom possesses the same energy. An atom of lead weighs two hundred and seven times as much as an atom of hydrogen, and yet when both the atoms are at the same temperature each has the same energy; one has great mass, the other great velocity. Immediately after the collision all the elements have the same velocity, that is at the moment of the formation of the third body, lead is excessively hot, and hydrogen much cooler. As equality of temperature is gained, the hydrogen robs the heavier elements of their energy, and may attain an extraordinary velocity. The velocity of hydrogen actually recorded in the case of Nova Persei, was fully a thousand miles a second. In this way the light gases escape away from the heavier ones, and leave them behind, the light elements forming vast ensphering shells constantly expanding outwards. The heavy gases tend to form an intensely brilliant nucleus, that has not sufficient energy for complete dissipation. Hence there is a limit to its expansion. But the outward momentum of the particles will carry them beyond the limit of equilibrium. When they come to rest, gravitation will cause the mass to shrink again; as it shrinks it will increase in brilliancy; but again the momentum of the molecules will carry them past the position of equilibrium, and this oscillation may go on for an indefinite number of times, until an approximate balance is obtained. This balance is not one of rest; for, as will be shown immediately, the third body must be in a rapid state of rotation, due to the conflicting forces of impact. Let us examine the light curve of the third body and we shall see that the curve deduced by dynamical reasoning (see Figure 9) is absolutely similar in every respect to the curve drawn at South Kensington, from actual observation of Nova Persei.

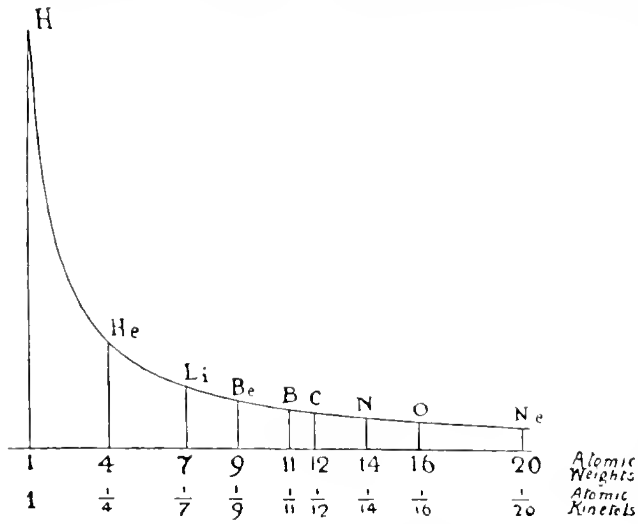


Figure 6. Atomic Kinetol.

Calculation shows the impact, that is, the initial explosion, takes an hour, and the body is at once of transcendent brilliancy. It then expands with extreme rapidity, hence the light curve to commence with is almost vertical. It increases with great speed for a short time, remains for a while approximately at the same height, and then begins to fall, falling much more slowly than it rose. Presently contraction sets in, during which time the curve rises, because, under the influence of pressure, the light becomes more intense. Then again expansion ensues with lessened luminosity, to be again followed with another period of compression, with increased light. And so the curve continues to oscillate for a period that is dependent on a vast number of special circumstances, which must vary with each nova. In the case of Nova Persei the oscillations were very long sustained.

The Form of the Third Body and its Rotation.

It will readily be seen that the light gases on the outside of the two impacting suns will be the first to meet, hence, as the material crowds in upon itself, this light material will, when the body is first formed, be at its centre. As we examine the effect of the collision on each of the two suns, we see that it must form a long valley in each; this valley gradually becoming deeper and deeper. As the two torn suns leave each other, the material deep down in its mass will be dragged along, and much of it will be left adhering to the end of the vast valley, that has been cut in each sun. As the suns leave one another the new third body stretches out into the spindle form, and the distribution of material will now be that the lightest elements will be at its centre, the somewhat heavier ones will surround these light gases, whilst the heaviest portion of the third body will be at the ends of the spindle. These ends may consist of elements whose atomic weight will seldom be less than forty or more than seventy. The reason it will not contain very heavy elements is because, for various reasons, it can be shown that when there is an exceedingly deep graze the three bodies do not part company, but form a rapidly rotating mass, that is probably what is known as a Wolf-Rayet star. I have named such a deep collision a case of Whirling Coalescence. Owing to this fact of the difference of the quantity of material meeting on opposite sides, the third star is set rotating. The mountainous mass of material left on each of the torn suns also in these scarred globes produces rotation. These complex phenomena explain many characteristics of variable stars, not however of interest in connection with Nova Persei. This peculiar property possessed by the light gases, of sorting themselves into concentric shells according to their speeds, we have called Atom Sorting or Selective Molecular Escape. The principle here introduced was fully studied in 1878, and the late Dr. Johnstone Stoney devoted a considerable amount of time to showing its influence with regard to hydrogen and other light elements, in our atmosphere.

The principle is of supreme importance in connection with the impact theory of cosmic evolution, and must be clearly understood. To simplify the conception a new dynamical term is necessary: it is an expression for the amount of energy that is possessed by a unit mass of any body. The necessity for, and the meaning of, the term is fully discussed on pages 15, 16 and 17 of "The Birth of Worlds and Systems," in Harper's Library of Living Thought. The new term is Kinetol. The kinetol possessed by monatomic molecules of the different elements when at the same temperature, is inversely as their atomic weight. Thus, the kinetol of hydrogen being taken as unity, the kinetol of helium would be one-fourth, of oxygen would be one-sixteenth and lead one two-hundredth-and-seventh part. The diagram (see Figure 6) represents the atomic kinetol of some of the lighter elements. Popularly speaking, kinetol is the power to escape from a force.

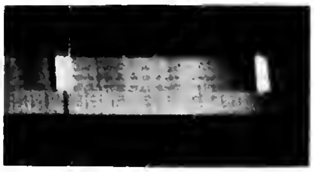


FIGURE 7.
Part of a spectrum of Nova Persei taken on the 5th of March, 1901, at South Kensington, and reproduced by kind permission of Sir Norman Lockyer, from his paper in the "Proceedings of the Royal Society," Volume 68.

The spectra of the stars shows that hydrogen is altogether the most prominent element that exhibits itself, and consequently hydrogen is the element which is most important to study.

It is probable that in almost all grazing impacts hydrogen will possess from fifty to a hundred times the kinetol necessary for it to completely escape the attraction of the third body. The whole work that it will do in completely escaping will not lessen its velocity one per cent. This fact furnishes a complete explanation of the phenomenon that has proved so puzzling in connection with the retention of velocity as shown by the spectrum of hydrogen in Nova Persei and other new stars.

THE SERIES OF SPECTRA OF THE THIRD BODY.

It has already been shown how exactly similar are the deduced light curves of the third body and the observed light curve of Nova Persei. The contrasted series of spectra are of much greater complexity, yet show the same actual identity of character. On the one hand, there is not a single observation in all the spectrograms that has not been dynamically deduced. And, on the other hand, although the observation of no single observatory seems to satisfy all the deductions made, yet, taking the whole world, the observations leave but little to be discovered. There are still a few minor deductions remaining to be confirmed by observation. Let us examine the salient characteristic of the spectra that must be produced by the successive phenomena of the third body. Clearly at first a mass so hot and under such stupendous pressure will give a continuous spectrum. Presently, as hydrogen escapes from the interior and forms a close atmosphere, the continuous spectrum will be crossed with black absorption lines of hydrogen.

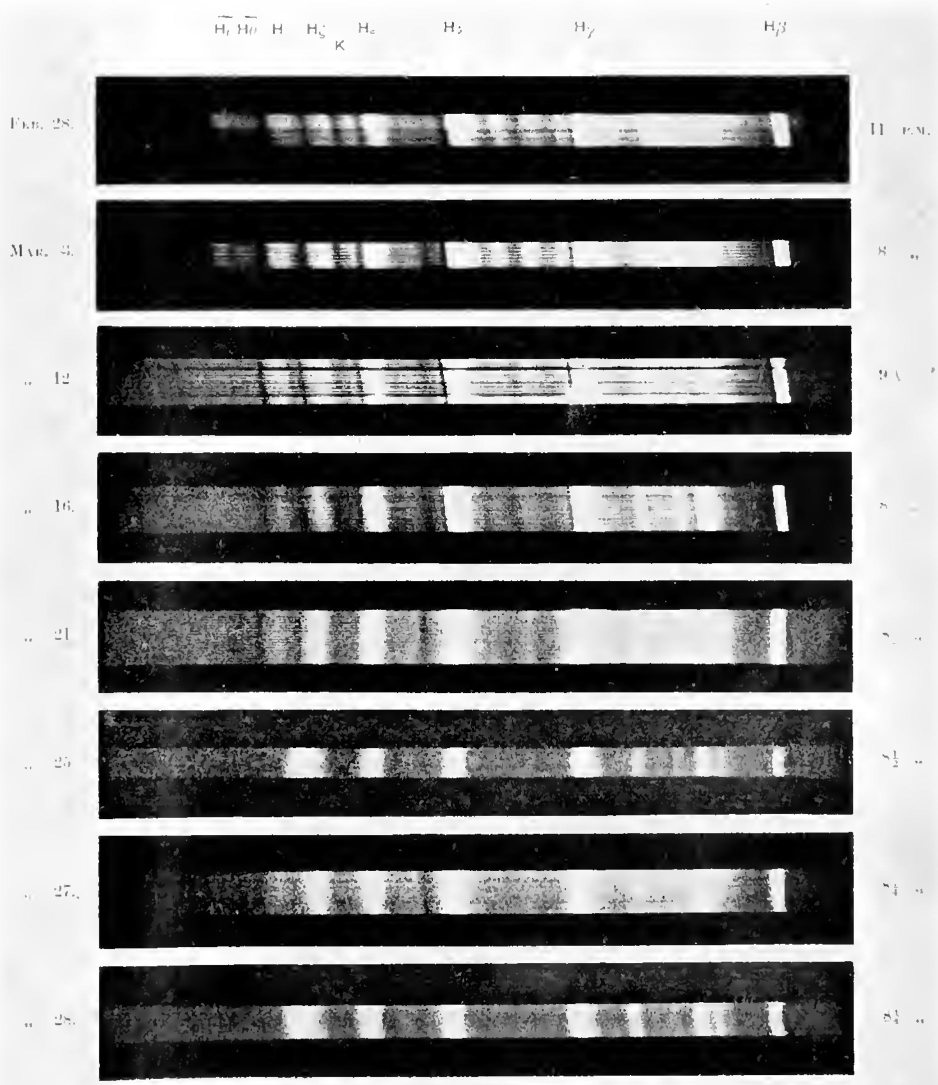


FIGURE 8.
Photographs of the Spectrum of Nova Persei, 1901, taken at Stonyhurst College Observatory, and copied from a Plate in "KNOWLEDGE" for January, 1902.

Soon, however, the hydrogen escapes and becomes free, and forms an ensphering shell many diameters of that of the brilliant nucleus of heavy matter. This brilliant gas shell, as it is expanding in all directions, is moving at every angle to the line of sight, both from and towards us. Hence what would, were the gas in a fixed position, be a bright line, becomes an exceedingly broad band, indicating at its extreme edges atomic velocities of a thousand miles away from and towards us. Hence we now have a continuous spectrum covered with brilliant bands of the hydrogen series. But the part of the shell of hydrogen that is immediately in front of the brilliant nucleus, must absorb its isochromatic rays and produce reversion. The hydrogen coming our way has its wave length shortened, that is, displaced towards the violet; consequently each one of these bright bands will have a dark band edging it, on the side towards the violet. Many observatories all over the world obtained spectrograms of Nova Persei, when it was exhibiting this spectrum. Those of South Kensington and Stonyhurst were both singularly perfect, and examples are given here (see Figures 7 and 8), and it will be seen that observation exactly corresponds with deduction. The next deduced change in the spectrum of the third body will be that as the speed of expansion of the ensphering shell does not appreciably diminish, the ratio of the portion of the sphere that is in front of the absorption nucleus must get to be extremely small. Consequently the dark lines edging the bright bands, although they will not alter their position, will become exceedingly thin and hair like. Later on, the tenuity of the gas shell will be so extreme that it will possess no absorbing power and will disappear. A little later on the vast ensphering shells of hydrogen will become so rare, that molecular encounter will diminish so much that the lessened luminosity will cease to photograph itself, and so the bright bands will die out. The atmospheric conditions do not seem to have been satisfactory at South Kensington, when these stages of Nova Persei occurred; but they show themselves beautifully in the Stonyhurst spectograms. Father Sidgreaves, the eminent astronomer of Stonyhurst, has stated:—"That he has no doubt at all but that Nova Persei actually was the third body, torn from a pair of colliding suns." He is quite opposed to the opinion expressed by some astronomers in *The Times*, that the phenomena of Nova Persei might be thought to be explained by the idea of a dense body passing into a nebula. He says the light could not grow up so suddenly. It would take an ordinary star fully a thousand years to pass from the outside to the centre of the Nova Persei nebula, whereas Nova Persei rose to a maximum in less than two days. This rapidity of formation renders it certain that if Nova Persei was the result of any kind of collision, it must have been the collision of compact bodies. There are fully a dozen other points of coincidence between deduced and observed spectral phenomena, but there are two that are extremely interesting and about which we must say a few words. For various physical reasons, already hinted at, I assumed that the ends of the spindle would consist of elements having atomic weights approximately that of iron and titanium, and because iron was a very abundant element in nature, I thought that the spindle ends would largely be made up of iron. Of course, the speed of the iron molecules would be much less than that of hydrogen, but as hydrogen was not escaping from the ends of the spindle, the iron would not have its kinetol lessened, and because its light would not pass in front of the nucleus, save under very exceptional conditions, the lines of iron would not have a shadow band on the end towards the violet, and would be moderately broad, yet not as broad as hydrogen. Figure 7 (given on page 365) shows part of a South Kensington spectrogram, a set of

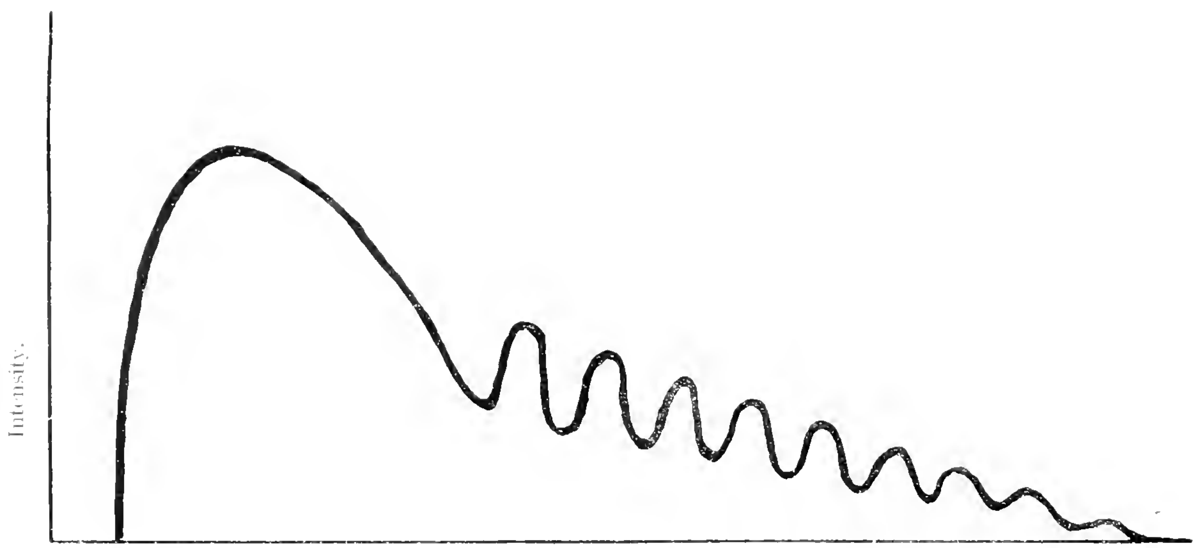


FIGURE 9. Deduced Light curve of the Third Body.

exactly such lines. On inquiry I ascertained from the observers at South Kensington that many of these lines certainly did come from iron, and there were also some that came from titanium.

The observers at South Kensington noticed a remarkable fact with regard to the broad hydrogen lines. They seemed streaky: towards the edges there seemed to be especial bands of greater intensity. In the theory of the third body, I have shown there is a line along which, in both directions, gas will be extruded. Axial Extrusion is the name we have given to this phenomenon. In the study of the origin of the universe, it is assumed to account for the origin of the white polar nebula that is distributed at each of the poles of the Milky Way. This principle also permits the hydrogen gas that is compressed at the centre of the third body to be expelled in the two directions polar to the plane of rotation. Doubtless it is these two vast streams of ejected hydrogen that give these two ribbons of intensity on the broad hydrogen bands. The observers at South Kensington also noticed minor ribbons of luminosity, and a careful study of the form of the third body shows other weak places, where, in a less effective way, hydrogen may be sent out in vast streamers.

There are quite a sheaf of other points of interest and coincidences, and some show themselves in connection with the pre-existing more or less annular spiral nebula that was lit up by the flash of Nova Persei, and that showed itself progressively in extending circumferences. Light, with its speed of one hundred and eighty-six thousand miles a second, for months progressively lit up the coils of that stupendous nebula, which I believe had been left behind in a previous impact of the same two gigantic suns, that by recurrent impact had produced the flash of Nova Persei. Deduction suggested also that extruded gas from the third body should generally pass through the stage of being a planetary nebula. And here, again, we have the same coincidences, but our account is already too long and we must conclude by stating that from its extreme brilliancy and its evanescence, Nova Persei was almost certainly formed by a very small ratio graze of two extremely massive suns, whilst Nova Aurigae was a moderately-deep graze of suns of much smaller mass. In the next number the coincidences of astronomical phenomena, with the deductions relating to the two torn suns, will be debated.

CYTOLOGY AND EMBRYOLOGY IN THE ENCYCLOPAEDIA BRITANNICA.

THE scientific articles in the last edition of "The Encyclopaedia Britannica" cannot fail to be of the greatest interest to the readers of this journal. They are clear and concise, and thoroughly up-to-date. That on Cytology, is of the highest importance, for "it is to the cell that the study of every bodily function sooner or later drives us." Space will only permit us to refer to one of the many interesting points elucidated in this article. Various views have been expressed as to which of the complicated processes which take place during nuclear division is fundamental and initiative. "The experiments of T. H. Morgan and E. B. Wilson, in which numerous centrosomes and asters are caused to appear in unfertilised sea-urchin eggs by a brief immersion in a 13 per cent. solution of magnesium chloride in sea-water, as also the possibility in many cases that even in normal fertilisation the cleavage centrosomes may arise *de novo*, make it no longer possible to regard the centrosome as a permanent cell-structure." "In the spermatogenic cells of *Ascaris*, A. Brauer has shown that the chromatin granules divide while still scattered over the nuclear reticulum and before either the formation of a spireme thread or the division of the centrosome." Clearly then, the formation of the achromatic spindle has for its purpose, not the division of the chromatin, for this has already occurred, but its distribution to the two daughter nuclei.

The article on Embryology is likewise full of interest. The question of the determination of sex has been much debated, but the balance of evidence, we are told, appears to favour the view that sex is an unalterable inborn character and does not depend on nutrition or other external condition. "Thus those twins which are believed to come from a splitygote are always of the same sex, members of the same litter which have been submitted to exactly similar conditions are of different sexes, and all attempts to determine the sex of the offspring in the higher animals by treatment have failed."

Various structures and organs appear during development to disappear again without representation in the adult form, but the writer of the article on Embryology gives little quarter to the recapitulation theory which attempts to explain this by asserting that the embryonic history of the individual is but a shortened Recapitulation of the ancestral history or history of the race. "A disappearing adult organ is not retained in a relatively greater development by an organism in the earlier stages of its individual growth unless it is of functional importance to the young form." Gills, for instance, are retained in the tadpole while they are lost in the frog, because they are of use to the tadpole, that is, to the larval form. Where organs are retained in a better developed state in the embryo than in the adult, it is simply because they have been of use to the ancestors in their larval form, though of no use to them in the adult, and have become in this way impressed upon their development; and only if they have been of value to the larval form in former generations is there any possibility of their retention.

REVIEWS.

CHEMISTRY

Triumphs and Wonders of Modern Chemistry. By GEOFFREY MARTIN, B.Sc., M.Sc., Ph.D. 358 pages. 76 illustrations. 8-in. × 5¼-in.

(Sampson Low, Marston & Co. Price 7/6 net.)

No one need accuse Chemistry of being a dry subject after reading this book of Dr. Martin, with its wealth of illustrative detail and its power of stimulating the imagination of the reader. Obviously it has not been written with the aim of scoring marks in the examination schools, and the author is therefore at liberty to dwell upon matters of interest which would not "pay" if regarded from that utilitarian point of view. There is nothing in the book that need be beyond the grasp of those who have no previous knowledge of chemistry, while the chemist may learn much by reading the author's vivid descriptions of the most recent chemical theories and their industrial applications.

The book opens with a chapter upon the mystery of matter, in which are ably summarised the principal theories as to nature of the atoms, and this is followed by chapters dealing with the properties of the atoms, the evolution of the elements, and the nature of chemical reaction.

Then come separate chapters upon water, air and some of the principal elements, including hydrogen, oxygen, nitrogen, sulphur, carbon and phosphorus, and the book concludes with an admirable account of fire, flame, and the principles of spectroscopic examination. As instances of the manner in which the book has been brought up-to-date it may be mentioned that the latest theories upon radio-activity are discussed, and that there is a capital description with illustrative photographs of the industrial methods of fixing nitrogen from the air.

Quotations from the poets and from the whole range of ancient and modern literature are found in plenty all through the book, and help not a little in the author's successful endeavour to make the science a living thing. If we may venture upon a criticism, however, we cannot help feeling that in many cases the author's illustrative analogies fall wide of the mark. For example, the comparison between the combinations of atoms in a chemical reaction with the coming together of the partners in a ballroom appears forced, and does not help to make the subject any clearer. The book is abundantly illustrated with excellent photographs, and with numerous sketches. It is a pity that most of the latter are out of drawing and in a future edition the author would be well advised to have them redrawn by an artist.

These are minor drawbacks, however, and taking the book as a whole we can warmly recommend it either as a present that will give pleasure to a boy or a girl, or as a reliable and most readable source of information for everyone who is anxious to know something of the constitution of the world in which we live.

C. A. M.

The Phase Rule and its Applications.—By A. FINDLAY, M.A., D.Sc. Text Books of Physical Chemistry. 356 pages. 134 illustrations. 7½-in. × 5-in.

(Longmans, Green & Co. Price 6/-.)

For the information of the non-chemical reader it may be explained that according to the *phase rule* of the late Professor Gibbs, the conditions of equilibrium in a given system of substances depend upon the relationship between the number of phases and of components simultaneously present. For example, ice, water and water vapour are different *phases* of the same substance—water, and may co-exist as different phases in a system.

When first the phase rule, which has proved so fruitful of result in the study of solution and chemical reaction, was enunciated, it was expressed in such mathematical terms as to be grasped only by those with a mathematical training, and the author of this book is to be congratulated upon the very lucid way in which he has presented a complex subject in a non-mathematical shape. Every step is made abundantly clear and each difficulty is smoothed away, and the student of chemistry or metallurgy whose work involves a knowledge of this branch of physical chemistry cannot do better than procure a copy of this exceedingly useful text book. It has deservedly reached its third edition, and has been brought up-to-date, so as to embody the results of the most recent researches upon such subjects as the metastability of metals.

C. A. M.

BOTANY.

British Plants—Their Biology and Ecology.—By J. F. BEVIS, B.A., B.Sc., and H. J. Jeffery, A.R.C.Sc., F.L.S. 334 pages. 115 illustrations. 5½-in. × 8¾-in.

(Alston Rivers. Price 4/6 net.)

Botany, possibly because of its general popularity, suffers by reason of many students restricting their attention to morphology, and paying but little heed to the physiology of plant life. To enable botany to take its proper place in education it must be regarded as a branch of biological science and the struggle between the plant and its environment must be studied.

Messrs. Bevis and Jeffery have produced a book which supplements the elementary text-book and the flora, and assists the student to associate form with function and function with environment. The first part deals with the fundamental external factors—water, temperature, light, air and soil; then follows a physiological section in which plants are considered with regard to functional similarities. The final part is the most suggestive, dealing as it does with plant associations and the evolution and distribution of the British flora. A careful study of this book will give the student a new point of view and a new interest in solving the various problems concerning the habitat of plants as well as the aggregation of individuals into communities.

H. H. P.

NATURE STUDY.

Methodical Nature Study. By W. J. CLAXTON. 195 pages. 20 plates. Numerous figures. 6¾-in. × 8¾-in.

(Blackie & Son. Price 6/-.)

One of the objections which those who wallow in the academical rut have to Nature Study is that it is not systematised sufficiently to fall in with their ideas. The title of the book under consideration should therefore please them though too much method in Nature teaching would destroy most of its advantages. In so far as the recurrence of the seasons is followed, and continued observations on the same material is advocated, Mr. Claxton's book is to be commended. The general treatment is a little too much like botanical and zoological text books in places; in others it is very sketchy, and occasionally inaccurate. What does the author mean by the mollusc's tongue being in a very rudimentary state? For it is a most effective instrument, as the gardener only too well knows. We should like also to know why the carnivorous slug *Testacella* should be "a great pest in a garden which contains dahlias." No doubt teachers will get a good many suggestions from the book, which is illustrated by numerous line drawings, and many familiar photographs by Messrs. Charles Reid, Henry Irving and Douglas English.

W. M. W.

GEOLOGY.

The Mineral Industry of Rhodesia.—By J. P. Johnson. 90 pages. 1 plate. 9-in. × 6-in., interleaved.

(Longmans, Green & Co. Price 8/6 net.)

This is an account of the present stage of development of the Rhodesian mining industry. Gold is, of course, the most important mineral, and 609,960 ounces of the value of £2,568,200 were mined in 1910. A brief account of all the principal producing and developing mines in 1910 is given, with notes on the mode of occurrence of the gold. It is everywhere found near the contact of the basement granite with the sedimentary and other rocks into which it intrudes. Whilst gold is the mainstay of the mining industry, many of the other metals are becoming increasingly important, and the geology indicates great future possibilities for them. Many non-metallic minerals are also mined, including diamonds and coal. An excellent chapter on hints to prospectors concludes the book, which should prove valuable both to the men on the spot, and those otherwise interested in the rich mineral industry of Rhodesia.

G. W. T.

By the courtesy of Messrs. Flatters & Garnett.

Tremadoc Beds near Criccieth.

Notice the curved strata and the marine denudation along the bedding and joint planes.

Field Note Book of Geological Illustrations.—By Hilda D. Sharpe. 51 pages. 86 photographs and 2 maps. 9-in. × 6-in., interleaved.

(Manchester: Flatters & Garnett. Price 3/- net.)

This book consists entirely of photographs intended to illustrate the geological features seen by students during excursions or when on holiday, and to assist them to recognise in the field the facts which have been discussed in class. Each photograph is accompanied by a short descriptive note, and while most of them will doubtless be illustrative to the student, there are a few, such as the "Wyche Cutting, Malvern," which convey little or no geological information. Some others have either been poor photographs or have suffered in reproduction. The book is interleaved and is provided with a number of blank pages at the end for notes or for the insertion of photographs. G. W. T.

Pebbles.—By E. J. Dunn, F.G.S. 198 pages. 76 plates. 9-in. × 6-in.

(Melbourne: G. Robertson & Co.)

The Director of the Geological Survey of Victoria has made good use of the fund presented to him along with the Murchison Medal by the Geological Society in producing this interesting book. He discusses exhaustively the form, material, shaping and transport of pebbles, and illustrates their endless varieties in seventy-six beautiful plates containing two hundred and fifty figures. Pebbles form an intermediate stage between boulders riven by various agencies from their parent rock, and the sand or mud to which they are ultimately reduced. Their story, as told by Mr. Dunn, is a veritable romance of science. The first seven plates illustrate the history of pebbles as they pass from angular boulders, through sub-angular and rounded pebbles, to fine sand, in a most graphic manner. A final chapter is devoted to the uses of pebbles by man as tools, weapons, sinkers, weights and sacred objects.

G. W. T.

PHILOSOPHY.

Creative Evolution.—By Henri Bergson. Authorized translation by Arthur Mitchell, Ph.D. 425 pages. $8\frac{3}{4}$-in. × $5\frac{1}{4}$-in.

(Macmillan & Co. Price 10/- net.)

Professor Bergson's philosophy is well deserving of the very widespread interest that it has aroused. One can say this without necessarily agreeing with his views. For what Bergson has to advance are really new ideas; and if new ideas are not always true ideas, they are always valuable as stimulants to thought. In the present case, moreover, it can hardly be denied that there is a large element of truth in Bergson's arguments, and that he puts forward a new way of viewing the problems of life and philosophy, which in itself is both valuable and useful; add to this a style which almost persuades one against one's will even where views the most novel are advanced. In parenthesis, let us further add that the work of translation appears to have been done in a most careful and satisfactory manner, Professor Bergson himself having revised the whole work.

Reality, so we understand Bergson, is Becoming. Concrete time is the stuff of reality: reality creates itself gradually, fundamentally it is absolute duration. Life transcends intellect, and thus it is only by the synthesis of intellect with instinct, or intuition, the two end products of the evolution of life in opposite directions, that a true philosophy of life is forthcoming. Life is the outcome of an impetus given once and for all; it is free and thus creates as it evolves. Materiality and intellectuality are the results of the inverse movement to that which is life. Both radical mechanism and radical finalism are erroneous, but the former more emphatically so than the latter. Bergson's arguments are splendid: but we doubt whether he has really proved that concrete time is fundamental reality, the creative force in evolution; and if time be not this, but merely a way we have of regarding phenomena—in a word, a mode of consciousness—Bergson's arguments against finalism will not stand. Moreover, it is difficult to conceive of life as the result of an impetus given once and for all. Not only do we ask, whence derived? but why given then and not at some other time? Was this the beginning of time, or if not, what sort of time preceded it? The difficulties are largely removed if one considers life as, in its origin, transcending time, but in its manifestations contemporary with infinite time.

The confines of a necessarily brief review do not permit of even a satisfactory outline of Bergson's philosophy, so many new ideas and ways of thinking does it contain; still less, then, do they permit of any adequate criticism of this system. All we have attempted above is to present some of its salient features. In conclusion, let us say that all those who desire to keep abreast of modern thought will certainly read this book, and will do so with interest and enjoyment.

H. S. Redgrove.

NOTES UPON THE FUNDAMENTAL SYSTEM OF STARS.—ADDENDUM.

By F. A. BELLAMY, M.A., F.R.A.S.

JUST as the second part of the article on "Notes upon the Fundamental System of Stars" was passed for Press, I received from Professor Boss, in response to my request, some additional information referring to certain details which brought the subject of those notes quite to date. This addendum will therefore serve both to include these, and to make one or two corrections.

The letter "s" should have been used instead of "z" for San Luis throughout the article: the final "s" is sounded as the English "z."

The only meridian circle at the Dudley Observatory is that known as, and inscribed on the cube "Olcott Meridian Circle." It was presented to the Observatory by Mr. Thomas W. Olcott, President of the Trustees at that time, and was made by Pistor and Martins, Berlin, in 1856; it is eight inches in aperture and one hundred and ten inches focal length, not ten feet.

Since 1904 various grants have been made to the Dudley Observatory from the funds of the Carnegie Institution of Washington, and in the more recent years a sum of four thousand pounds to seven thousand pounds each year.

Previously to the connection with the Carnegie Institution the Dudley Observatory had produced a catalogue of about ten thousand stars, eight thousand being between declinations -20° and -37°, to the 7·5 magnitude, and these observations were made in the years from 1896-1901. This work is in catalogue form, but is not yet published.

While this work was in progress, and especially in 1901, after observations upon it had been completed, Professor Boss undertook a comprehensive work concerning all the stars visible to the naked eye from the northern to the southern pole. The object of this work was to ascertain, with the greatest possible accuracy, the proper motions of each of these stars. Also included in this were all stars, of whatever magnitude, that had been accurately observed previous to 1855. It was this work that the Carnegie Institution of Washington began to aid in 1904. The scheme, though an exceedingly extensive and laborious one, was regarded as preliminary to a larger one that is now in progress at the Department of Meridian Astrometry of the Carnegie Institution of Washington. It may be remarked, as it is not generally understood, that this and the Dudley Observatory, Albany, N.Y., are essentially one.

The result of this preliminary work, just referred to, has been published under the title of a Preliminary General Catalogue, formed from various sources. It contains the positions of six thousand one hundred and eighty-eight stars reduced to the epoch 1900, and it includes the results for the primary design of computing proper motions from a collection, as complete as possible, of all accurately observed star-positions made during the history of Astronomy, each authority being systematically corrected to make it homogeneous with the mean of all the most reliable observers.

On the arrival of the second expedition, in February, 1909, the piers were ready, and the instruments were carefully mounted, adjusted, and the principal constants were investigated during the month of March—naturally as the consequence of very strenuous exertions.

There were usually two sets of observers for each night. In each set there was the principal observer at the telescope, and an assistant to read the four microscopes for each star. One set observed at intervals from about 4 to 7.30 p.m., then continuously to about 11 p.m., and again for about an hour near sunrise. The other set observed from about midnight to 4.30 a.m. The observations were pushed unremittingly in this manner until the end. Additional assistants, Messrs. Mearns and Jenkins, arrived in San Luis in September, 1909. There were always seven observers, and for a short time ten observers.

In the first twelve months from April 6th, 1909, nearly sixty thousand complete meridian observations were secured. For observations of this class, this record has only been approximately approached at Cordoba, Argentina, under the direction of the late Dr. B. A. Gould, where in one year about forty thousand meridian observations were obtained.

The meridian observations at San Luis were completed in January 1911, and the members of the staff returned to the United States in February and March. They secured in all about eighty-seven thousand observations, upon about fifteen thousand stars including all the stars south of declination -20° noted as of the seventh magnitude or brighter, all of the Lacaille stars, and all the stars accurately observed, previous to 1860, at the principal observatories in the Southern Hemisphere. These stars were each observed four or more times. About two thousand standard stars were each observed from eight to forty, or more times.

In addition to the great work which these eighty-seven thousands of straightforward observations entailed, very extensive researches of immense importance to accurate fundamental meridian work were carried out to determine the general and daily constants of the instrument, in order to facilitate the reduction of the star-observations in an accurate and systematic form. These reductions are now in progress at Albany with a large force of computers, so that astronomers will not have to wait many years, as is usual with most meridian work, before the catalogue is published: Professor Boss believes in expeditious work.

In the summer of the present year it is anticipated that the Olcott meridian circle will be again installed and ready for work at the Dudley Observatory, Albany. The standard stars will be again observed as already described, and, later on, the observation of all the stars down to the seventh magnitude that are north of -20° will be undertaken.

I will conclude these "N[illegible] quotation from a letter from Professor Boss to me[illegible] "The last observation was taken (at San Luis [illegible] Jan. 30, 1911. This work has been accomplished at a rate far beyond my anticipations. The great prevalence of clear nights—two hundred and eighty *per annum*—the large force of observers—seven to ten, and the resistless zeal of the staff are responsible for this." As an old meridian-circle observer it is pleasant to read this appreciation of the observer's work, which, somehow, has usually escaped inclusion in the introductions to observatory star catalogues.

THE ASTRONOMY SECTION AT THE CORONATION EXHIBITION.

THE admirable principle of devoting a section of a large exhibition to Science, which was first instituted at the Franco-British Exhibition at the White City, in 1908, and repeated at the Japan-British Exhibition last year, has received increased development at the Coronation Exhibition this year. Much might be said of the exhibits in the several branches of Science there shown, but our present remarks must be confined to those in the section devoted to Astronomy.

These exhibits are deserving of more than a passing notice, as they embrace some of the most recent results in astronomical research. They consist generally of a collection of old astronomical instruments, models, and photographs of celestial phenomena.

Many of the instruments have been exhibited at previous exhibitions—notably the very fine and varied collection of Astrolabes, Quadrants, Nocturnals and Dials shown by Mr. Lewis Evans. Seeing that such were the only instruments possessed by astronomers for many centuries for determining the positions of the heavenly bodies and for giving the time, it is interesting to examine the differences in construction and estimate the very limited accuracy that was possible with such instruments. Mr. Evans shows Oriental and European Astrolabes dating from the fourteenth to the seventeenth centuries, and a large collection of Sun Dials and Quadrants of the sixteenth and seventeenth centuries. In this connection there is a very interesting exhibit from Gonville and Caius College, Cambridge, of an astrolabe presented to the College by John Caius, one of its founders—the case of which is richly embossed and of peculiar beauty. Four examples are exhibited of the Davis Quadrant or Back Staff, one of which is shown by Mr. Lewis of the Royal Observatory, Greenwich, who has contributed a very interesting account, with a drawing, of the method of using it. From this we learn that the Back Staff was invented by Captain John Davis, in the year 1590, previous to his sailing for the South Seas. Before that time the only means of measuring the altitude of the sun was with a simple quadrant, such as the very fine specimen by Magini, shown at the Exhibition. The arc of the Davis quadrant was divided into degrees, and had in addition a Gunter's scale for subdivisions. A Vernier was not applied till about 1618. Some fifteen years later Elton, the clockmaker, added an index arm on which he placed a level which made the observer independent of the horizon. A further improvement was made sixty years later by Flamsteed, who added a lens to the instrument, and thus it was used until Hadley invented his quadrant in 1730.

Perhaps the most interesting exhibits in the Astronomy Section are those contributed by the Royal Observatory, Greenwich, which embrace two models of remarkable interest. The first is a model of the orbit of Jupiter's Eighth Satellite, showing the path of the satellite round Jupiter from the time of its discovery in 1908 to the year 1916, predicted from observations made in 1908 and 1909, by a method devised by Dr. Cowell, the necessary calculations being made by Dr. Crommelin. It is doubtful whether an astronomical model so instructive as this has ever been constructed. The path of the satellite is indicated by wires supported by pillars at every three hours of Jovicentric Right Ascension. The path of the satellite from 1909 to 1910 is shown by a different coloured wire for each year. It will be remembered that the motion of the satellite is retrograde—the mean sidereal period of revolution is nearly two years—the mean distance is fourteen millions of miles and the mean eccentricity 0·38. The result of this great eccentricity is that the distance of the satellite from Jupiter varies from eight to twenty-one million miles, and the Greenwich description of the model states that it is possible for the eighth satellite to be nearer to its primary than the seventh. The model gives also the orbits of satellites thus VI. and VII. and the five inner satellites to scale in their proper phase. The scale of the model is eighty inches = one solar unit, or one inch = one million and one hundred and sixty thousand miles.

The second model referred to is that of a star cluster in Taurus which has been shown by Professor Boss to form a connected group of stars moving through space in the same direction and with a common velocity. The exceptional interest that attaches to this model warrants us in appending the description of it given by the Royal Observatory. "This model represents a cluster of bright stars which is comparatively near the earth. The group covers an area in the sky fifteen by fifteen degrees, and is situated in the region of the Constellation Taurus. From a study of their Proper Motions, Professor Boss has shown that they form a connected cluster of stars, moving with a common velocity and in parallel directions. The present position of the Sun, with regard to the cluster, is shown by the large white ball placed at the end of the arm projecting in front of the model, the plane of the base board being that of the Earth's Equator. The wire along which the white ball runs represents the path traversed by the Sun (or the parallel to that traversed by the cluster; for we may consider the Sun to be moving past the cluster, or the cluster past the Sun). The small column to the left of the model indicates the position of the Sun eight hundred thousand years ago. At the present time the distance of the Sun from the centre of the cluster is eight hundred billion miles, or (say) eight million times the distance of the Earth from the Sun. Relatively to the Sun the cluster is moving at a velocity of twenty-eight and a half miles per second, a velocity which will carry a star eight and a-half times the distance of the Earth from the Sun in a year. The distances of the stars in the cluster from their nearest neighbours are much the same as the distance of the Sun from its nearest neighbours, and all the stars in the cluster would be included in a sphere of one hundred and thirty billion miles radius. At present the stars are of magnitudes from three and a half to six and a half; after sixty-five million years the group will appear as a globular cluster about twenty minutes of arc in diameter, consisting of stars from ninth to twelfth magnitude. Of these forty-one stars, fourteen are white stars, whose spectra are like that of Sirius: the spectrum of the others show them to be in a somewhat more advanced stage, but only a few of them have reached the stage at which the Sun now is. They appear to be stars of great luminosity; three of them would be more than one hundred times as bright as the Sun at its distance; six between fifty and one hundred times as bright; twenty-two between ten and fifty times; and the faintest of the forty-one stars has five times the luminosity of the Sun. Out of the fourteen stars in a group, which have been examined with the spectroscope, eight have proved to be binaries. It is probable that quite a number (fifty) of fainter stars also belong to the cluster; but their Proper Motions are not as yet sufficiently well determined to be certain."

It is not too much to say that considering the care and exactitude with which they have been constructed these two models are unique.

There are exhibited in the Astronomy Section a large collection of photographs and transparencies contributed by the Observatories of Greenwich, Cambridge, Stonyhurst and the Cape, the Royal Astronomical Society and others. Among the most interesting is a very beautiful series of transparencies contributed by M. Deslandres, from the Meudon Observatory. These comprise some thirty spectroheliograms of the Sun in calcium and hydrogen light, showing the most recent and remarkable results obtained at that Observatory.

To understand the great advance that has been made in this branch of solar research in the last few years, it should be borne in mind that up to the year 1908, spectroheliograms of the Sun's surface were obtained with instruments of such moderate dispersion that the radiations from several layers in the solar atmosphere were integrated. As the lower layers are the more brilliant, the forms of the upper regions were more or less masked. The construction of a more powerful instrument at Meudon, has enabled M. Deslandres to satisfactorily isolate the light of the upper atmosphere from that of the lower strata. The results can be very well studied in the photographs exhibited. Numerous examples are shown taken in pure K3 light—the highest layer in the Sun's atmosphere yet examined. These are new, and the credit of obtaining them belongs to M. Deslandres. Comparing these with those taken in K2·3 light it is found they possess characteristics which distinguish them clearly from the lower layers. Striking examples are shown of the curious black markings called "filaments," and the connection of these filaments with solar prominences. Equally striking is the fact noted by M. Deslandres, that some of these filaments seem to form a zone round the poles. The photographs taken in hydrogen light are equally worthy of study. They show remarkable differences, according as they are taken with the centre or the borders of the Hα line.

Interesting photographs are exhibited taken with the "Spectroenregistreur des vitesses," that is, a spectro-heliograph of Velocities, which photographs the displacements of the spectrum lines in the line of sight for all points on the solar disc. The study of the results obtained with this new method of M. Deslandres shows that vapours are rising over the areas represented by the dark filaments, and descending over the areas represented by the bright faculae. Space does not allow of our giving a more detailed account of this exhibit which is deserving of close study.

The late M. Charles Emile Stuyvaert, of the Royal Observatory, Brussels, devoted the last ten years of his life to the construction, in wax, of a model of the moon which was almost completed at the time of his death in 1908. The model was made on a scale of one-millionth the natural size. One portion of it representing the Lunar craters Arzachel and Alpetragius is shown at the exhibition, and is one of a series of twenty-four similar models which represented the complete hemisphere.

On the whole, the science of Astronomy is fairly well represented at the Exhibition, not only in the list of those who have sent contributions, but from the fact that the exhibits may be considered in many respects as indicating the most recent advances in the science.

NOTICES.

NOTES OF A NATURALIST IN THE MEDITERRANEAN.—Mr. G. B. Hony asks us to point out that the date which was given in the August number for the appearance of Nightingales at Granada as March 10th should be May 10th.

A UNIQUE SUNDIAL.—Mr. J. A. Hardcastle writes to say that at his request Colonel W. G. Armstrong some time ago described a similar sundial to that of which Mr. A. Paul Monckton gave an account in the August number, in *The Journal of the British Astronomical Association*, and that Miss Agnes Fry has pointed out that there is one depicted in Holbein's picture of "The Ambassadors" in the National Gallery.

APPARATUS FOR ELECTRO-THERAPY AND DIAGNOSIS.—Messrs. W. Watson and Sons' new catalogue dealing with these subjects runs into nearly one hundred pages. Besides containing illustrations of all the most up-to-date coils and X-Ray tubes, screens and radiometers, it shows some interesting pictures of an improved intensifier screen called the "Sunic" for X-Ray work, by which the exposures are reduced by ninety-five per cent. The saving in the life of the tubes quickly repays the cost of the screen. The figure showing sciagraphs of a hand taken with an exposure of one twentieth of a second on a plate of which half only was covered with the screen, is very remarkable.

THE FÉRY REFRACTOMETER.—We have pleasure in announcing that Messrs. Adam Hilger, Limited, have introduced M. Féry's Refractometer and have issued a descriptive pamphlet with regard to this instrument which is a direct reading refractometer for taking the refractive index, for sodium light, of oils, solutions of acids, sugar solutions, mixtures of glycerine, alcohols and so on with water.

AN IMPROVEMENT IN THE MICROSCOPE STAND.—Messrs. R. & J. Beck have introduced an improvement in the shape of the stands of many of their microscopes which allows the limb of the microscope between the fine adjustment screw and the stage, to be grasped by the whole hand so that when the instrument is lifted none of the adjustments are altered. The same firm has put upon the market a grinding and polishing machine of a most compact nature for the purpose of making microscopical specimens for metallurgical work.

PRISM BINOCULARS.—Mr. E. Leitz sends us an illustrated list of his prismatic binoculars, which includes several new patterns. At one end of the series is an instrument giving a magnification of four diameters, which is used in the theatre while at the other end is a field-glass giving three times this magnification. There is a new glass also with a magnification of eight, which has an enlarged field of view and an improved stereoscopic effect. The latter is obtained by increasing the distance between the object glasses relatively to that between the eye pieces, and this, particularly at the range at which a student of natural history would require to use the glass, certainly assists vision.

MICROSCOPES AND ACCESSORIES.—Section one, Part one, of Mr. C. Baker's catalogue deals with the microscopes made by his well-known firm. Among special microscopes are the inexpensive ones designed for nature students and meat inspectors, while we may also mention the diagnostic microscope for the use of officers in foreign medical service for the diagnosis of malarial fever. A very similar model has also been designed for the use of travellers.

Parts two, three and four of the same catalogue are occupied by dissecting instruments, stains, mounted specimens for sale or hire and apparatus for collecting pond 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, 1911.

THE METEOROLOGY OF THE UPPER AIR.*

By J. EDMUND CLARK, B.A., B.Sc., F.G.S., F.R.Met.Soc.

Being the Presidential Address, 1911, to the Croydon Natural History and Scientific Society.

When last year I addressed my fellow members, who have honoured me by placing me in the chair, which I am now vacating for one† who has long given us able service, reference was made to the three chief forward strides made in the realm of Science during the opening decade of this twentieth century. These are familiar to us as Mendelism, Radiology (if that word may be applied to express the idea briefly), and the exploration of the Upper Air. The first of these was then enlarged upon; the second does not, perhaps, come so entirely into the purview of our usual activities; and it is the more appropriate that, as a worker in our second section of Meteorology, I should turn to the subject of the Upper Air, just as a consideration of Mendelism linked itself with our first Section—the Botanical. This subject, moreover, claims an added interest in view of the remarkable progress made in the last two years in practical flight by man.

Although few definite generalised results had been reached previous to the present century for heights much exceeding one mile (two kilometres), pioneer work of no small value dates back to the early sixties. For moderate heights the first beginning was made one hundred and fifty years before. The astronomer, Professor Alexander Wilson, of Glasgow, and one of his students, in 1749, attached thermometers to kites strung in series. This was three years earlier than Franklin's classic experiment, by which he proved that lightning was an electric discharge.

From that day on, kites have been one of the chief methods for the investigation of the free air in its lower parts, second in importance only to the results in higher parts by balloons. Lofty mountain stations have also afforded many valuable facts. But it is obvious that records so obtained are viciously affected in a double manner, so far as the real state of the free air is concerned, namely, by the disturbing effects of the land surface, with its own conditions of temperature and moisture, and by the dislocation, through the slopes, of the normal atmospheric flow, resulting in profound modifications of temperature and saturation.

For practical purposes only one other source of knowledge remains, that afforded by clouds as to wind direction, saturation, and whether the stratum is above or below the freezing-point. The first scientific work through clouds began with their classification by Luke Howard, in 1803, which, after remaining practically unaltered for nearly a century, has now been re-organised rather than replaced.

* *Authorities.*—Besides the frequent communications during the last few years to the Royal Meteorological Society, and in *Symons's Monthly Meteorological Magazine*, the writer has specially consulted the valuable summary of our knowledge presented by Messrs. Gold and Harwood to the Winnipeg Meeting of the British Association in 1909; Sir John Moore's "Meteorology, Practical and Applied" (1910); Meteorological Office Publication No. 202 (Perturbations of the Stratosphere); "Das Werter"; and Mr. William Marriott's account of James Glaisher's Meteorological Work (1904). There is a very informing article by Professor A. Lawrence Rotch, the able director of the Blue Hill Observatory, near Boston, U.S.A., in *The Scientific American* of October 22nd, 1910.

† William Whitaker, F.R.S., F.G.S.

The important work carried out through balloons is of the more interest to ourselves, since for thirty years the originator of scientific upper air exploration by this means, John Glaisher, lived in our midst. True, a small beginning had already been made in 1852 by Mr. Welsh, of the Kew Observatory. In 1858, the British Association appointed a committee to investigate decrease of temperature with altitude, but it practically did nothing. A new committee, appointed in 1861, included Admiral Fitzroy, Airy, Brewster, Herschel, Tyndall and Glaisher. After disheartening failures the generosity of Coxwell came to its rescue by offering to build a balloon for their use. Mr. Glaisher responded to this enthusiasm by determining himself to make the observations. Thus began in 1862 the famous ascents by which for the first time approximately correct data were obtained for what we may call the middle region of the atmosphere at present accessible for meteorological records. In the course of three years a height of eleven thousand feet, or over two miles, was exceeded on no less than eleven occasions, including that most famous ascent from Wolverhampton, on September 5th, 1862, to the unprecedented height of about seven miles, when Mr. Glaisher became unconscious and Coxwell, with hands frozen, barely succeeded in pulling the valve cord with his teeth. This height has probably never been surpassed by any balloonist of later years. But no observations were taken above about thirty-one thousand feet, whereas, in 1901, Berson in Germany took records to nearly thirty-five thousand five hundred feet. In this case both men became unconscious, only reviving when they had fallen two-and-a-half miles. In 1875, two out of three French meteorologists were suffocated at a height considerably less.

These disconcerting consequences indicated only too plainly that direct observation by manned balloons was only possible up to six, or, at most, seven miles, and that but rarely, at immense cost. This has led to the present development of free balloons, or *ballons sondes*, a method already suggested by Le Verrier in 1874. It had, indeed, been quickly acted upon, but only in the form of pilot balloons, to determine wind direction and height of clouds, and by these, from 1877 onwards, much valuable knowledge was secured.

While balloon work was thus developing, advances of equal importance were made by means of kites. In 1883, E. D. Archibald first used piano-wire in experiments on wind velocity. His Biram's anemometer was, perhaps, the first recording instrument employed in Upper Air research, but it only gave the total from beginning to end. Two years later began the splendid series of observations which has made the Blue Hill, in Massachusetts, a household word wherever meteorology is followed; and here it was, in 1890, that William A. Eddy devised a form of tailless Malay, or—as we used to call them at school—Dutch kite, which now, as the box-kite, has superseded all others. At Blue Hill again, four years later, was sent up the first continuously recording instrument, and from this date progress was rapid and wide-spreading, for, in 1898, the newly-founded International Aëronautical Committee was already recommending similar work for all stations of the first class, advice which was adopted in France and Russia. Work in England was initiated by Mr. W. H. Dines, especially with flights from tug and shore on the west coast of Scotland in 1902, work since continued for the Meteorological Office, in association with *ballons sondes*, first at Oxshott, since at Pyrton Hill, in Oxfordshire. To him, perhaps, more than to any other person, England is indebted for her present good position in this new field of exploration. The famous French savant, however, M. Teisserenc de Bort, first achieved a height of over a mile, by a kite flown from a Danish gunboat in the Baltic, a height which now has in some instances been nearly trebled. It was not long before our British Office added Upper Air records to its weekly weather reports, as they were taken at Glossop, Pyrton Hill, Ditcham Park and Brighton. At the first station, under the supervision of Manchester University, daily records are made, as far as possible supplemented by balloons when the wind is deficient.

But kites are, of course, strictly limited in height of ascent, and it is with pilot balloons and *ballon sondes*[*] that the recent extraordinary success in obtaining extensive series of records at heights up to and above ten miles have been secured. Thirteen to fourteen miles is perhaps the present thoroughly ascertained limit.[†] These ascents are made by means of rubber balloons, usually weighing half a pound and about half a metre across, filled with hydrogen and used either singly (sometimes with a parachute), or else in pairs. They are filled sufficiently to burst at a given elevation (one only in the case of a pair, when the other acts as a parachute for the combination) and carry special recording apparatus, carefully guarded against rough shocks when striking ground again. The heights, when possible, are determined by one or more theodolites to check the aneroidogram record, on which alone, more frequently, the observations have to depend.

Besides more sporadic work concerted observations have, since 1901, been made on the first Tuesday of each month by nearly all European countries. To the instruments is attached a ticket with instructions to the finder and the offer of a reward for its return. As a rule more than half those sent up are so recovered, sometimes after a flight of over two hundred miles.

[*] A pilot balloon gives wind directions at varying heights by theodolite observations; the name, "sounding balloon" is applied more usually to ballonets with recording instruments.

[†] Some English records have been obtained almost certainly for at least fifteen miles; but the values above twelve miles are subject to serious possibilities of altitude error.

Having thus indicated the manner in which instruments have been and are carried to various heights, a few details concerning them will be appropriate before discussing the results obtained.

Glaisher, in Coxwell's "Mammoth," devoted himself mainly to the relation of height with temperature, and with hygrometric conditions, while not overlooking possible chemical and magnetic changes, cloud forms, changes of air currents, and so on. His outfit included a mercury barometer, aneroid, dry and wet bulb and maximum and minimum thermometers, Daniell's and Regnault's hygrometers, horizontal magnet, electrometer and sealed exhausted tubes. This appalling array for a single observer was set out upon a board, ready in case of danger to be instantly packed for safety. Coxwell acted as timekeeper as well as pilot. Each high ascent cost £50, so that the number available from the British Association grants was limited.

In recent years, of course, self-recording instruments have done the work, those intended for kites being the more solid in form. Yet even the complete set now usually attached to these weighs only one-and-a-half to two-and-a-half pounds, including a clock with recording drum, a large double Aneroid or Bourdon tube barometer, Bourdon tube thermometer,* Robinson anemometer, and hair hygrometer. This and the thermometer are cased in a polished aluminium ventilation tube, having a vane to keep it end on to the wind. This is most essential to ensure tr[illegible] temperature and humidity records. Unfortunately Glaisher's results [illegible] some extent vitiated from ignorance in his time of the necessity for this. In England, now, the much lighter apparatus designed by Mr. Dines is used; essentially a cardboard disc, revolved by clockwork. On one side of its upper face is recorded pressure and humidity; on the other temperature and wind speed.

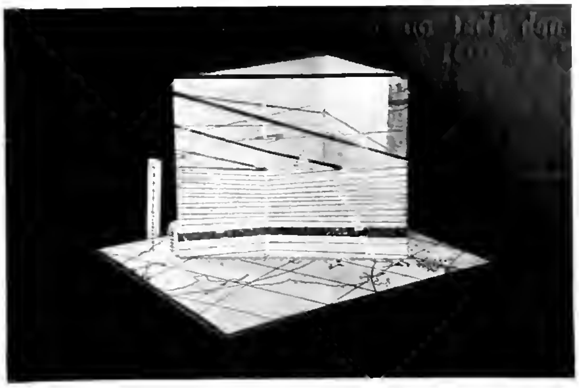


Figure 1.

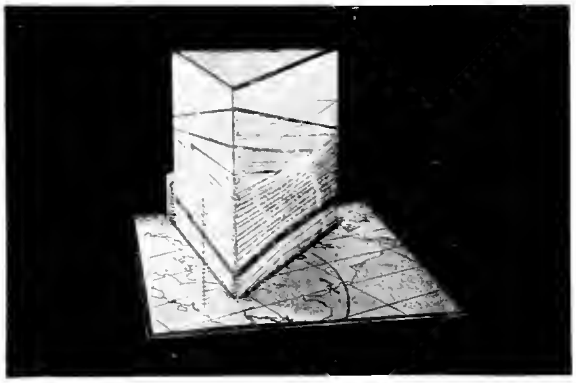
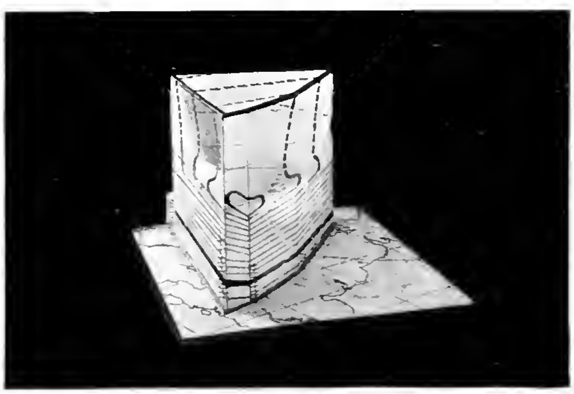


Figure 2.

Figure 3.



By the courtesy [illegible] W. N. Shaw, M.A., D.Sc., F.R.S.

Figure 4.

Temperatures and Pressures in a block of Atmosphere fifteen miles thick, over a portion of the British Isles. July 27th and 29th, 1908.

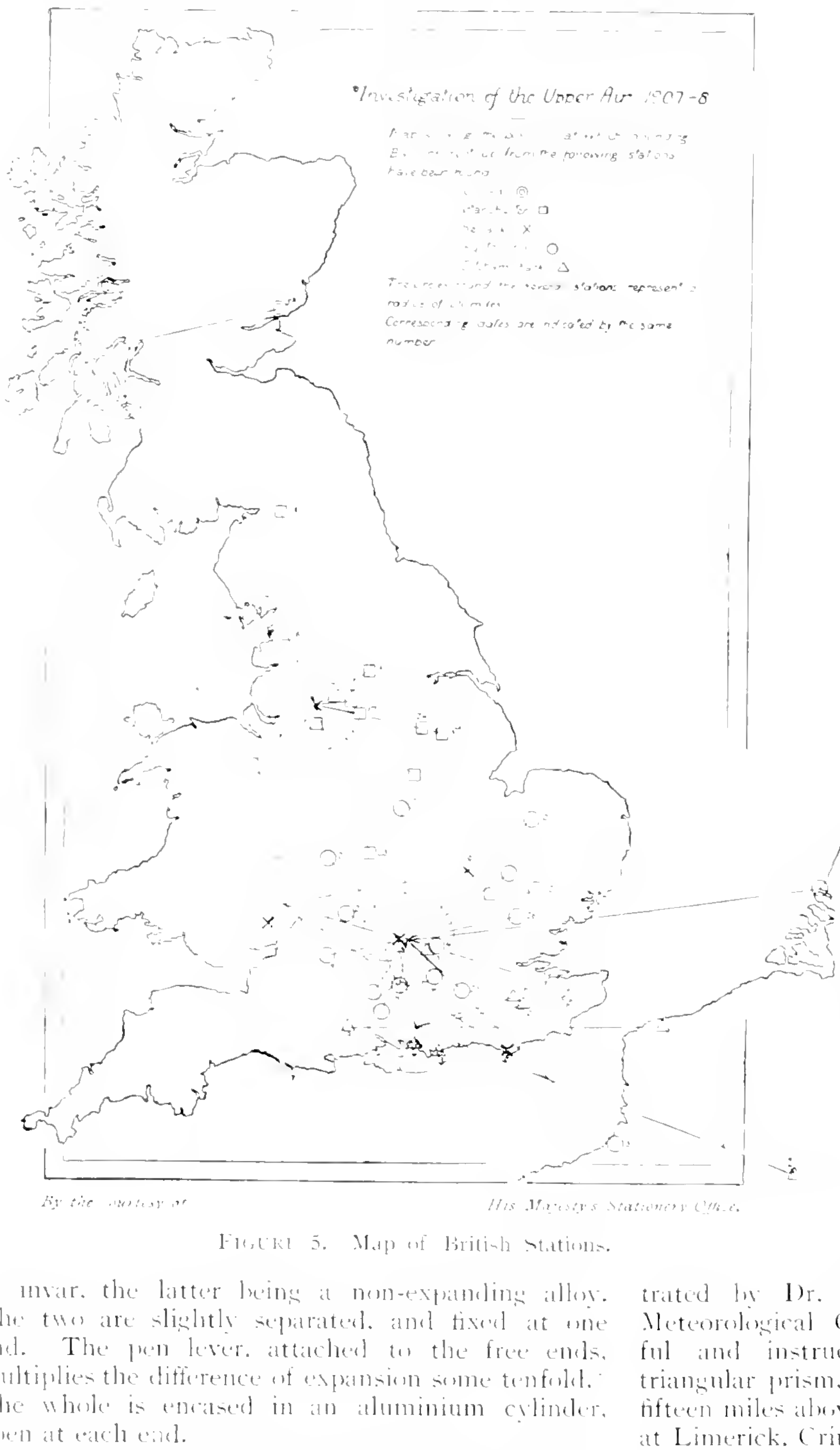
For *ballons sondes* still lighter apparatus is required. Out of England the usual instruments weigh about one-and-a-quarter pounds. The German form, perfected by Assman, consists of an endless sheet between two drums. One of these is turned by aneroid changes. Two pens pressed against the sheet are moved at right angles to this motion by changes of temperature and humidity respectively, being attached to the necessary instruments. Time may also, however, be recorded by a small clock, though this is not essential, and the whole is encased.

In England, again, the far lighter Dines' instrument prevails, weighing either three-and-a-half ounces or one ounce. This, however, discards humidity records. The aneroid is attached by one face to the frame, by the other, indirectly, to a parallel rod of invar, a lever from which moves a stylus across the face of a silvered metallic strip, which is attached to the frame. The invar rod is itself part of the metallic thermometer, so that at constant temperature its style makes a parallel scratch, which, however, diverges with a fall of

* Bourdon tubes are circular arcs, the tube exhausted for barometer, and filled with a suitable liquid for thermometer. Varying pressure alters the curve.

temperature. The scale is such that one-tenth inch equals 100° C. so that 1° C. or ·001 inch can easily be read with a low power microscope. A thin strip of German silver is used with the rod of invar, the latter being a non-expanding alloy. The two are slightly separated, and fixed at one end. The pen lever, attached to the free ends, multiplies the difference of expansion some tenfold.* The whole is encased in an aluminium cylinder, open at each end.

Because of this extreme lightness, English results include a larger proportion of records up to twelve miles or so, which is some set off, both to the omission of humidity records and the greater danger of loss by falling into the sea.



By the courtesy of His Majesty's Stationery Office.

FIGURE 5. Map of British Stations.

As to accuracy Dines is correct for temperature within 0·8° C against 1° C by the Continental records, but the height records are less reliable, the average pressure error being eight millimetres or one-fifth inch, against five millimetres, or rather under one-sixth inch. Although at three miles these errors are only about one hundred and fifty yards, at nine miles they increase respectively to about five hundred and fifty and four hundred and thirty yards, and at twelve miles to over one thousand one hundred (one kilometre) and six hundred and seventy yards.

Finally we turn to the object of all this work and the measure of results attained. As to the former there is now added, so far as the first two miles or so is concerned, the additional desire of knowledge helpful to aviation. This has already borne fruit: for it has been established that eddies and uprush gusts,—most dreaded of all dangers by the fliers,—rapidly decrease as the surface is left.

But the original incentives, other than purely scientific, were more entirely meteorological and practical, namely, to enable the authorities responsible for weather forecasts to attain a yet greater accuracy. So long as surface observations only were available, any complete discussion of the causes and modes of air movements was plainly as impossible as it would be for a geographer thoroughly to survey a country without leaving a railway running due north and south. For just as, to him, east and west observations are equally as essential as north and south for his two-dimension chart, so also does the meteorologist require to work in three directions for his three-dimension chart. Already this has been strikingly illustrated by Dr. Shaw, the capable head of our Meteorological Office, who built a most beautiful and instructive model, in the form of a triangular prism, of the atmosphere to a height of fifteen miles above the British Isles, the angles lying at Limerick, Crinan and Pyrton Hill in Oxfordshire (see Figures 1 to 4). A casual glance reveals the chief and least expected phenomenon brought to light by these Upper Air explorations, to which reference may now be made.

It has been, of course, long known that

* This description follows the construction of the lighter apparatus, as used in 1910.

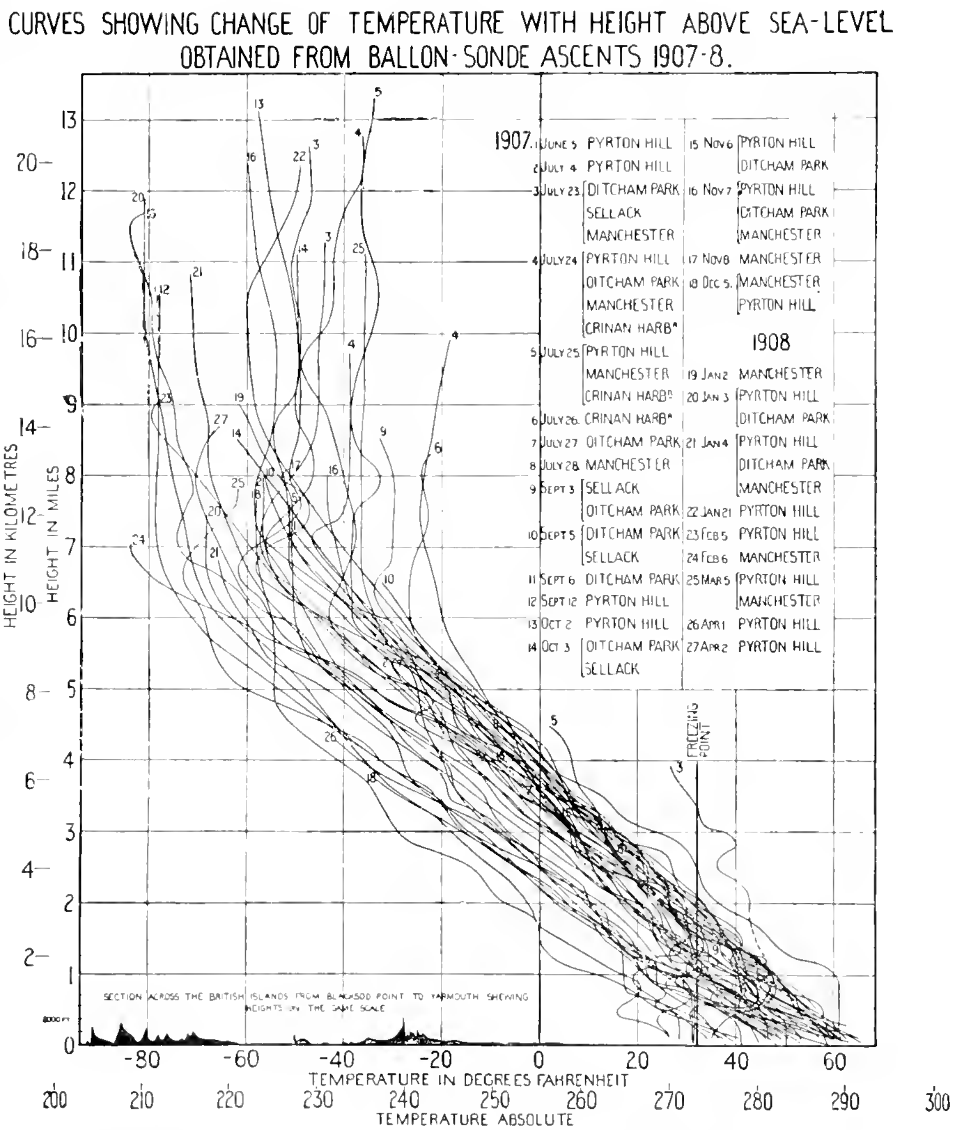
temperature decreases rapidly with height, namely, at the rate of 1°F. for every three hundred feet. It is now well established that, in the lower two miles, this is frequently reversed, a fact previously thought exceptional. But from this height up, as shown by the closely-set parallel lines of the model, there is great and constant regularity. Formerly, it was supposed that this continued unbroken until the cold of space was reached, presumably somewhere near absolute zero, or − 273°C. No one dreamt of any serious divergence. When, however, the *ballons sondes* records began to accumulate, one of the most obvious facts obtained was that at a height, usually of about six miles, temperature *ceased to fall*, and on the contrary tended again to rise, and that this unlooked-for reversal, so extraordinary that as yet we have for it no certain explanation, continues as high as we have at present any observations, namely, at the least up to a height of fifteen miles.

In other words, whilst we still cannot but believe that, outside our atmosphere, the cold of space is intense beyond easy conception, so far as actual knowledge goes, it ceases to grow colder at a height of six miles and remains practically unaltered through, at any rate, the succeeding eight or nine miles.

This layer was first named, very appropriately, the "isothermal layer," but, to connect it with the regions of change beneath, these latter have been called the "troposphere," the upper the "stratosphere." The latter lies above the highest visible clouds.

The average height of the lower surface of the stratosphere, which is, however, subject to considerable local perturbation, alters both with the season and latitude, being, in Europe, least (9·1 kilometres, or about five-and-a-half miles) in March, and highest (11·9 kilometres or about seven miles) in October. The only decided break in the curve is for September, a kilometre lower than August, and one-and-a-half kilometres below October. It is suggestive that here also occurs, at least in the British Isles, the chief break in the rainfall curve. This, also, is the time when the north trade winds are at a minimum, and there may well be some association. The temperature is lowest in February (−80 F.), highest in September (−60 F.).

Observations outside European latitudes are still exceedingly rare, but some special ascents in East Africa, over the Atlantic, and in the West Indies, have given important evidence as to equatorial conditions. Over the Atlantic the stratosphere was not reached at fifteen kilometres, which is nearly nine miles, or half as high again as the European average. It was, however, revealed by two ascents made on the Victoria Nyanza, which reached a mile and three miles higher (ten and twelve miles). Here, in equatorial regions, was recorded the lowest air temperature yet obtained, 119°F. below zero (−84°C). Thus we have the interesting result that the regular fall of temperature continues up

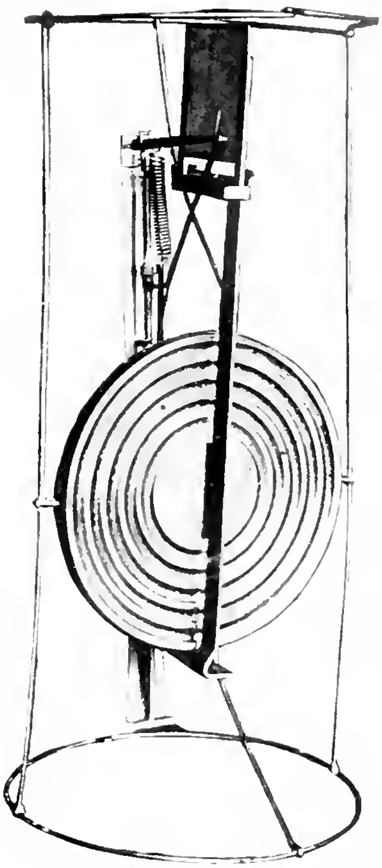


By the courtesy of *His Majesty's Stationery Office.*

Figure 6. Relation of Temperature and Height.

to the base of the stratosphere, however high that may be.

Wind changes are a second most important element in passing from the troposphere to the stratosphere, especially as to velocity. At times this is extreme. Thus at Ditcham, July 28th, 1908, it fell from over forty-five miles an hour to about six miles. Three days later, however, from over seventy miles, the drop was only to fifty-eight miles. The stratosphere, therefore, is comparatively a region of calm as well as of even temperature. This appears to continue at least up to fifteen miles. But at some higher point there is a reverse change. To dust from the Krakatoa Eruption, in 1883, was assigned an initial height of about thirty miles. At this height, which is just double that explored by recent investigations, was found over the equator an east wind that carried the dust with a velocity of some seventy to eighty miles per hour. At a height of about fifty miles the long enduring streak from the meteor seen on February 22nd, 1908, travelled with velocities up to and over one hundred miles an hour.



By the courtesy of His Majesty's Stationery Office.

FIGURE 7. Dines' Balloon Meteorograph.

We must not forget that the assumed extent of the Earth's atmosphere, some two hundred miles, is at least fourfold this height. Its density still suffices to raise meteors to white heat, by friction, up to about one hundred miles.

Observations at Potsdam indicate that, with a mean surface velocity of twelve miles an hour, the speed is seventy-five per cent. greater at a height of five hundred feet, and a hundred per cent., or doubled, at rather over the mile. It is trebled at about two miles, and above three miles rises to over fifty miles an hour. Up to fifteen hundred feet the velocity almost always increases, but it frequently falls off higher than this, especially with South-east winds. The velocity just below the stratosphere may exceed two hundred miles per hour.

The interest and importance of the unexpected results detailed above must be the excuse for dwelling upon them at such length, so that other very valuable discoveries must remain without reference. But what has now been said suffices to indicate that, as in the case of Mendelism and Biology, the advances of Meteorology in the region of Upper Air exploration during the opening decade of the twentieth century are destined long to stand in the foremost ranks of scientific achievements.

By the courtesy of H. R. Mill, D.Sc.

FIGURE 8. Dines' Box Kite.

METEOROLOGICAL PHOTOGRAPHS.

THE United States Weather Bureau is forming, in its library at Washington, a collection of meteorological photographs, and will welcome additions there to from all parts of the world. The following classes of pictures are among those desired:

1. Views of meteorological offices, observatories and stations.
2. Pictures of meteorological apparatus.
3. Portraits of meteorologists; views of their homes and birthplaces.
4. Views showing the effects of storms, inundations, freezes, heavy snowfall and so on.
5. Cloud photographs.
6. Photographs of optical phenomena (rainbows, halos, Brocken spectre, mirage and so on).
7. Photographs of lightning and its effects.
8. Photographs of meteorologically interesting pictures in old books, or of early prints and paintings. (e.g., contemporary pictures of the damage wrought by the Great Storm of 1703, in England.)

Persons who are willing to present such pictures to the Weather Bureau, or who will furnish them in exchange for Weather Bureau publications, are requested to address:

Chief U. S. Weather Bureau,
(Library.) Washington, D. C.

It will add much to the value of these pictures if the sender will kindly note on the back of each as much pertinent information as practicable. On picture of classes 4-7, inclusive, should be stated at least the date, hour, and place at which each picture was taken, and the direction toward which the camera was pointed.

THE NEW ASTRONOMY.

II.—DOUBLE AND WONDER STARS

By PROFESSOR A. W. BICKERTON.

THE Star that rules our planetary system is a comparatively steady and commonplace luminary. The Sun has its storms, but for thousands of years no one knew of them. He is neither strikingly large nor inordinantly small. Sir David Gill says: "Our Earth is a very insignificant planet revolving round a very insignificant Sun." The more the stars are studied, the more complex a very large number are found to be, and some hundred thousand are larger than our Sun. Scores of thousands of them are double, and between one and two thousand of them are known as Wonder-stars because they exhibit fluctuations of intensity. In 1596, Fabricius missed a star that he had seen some little time before. Then again in a few months he was astonished to see it once more. He soon found that there was a rough regularity of a little less than a year in its waxing and waning period. Because it was in the Constellation of the Whale and such an extraordinary star, he called it Mira Ceti, or the wonderful star of the Whale. Although we now know over a thousand variable stars, this *o* Ceti or the star Omicron of the Constellation of the Whale, is perhaps still the most remarkable Wonder-star of the entire heavens, and probably many astronomers would have to admit that they know as little of the cause of its remarkable fluctuations as did its discoverer Fabricius.

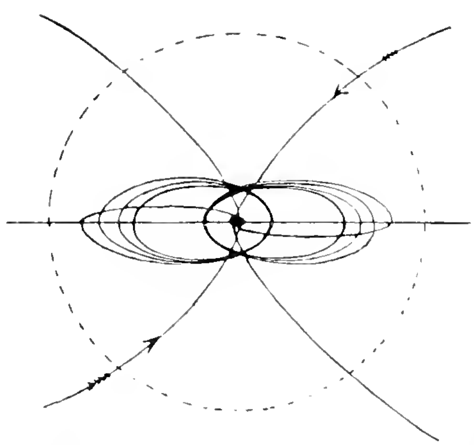


FIGURE 9. Diagram showing the formation of the orbit of a Double Star.

The dotted circle represents the nebula expanding beyond aphelion distance.

The two continued hyperbolas represent the path of the two stars had there been no collision. The collision occurring, the orbit becomes a long ellipse, that becomes of less eccentricity because the nebula has expanded.

The meteoric nucleus left behind by the third body will produce a resistance at perihelion and this will tend to make the orbits more circular, as shown in the diagram.

Another very remarkable variable star is named Algol, or the Demon star, and this has also been known for a great many years. Mira seems to have every kind of irregularity of variability, whereas Algol is as regular as a clock, and the cause of the variation of this star is well known. The Demon is a double star, consisting of a dark and a luminous body, and the variation of its light is due to the dark sun coming in front of the bright sun and eclipsing it once in every revolution. Some of these variable stars take more than a year to go through their cycle, and some only a few hours. They vary in all kinds of different ways, but apparently there are but few of them but may be explained on the principle of "partial impact" and "the theory of the third body."

Leaving actual observation we will return to deduction and try to trace dynamically what must happen to the two torn suns that we have assumed to have cut deep valleys in one another, and that have passed one another and are increasing their distance in space whilst leaving between them the exploding star. One of the first things we must study is the effect of the attraction of this temporary third star upon the two escaping suns. In the story of Nova Persei some few of the salient properties of this third star were discussed. One was that it is thermodynamically unstable, and hence it necessarily explodes. Consequently it is quite certain that when suns do graze they actually must produce a nova. The property we have now to speak of is the power of this body to capture. This property, like its thermodynamic instability, does not seem to be one that is easily grasped by observational astronomers. The power of the third star to capture, tends to make the two torn suns into a pair: that is an orbitally connected double star. Supposing that two equal stars have each grazed off a sixth, the new third body will have twice the mass lost by either. Each torn sun will have a mass of five-sixths of what it had before the collision, and the third star two-sixths of one of them. Each of the two retreating stars is subject to the attraction of the other torn sun, and of the new star. That is, each of the suns when at similar distances are subject to an attraction of seven, whereas before the impact they were subject to an attraction of six. But the third star remains at rest in space, and the two torn suns are flying from each other, so that the attraction of the third star is effective longer upon each of the torn suns than they are upon one another. Consequently the effective attraction is more than seven, is really equivalent to about nine, that is one-and-a-half-times as much as before the collision. If the stars had any proper motion before attraction brought them together the orbit at impact would have been a hyperbola, generally very close to a parabola. After the collision the additional attraction will in very many cases convert the orbit into an ellipse and consequently the two torn suns will be wedded by the influence of the third body into an orbitally connected pair, that is, into a double star (see Figure 9). If the proper motion were large, and the graze small, the capturing power of the third body would not suffice to wed the two stars into a binary. The number of pairs of variable stars that are too far separated to be considered physically-connected binaries seems to suggest that this must happen frequently. A list of some of these pairs of variables that were found in less than a thirtieth of the celestial vault is given on page 89 of "The Birth of Worlds and Systems."

It has been argued by astronomers that the orbit of double stars that had been wedded by impact, must be such as to cause the stars to collide again at every periastrum. This, probably, as a rule, is not the case, but occasionally such recurrent impacts apparently take place. Agencies, however, come into play that tend to prevent recurrent impacts: these agencies are fully discussed in "The Birth of Worlds and Systems." We will give one very efficient agent that tends to prevent recurrent impact. The pair of torn suns are wedded by the attraction of the third body, but this third body is largely dissipated before the two stars reach their greatest distance. Hence it is not there to attract them back again. Consequently they do not approach so near one another at periastrum as they would have done had the third star remained the same mass that it possessed when first formed. The several factors fully account for the low eccentricity of many binaries. There is great reason to imagine that both Nova Persei and Mr. Espin's star are cases of recurrent impact. In the case of Nova Persei a peculiar concentric-looking nebula existed before the impact took place that produced Nova Persei itself. As exactly such a nebula might have been produced by a previous impact, this idea of recurrent impacts seems to furnish a sufficient explanation of its existence. The accompanying Figure 10 is one of those taken as the nebula was progressively lit up by the flash of light that was produced by the exploding third star—the flash we saw and named Nova Persei. We have every reason to suppose that this was the case, because, as the light was progressively reflected from the whorls of the nebula, it showed the characteristic blaze band spectrum that was so unique a peculiarity of the flash period of Nova Persei.

The reason why we may think of Nova Lacertae as being the third body produced by a recurrent impact, is that one of the two stars that came into impact in this case appeared to have been a variable star before the partial impact occurred that produced this apparition. It may be worthy of note that one of the dynamical deductions as to the properties of the third body is that it passes through the stage of being a planetary nebula. Nova Lacertae is now said to have become a planetary nebula.

I cannot enter into greater detail here because the "theory of partial impact, and the third body" is so wide as to really constitute a new cosmogony. I would refer students to the original papers in the transactions of the New Zealand Institute, for the years 1878, 1879 and 1880. These are in all the important libraries of London.

If double stars are produced by the grazing impact of suns, in their early days they must have exhibited the scars produced by the encounter and sometimes be doubly variable; but there are many reasons why this scarred condition should last very much longer in some stars than in others. Consequently we should expect to find a comparatively large number of double stars that exhibit variability and a few that show double variability. There are several double stars actually known to be thus doubly variable, quite a large number of double stars that are single variables, and still more double stars that are coloured, a state which has been deduced as being a final condition of variability before the torn suns have healed completely and once more become normal stars.

It would be an extremely important piece of work were some of our amateur astronomers to find the many variable stars that are double, and especially the many spectroscopic binaries that are variable and in which the variability is not due to eclipse. Mr. Espin and Mr. Victor Anestin, have already found some most valuable and remarkable results in connection with double stars, their association with the various classes of variable stars and with density of star distribution.

Let us now examine in some detail the condition of these torn suns with respect to the distribution of the material, and the character of the motions developed in the suns that have come into grazing impact.

Nearly the whole of the dynamical conclusions regarding the grazing impact of suns were worked out over thirty years ago, and they have been subjected to endless debate and calculation on the part of mathematicians and astronomers. If we grant the fact that collisions must occur, as on the grounds of the doctrine of probability seems inevitable, we have an actual explanation of the phenomena of temporary, variable and double stars, for we cannot doubt the accuracy of the thermodynamic deductions that are here presented.

When these basic deductions are combined with the fact that there appears to be scarcely a single one of all these complex deductions but has been confirmed by observations, we must admit that impact, if not of the supreme importance that is suggested by these researches and observations, must be a stupendously large factor in cosmic evolution and worthy of the most careful and detailed study on the part of astronomers.

The diagram, Figure 11, page 382, taken from "The Birth of Worlds and Systems" was drawn to show the distribution of material at the moment when the three bodies are parting company. Assuming the similar suns to be of average dimensions, we can imagine the valleys which have been cut along the equators of the two torn suns to be perhaps something like a million miles in length. The valley commences with a mere scraping away of the atmosphere; it then becomes deeper and deeper, until it reaches far down into the sun. The material is dragged forward, and at the moment of parting with the new third star, it is heaped up into a huge mountain of fire, hundreds of thousands of miles high. This material being carried by momentum in the direction in which it has been dragged, tends to follow the third star, and so produces rotation in the general plane of the orbits of the two stars. In all probability before the impact occurred the star had a rotation of its own, and hence, immediately after the impact, a tumult of conflicting motions of the most extraordinary character must ensue. There is first this struggle of the two rotations, the original and the impressed rotations, that must result in a most extraordinarily irregular rhythm. Then, again, we have gravitation exerting itself, struggling to make the highly-distorted body into a sphere. We have to remember that not merely is there the enormous disturbance in the form of the torn sun due to the impact itself, but there is the disturbance due to tidal action, and although it is possible that Chamberlain and Moulton greatly exaggerated this action, still tidal deformation must be of a stupendous character. Hence we have gravity struggling to make this ill-formed mass into a sphere. A tremendous inertia of motion will be set up whose momentum must carry the material past the position of equilibrium, and thus another amazingly irregular tidal action must be at work in each of the two torn suns.

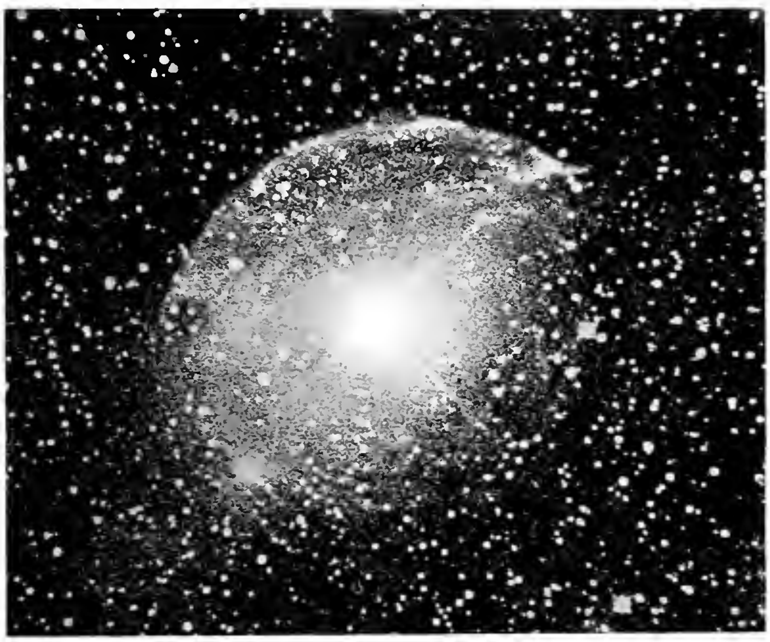


Figure 10. The Nebula about Nova Persei, photographed at the Yerkes Observatory by G. W. Richey, September 20th, 1910.

This heated mountainous mass must produce convection currents of ordinary gas and volatilized metals, and when this is projected, as it must be, in many cases, for hundreds of thousands of miles above the surface of the star, in certain positions this must produce bright line spectra. Especially will such spectra be crossed by the bright line of hydrogen, and this deduction has been conclusively borne out. In fact, not merely are these stars known to be thus characterised, but hundreds of them have actually been discovered by especial search directed to the finding of such bright lines. Amongst the variables so discovered, some have proved to be doubly variable double stars: that is to say, double stars that have been so recently wedded by attraction of the third body that they may be actually considered to be on their honeymoon.

It will easily be perceived that all the struggles of motion and the changes in the margins of these vast volcanoes must alter in the most extraordinary degree the intensity of luminosity at the period of maximum. It must even alter to some extent the time of the apparent maximum itself.

It might be thought that this complex series of motions, as well as conduction and convection, would rapidly bring about a condition of equilibrium; hence that this inequality of heat of the rotating star would not last long.

A detailed study into all the conditions that presented themselves was made in 1879, and it was shown that a great number of the agencies tending to equality balanced one another and became ineffective. Hence it appeared at that time—and the opinion has not altered since—that approximate equality would not be attained for many hundreds, or in some cases thousands, of years. One of these factors, convection, may be due to lightness, produced either by high temperatures or by low atomic weight, and a study of these two characteristics will show at once that the two are tending to counteract one another.

We have already referred to the fact that atom sorting, or molecular escape, will tend to leave behind, in the third body, a rotating swarm of nebulous meteoric dust. In most cases, a good deal of this may be associated with the torn suns, and the torn suns would also, by the extraordinary violence of the volcanic ejection, tend to produce vast atmospheres. It is clear these atmospheres must tend greatly to alter the character of the luminosity produced. One point is obvious, the variable star is sending its vast revolving searchlight through the whole circumference of the heavens. When it is shining away from us it will light up all those dust particles that are on the further side, and illumine them as the Sun does our satellite when it is full moon. Hence we have an obvious explanation of the phenomenon that characterises a number of variable stars, namely, that they present a nebulous appearance at minimum, that is, when the star is sending the searchlight of its vast volcano away from us. Such, then, are some of the characteristics of the torn suns. We also see how amazingly impacts must differ the one from the other; collisions must occur between suns of great difference of mass, of differences of density, of age and hence of luminosity, and then again we have collisions from the mere graze of the atmosphere to almost direct impacts. We may have impacts in which the size of the two impacting bodies are so unequal that the one may bury itself in the body of the other, and produce a gigantic volcano, such as I have imagined to have originated the variability of Mira. I have discussed this in "The Birth of Worlds and Systems."

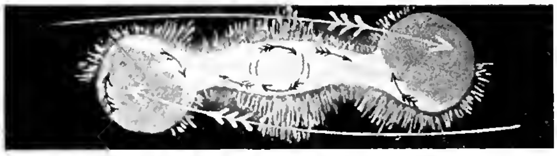


FIGURE 11. Diagram showing material dragged to the preceding end of valley.

Some scientific men have objected to the minute detail in which I have described the phenomena deduced as following grazing impacts. They say that we cannot know the exact circumstances, as every conceivable variety may occur: but grant that we have suns anything like approximately equal, and of the compactness that characterises most of them, then there are sixteen well marked characters and basic properties that the third body must exhibit as deduced dynamical generic principles.

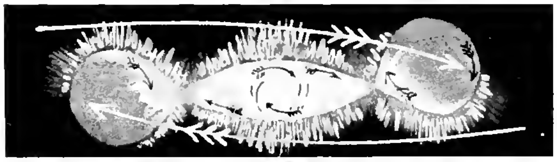


FIGURE 12. Diagram showing why the light in recently torn variables rises quickly and falls slowly.

Obviously we cannot describe a tithe of all the endless possibilities of variation, but we will just take one kind and imagine pairs of similar suns coming into collisions in which the impacts differ from a mere graze of atmospheres down to the almost direct collision, similar to that which in all probability originated our solar system.

With a very shallow graze we have an evanescent flash of light, and the formation of a pair of variables that will continually increase their distance from one another, due to the original proper motion not having been wholly destroyed by the very slight attraction of the small third body.

The pairs of variables given on page 89 of "Birth of Worlds and Systems," are examples of shallow grazes, of course much deeper than the mere atmosphere. Nova Persei is an example of a deeper graze although shallow. The Pilgrim star of Tycho Brahé was a still deeper. Nova Persei appears once to have struck deep enough to have wedded it into a double star. Then we pass through grazes deep enough to produce double stars that are capable of being separated only by powerful telescopes. With still deeper grazes it is dynamically certain that the collision must result in spectroscopic binaries in which the stars revolve around one another in periods of only a few days: of such a type is Algol, and the Cepheids. The variability of several of these appears to be due almost entirely to mere eclipse, the great volcanoes that were existing at the time they wedded have died down: but a surprising number of these stars, both eclipsing and otherwise, still show the blaze of the volcanic scar that was produced by the tremendous blow of their encounter. Again, we go to deeper grazes and the stars scarcely separate, the vast meteoric nucleus of the third star remains as a huge tongue of fire joining the revolving stars into one immense dumbbell-shaped mass of fire. The torn suns themselves, although one vast fiery mass, may still show signs of the giant volcanoes that are still active on the surface, but tidal action has stopped independent rotation, and all changes of brilliancy or of character are synchronous with revolution, because revolution and rotation have become isochronous the one with the other. The best example of this is Beta Lyrae.

When the depth of the graze reaches to a cut of more than a third, unless the original proper motion was enormous, the capturing power of the third body becomes so very great that the three stars do not part company, but whirl around one another as a huge bun-shaped mass. There is every reason to suppose that some of the Wolf-Rayet stars have originated in this way, and their spectrograms tell us the story that this is the mode of their genesis. This fusion we call cases of "whirling coalescence."

Still deeper collisions, and suns revolving slowly are produced. It would seem by the low angular velocity of our Sun that this must have been its origin. It has been suggested in my various books on the subject, that planets did not originate from the body of the sun, but were step-sons and daughters that belonged to one or both of the original bodies whose coalescence made up the Sun.

Professor See has called his great book "The

From "The Birth of Worlds and Systems," by kind permission of Messrs. Harper and Brothers.

Capture Theory" in order to emphasize this same fact; he has independently deduced the idea that the planets could not have originated from the Sun, and has most conclusively demonstrated the erroneous nature of all the old hypotheses. Thirty years ago I showed that the surface velocity of the Sun would have to be increased some forty thousand times its present amount to enable matter to separate itself and remain independent of the body of the Sun.

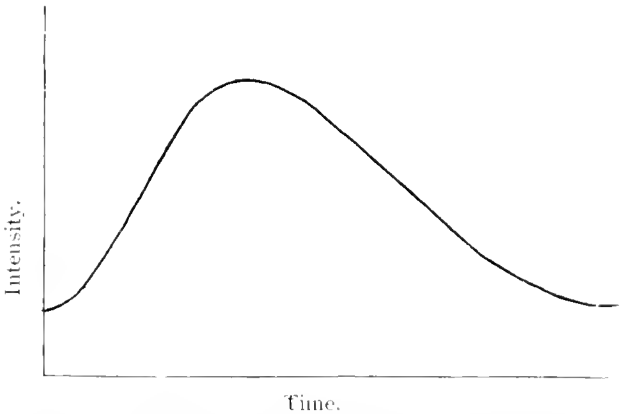


FIGURE 13. Deduced light curve of single variable in which the impact was of recent date, hence the light rises quickly and falls slowly.

Another variable is probably near this star, or it may be one of an orbital pair: its spectrogram should show bright hydrogen and perhaps other bright lines during portions of each revolution: nebulosity at minimum may be expected.

The spectral lines of planetary nebula should be looked for in all spectroscopic binaries, all variable and Wolf-Rayet stars. The pairs of variables on page [illegible], "Birth of Worlds and Systems," should be examined both for planetary nebulae lines and for nebulosity. Midway between the pairs, the meteoric residue of the third body should be sought for.

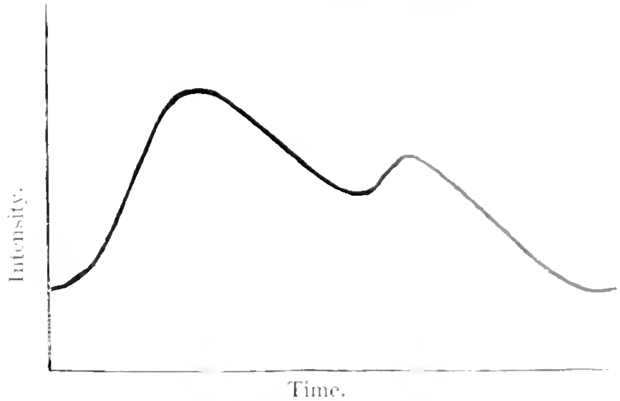


FIGURE 14. Deduced light curve of a non-eclipsing spectroscopic binary.

Associated by impact at a comparatively recent date.

Tidal action has made the time of rotation of each sun synchronous with the period of revolution.

The volcanoes remain active in each sun. The phases of the volcanoes being approximately half a revolution apart, the spectrograms should intermittently show bright hydrogen lines.

Nebulosity should be looked for with long exposure and great light gathering power.

Since I have been in England I have devoted many months to the study of the light curves, the spectrograms, and other peculiarities of variable stars, and there is not one amongst the whole that I have studied but seems to have originated in some form of impact. The extremely singular light curves and eccentric distribution of variables in star clusters received fairly satisfactory explanations. The eccentric light curves of the Cepheids received most satisfactory explanation. Eta Aquilae is perhaps the most typical of these stars. It is a spectroscopic binary of a little over seven da[illegible]. We must assume that in so close a pair [illegible]tion must have made rotation isochronous with revolution. It appears that the impact occurred a sufficiently short time ago that the volcanoes of impact exist in both the stars. As the pair revolve, first one of these and then the other comes into view, giving us the well-known curve of the Cepheids. Perhaps the most wonderful example of the combination of many deductions in one pair is the doubly variable nebulous double star, with an oscillatory orbit, that we worked out in Sydney during the time I was there two years ago. This star, also S.S. Signi, and a number of other peculiar variables, I have described in detail in "The Birth of Worlds and Systems."

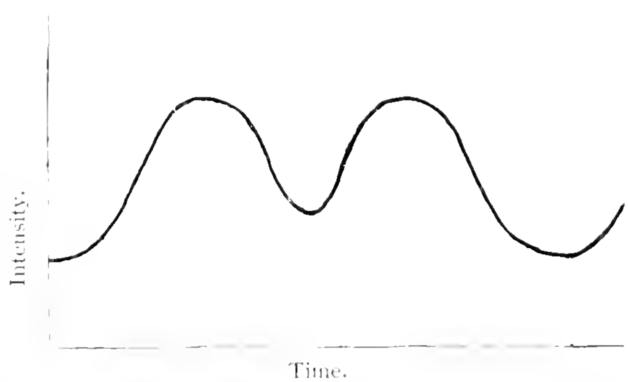


FIGURE 15. Deduced light curve of eclipsing spectroscopic binary produced by impact of nearly a third, hence the pair has just escaped whirling coalescence.

The cuts in the torn suns were so deep, and the third body consequently so large, that each star has been greatly heated and so extensively bathed in the volatilized shining fluid, as to have become a luminous sun. Much of the third star will remain partly as a tongue of fire joining the two torn suns; partly as a nebulous and gaseous atmosphere, this latter giving bright lines. Perchance the nebulosity may occasionally give the star a hazy definition, especially with long exposure. In case the impact that produced this combination be of recent date, a hump of light may indicate the volcano of impact on one or both the suns, and may show on the light curve. Possibly the lines of a planetary nebula may be detected if carefully sought for by means of an analysing spectroscope.

In the next article, after a few words devoted to star clusters and planetary nebulae, we will discuss the phenomena that may be deduced from the impact of White Nebulae and the interpenetration of vast Stellar Systems such as the Magellanic Clouds or the Galaxy itself.

NOTE.—ASSOCIATION OF VARIABLE STARS WITH NEBULOUS MATTER.—It is well to understand the thermodynamic intensity of the volcanic ejection of solar volcanoes. Ejections from so calm a body as our Sun run into velocities of hundreds of miles a second. Compare the speed of 200 miles with half-a-mile a second, which is the velocity of our swift projectiles. $(200 \times 2)^2 = 160,000$, that is, the energy of a Krupp shell would be 160,000 times greater than it now is, were it moving as swiftly as some solar protuberances. This then is the order of the Kinetol of projection in the torn suns.

THE ZOÖLOGICAL SIDE OF COMMERCE.

HORSE-HAIR.

By HUBERT H. POOLE AND WILFRED MARK WEBB.

The part which animal products play in our everyday life is very important indeed, and many of them go through very elaborate processes of preparation. The whole subject is attractive, and especially so in the cases where there is no possibility of the creatures most directly concerned being ruthlessly exterminated.

We therefore propose to contribute a series of articles on commercial zoölogy to the pages of "KNOWLEDGE," and while all will be of general interest, some of them will have a special attraction for the specialist who deals with the groups to which the animals in question belong.

Mammals are at one end of the scale, and their most characteristic external feature is the presence of hairs. Indeed, there is practically no member of the class which does not produce hair at one stage or another of its existence. That of the horse is especially well developed on the neck and tail, proving ornamental in both instances, but in the latter also useful for brushing away flies, which often are a great source of irritation.

FIGURE 1.
Sorting the horsehair over suction screens.

The horse-hair used for commercial purposes arrives in bales up to half a ton in weight, and a hundred and twenty pounds in value. The chief sources of supply are Great Britain, North and South America, Australia, Germany, Russia and China. The tails are the best, because the hairs are hard, the manes being soft and therefore of inferior value. The specially long hairs are, of course, suitable for particular purposes, but we will deal

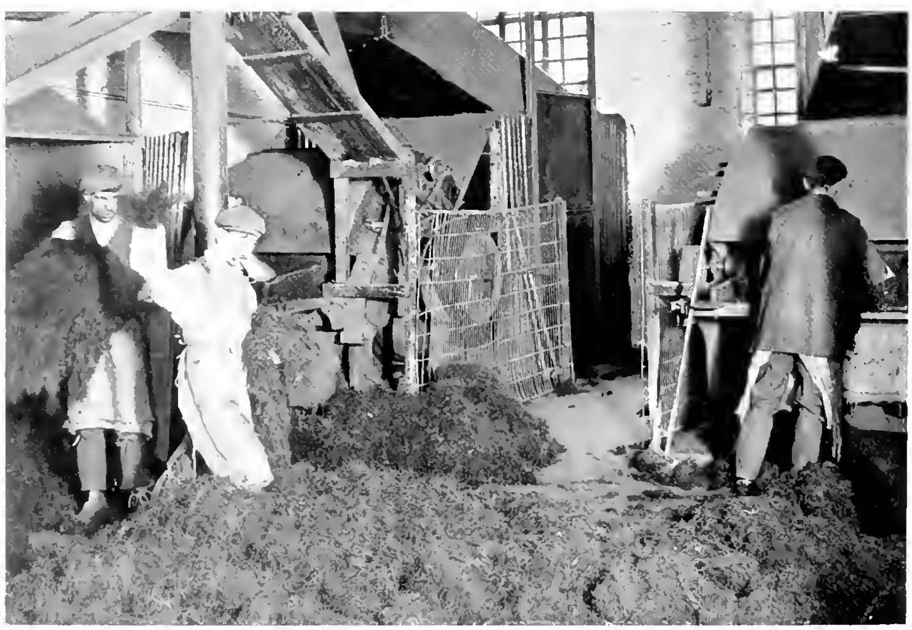


FIGURE 2.
Mixing various kinds of hair together.

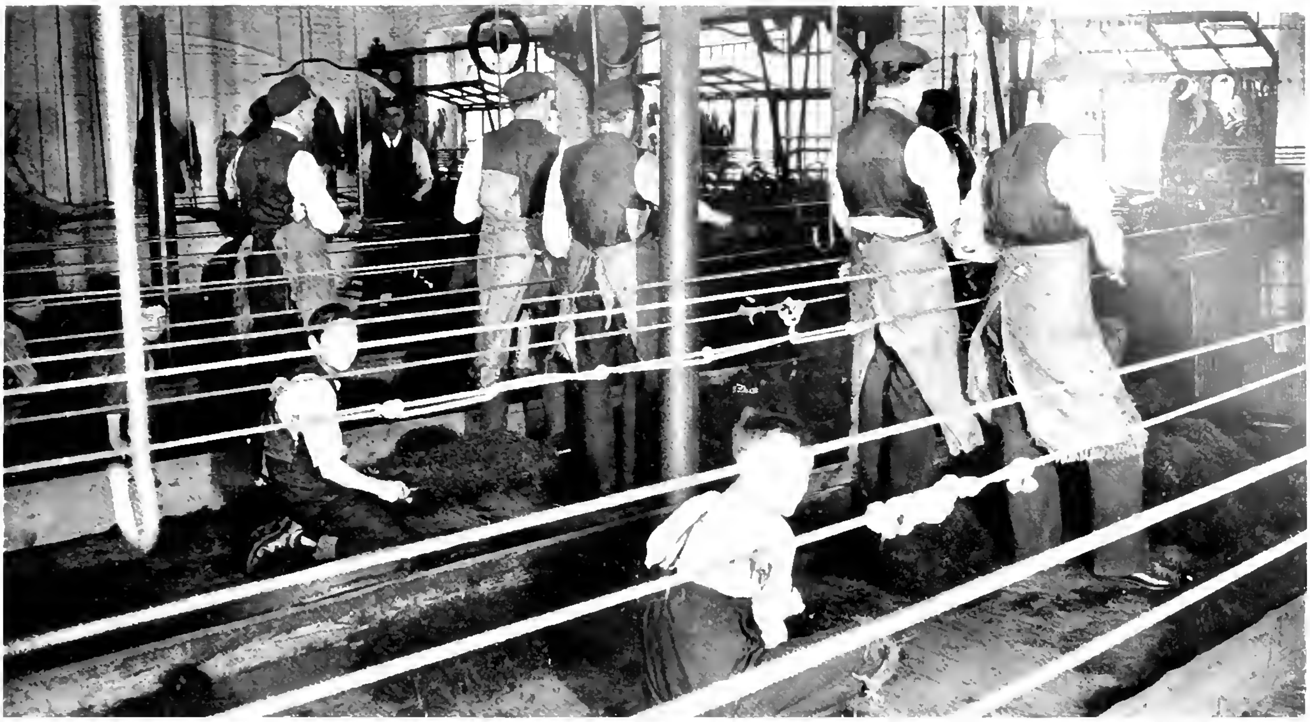


Figure 3.

The walk in which the horsehair for stuffing purposes is twisted into ropes.

first of all with those of ordinary length, which are to be prepared for stuffing furniture, and no one who has not seen the process would imagine how elaborate this is.

The hair is first sorted over suction screens (see Figure 1), which draw out the dust and carry it away. Colour forms the first basis of classification, black, white and grey hair being distinguished, and after this the hair is divided up according to its various lengths and its quality. That which is to appear black is dyed in log-wood, washed and dried, and then, as is shown in Figure 2, the various hairs

Figure 4.

The careful untwisting of the rope after steaming and drying.

Figure 5.

Hand carding the untwisted horsehair from the ropes.

[illegible] mixed together on the floor so as to make stuffings of various prices. After this the material is passed through a series of mixing machines or mills, which are provided with exhausts for taking out any dust which remains.

The hand carding process is shown in Figure 5, and finished horsehair is to be seen in the background. The finer the quality the smaller the rope and tighter its coils. The hair from English cart horses is the best, because it is the strongest, and for the highest qualities long hairs are used. The very finest grades cost up to seven shillings per pound wholesale. Black hair is usually somewhat stronger than the white, but Queen Victoria, who was very partial to horse hair mattresses, always had the best quality of white hair. As it takes about forty pounds of hair to make a full sized mattress, it will be seen that the cost is somewhat considerable.

FIGURE 6.
Horsehair ropes hanging up to dry.

One man in the employ of Messrs. William List & Sons, who very kindly gave facilities for this article to be written, can boast of over sixty years' service, while several can claim over forty. The men train their sons, as a long experience is necessary in nearly all the processes.

Now comes the most curious part of the process. A short walk is provided something similar to that on which hempen cords are made and here the hair is twisted up to form ropes. Each pair of workmen is followed by a boy who beats up a fresh supply of material and that which is dropped, with two sticks, thus getting it ready for the use of the twisters. The ropes are again twisted upon themselves, soaked for two hours in water, then baked at a temperature of upwards of 350° F. for twelve hours. The damp heat, as may be well imagined, destroys all bacterial life that might possibly exist in the hair, and at the same time fixes the curl. The ropes (see Figure 6) are hung up to cool for three days. The low qualities are then untwisted and carded by machinery, though this process is liable to break the staple (see Figure 7). The good qualities are opened out (see Figure 4) and hand carded, the [illegible] twists being placed on the bent pins of the carder which give somewhat, as they are fixed into leather that is in turn fastened to a board.

FIGURE 7.
Untwisting and carding the ropes of the lower grades of hair by machinery.

Messrs. List get the longest tails from China and Russia. These are disinfected before they are handled, as a precaution, and after being dipped in a bath of soft soap and soda, are wet hackled (see Figure 8) to get out all the short fur. The sorted hairs are dry carded, being piled up on a board which is studded with long pins and drawn from the two

Figure 8.
Wet hackling the long hairs which are not used for stuffing purposes.

Figure 9.
Drawing out the hairs and sorting them into various lengths.

ends between an old razor and the thumb to lengths down to five inches (see Figure 9).

White hair which is thirty inches long and upward is used for violin bows. This is exported largely to Germany by Messrs. List. Black hair, which as we have said before is slightly stronger, is used for the bows for double basses. Shorter hair, according to its length, is tied in bundles and sold to brush makers or to plume makers, for whom it is dyed various colours for ornamenting helmets and the bridles of cavalry horses.

A more extensive use of the long hair is for weaving it into seatings in which a linen warp is used, while the hair cloth which tailors employ for stiffening garments where elasticity is required is made with a warp of cotton. The widths vary from sixteen to thirty-four inches, and it may be pointed out that to produce a thirty-four inch cloth the hair must be thirty-eight inches long. Some of the hair is of exceptional length, and one tail in an extreme case which passed through Messrs. List's hands measured seventy-two inches. The brown hair is used for fishing lines and was much in vogue years ago for cod fishing. One advantage of the old method was that only healthy fish were caught, while now, it stands to reason, the trawls will bring up all that come in their way, whether they are in good condition or not.

Wigs for judges and barristers are made from what is known as "dead" hair which has no glint upon it, and is specially picked out for the purpose.

The hair from the tails of cows and oxen is also used for one or two purposes. The ends of the tails themselves are brought over attached to the skins and always show a twist. This with the very rarest of exceptions is in one direction. The cow tails are dressed whole and undyed (as are sometimes horse tails from South America), for export to South Africa, where they are used for personal adornment by the natives. The latter insist on the hair being undyed, and they plait it into bracelets and over gourds used for snuff, as well as combine it with the wire which is put over sjamboks and sticks. They also use it for threading beads. North American Indians use dyed hair for the same purpose, and for weaving into their moccasins.

The cow hair is also drawn for weaving into sieve bottoms to form strainers for cooks and gun-powder manufacturers, while horse-hair bags are used for oil and cider presses and for brewers' straining-cloths.

Lastly, goats' hair from China and Tibet, being very soft, is used for babies' brushes. But the making of brushes generally is a subject which may well be dealt with in another article.

Figure 10.

Specimens of the hair before and after it has been put through the various processes.

SOME NOTES ON PLANT PHOTOGRAPHY.

By SOMERVILLE HASTINGS, M.S.

Author of "Summer Flowers of the High Alps"; "Toadstools at Home"

In the following pages I want to try and give the results of a fairly extensive experience of the photography of plants, both in monochrome and colour (autochrome). This has been, for the most part, out of doors, but I have also done some indoor or studio work. I must, from the very first, frankly admit that I know very little of what other workers have written on the subject, what little knowledge I possess being derived almost exclusively from my own experience and failures, so that I can safely say that all the suggestions herein contained I have myself tried and found to be of value.

The Camera.

Let me first of all tell you of my apparatus. I am, at the present time, using a quarter and a half-plate camera for field work and another half-plate camera mounted on a special stand for the studio. By a simple device, the reversing back of my quarter-plate camera can be attached to both half-plate instruments so that I am able to use my quarter-plate slides and changing boxes with all three cameras. These are very ordinary instruments of no special make. They give double or triple extension and have rising fronts, though I never use this attachment. What I do consider of importance is a swing-back giving a large range of movement in the vertical direction, and a side swing as well; and perhaps I had better, first of all, try and explain why these attachments are so valuable. I use the swing-back in exactly the opposite way to that in which it is generally used, not for reducing distortion at the expense of focus, but for the very reverse effect. By the help of a swing-back, any plane surface, whatever its inclination to the plane of the camera, can be readily focussed. Suppose, for example, we are photographing a plant, say a snowdrop, as it grows in the vertical plane, with the camera pointing obliquely down upon it. Such an aspect has the advantage that in it we get the ground immediately behind the plant or surrounding objects as a background, whereas, with the camera on the same level, the plant stands out against distant objects or sky, and the sense of proportion is lost. Moreover, it is much more convenient to focus in this position. Suppose then that the camera is tilted and directed obliquely down upon the plant with a large aperture to the lens, and we have focussed the flowers on the screen (AB) (see Figure 1), the lower leaves and base will be hopelessly out of focus. The natural tendency under these conditions is to throw backward the swing-back so that the focussing screen becomes more vertical (AB^1). But the effect produced will be just the reverse from that intended, the lower leaves will be still more out of focus. What we have to do is to throw forward the swing-back, so that its inclination to the vertical is increased (AB^{11}), that is, to bring the upper part of the focussing screen nearer to the object focussed, that is to the lower leaves. When, however, we are looking down on a group of plants near the ground, when, in other words, the object to be focussed is more in the horizontal plane, the swing-back is used in the reverse manner and the focussing screen becomes more vertical. Not infrequently also, when a row of plants is being photographed, the most satisfactory point of view is not directly in front but rather to the side, and in this case the side swing, used very much as described above, becomes extremely useful. By means of an efficient swing-back, therefore, any plane surface, whatever its position, can be focussed, and although undoubtedly a certain amount of distortion results, as we are photographing plants and not architecture, this can generally be neglected. So that, to return to the subject under discussion, in selecting your camera be sure and see that the swing-back has an extensive range of movement and that there is a side swing also.

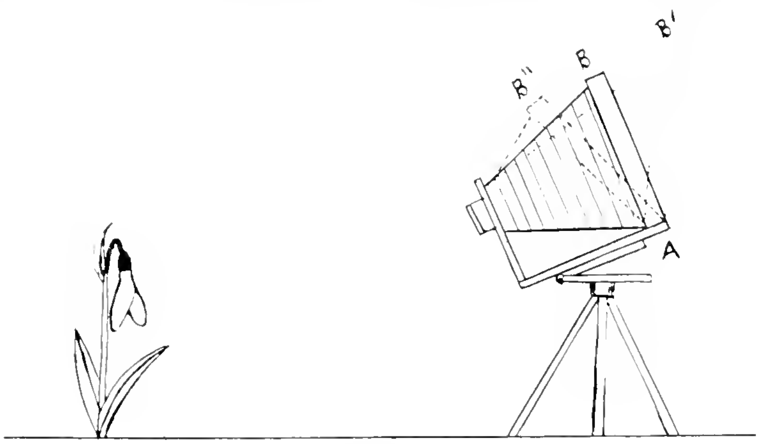


Figure 1.

To illustrate the use of the Swing-back in Plant Photography.

Tilting Table.

Another necessity for satisfactory field work is a tilting table so arranged that the whole camera slides backward and forward upon it. As I have never been able to purchase one of these and have always had to have it made, I may as well describe it in detail. I have never found a ball and socket top to the stand sufficiently rigid and have always had to use a tilting table. It is important that this part of the apparatus shall be firm for small degrees of tilting as well as large, otherwise, when the dark slide is introduced, the whole thing slips, and the photograph obtained is not what was intended. To achieve this, it is essential that the locking screw (A, Figures 2 and 3) be as near as possible to attachment screw (B) when the tilting board is closed. The tilting table should open to a right angle so that the camera may look vertically down when photographing tiny plants.

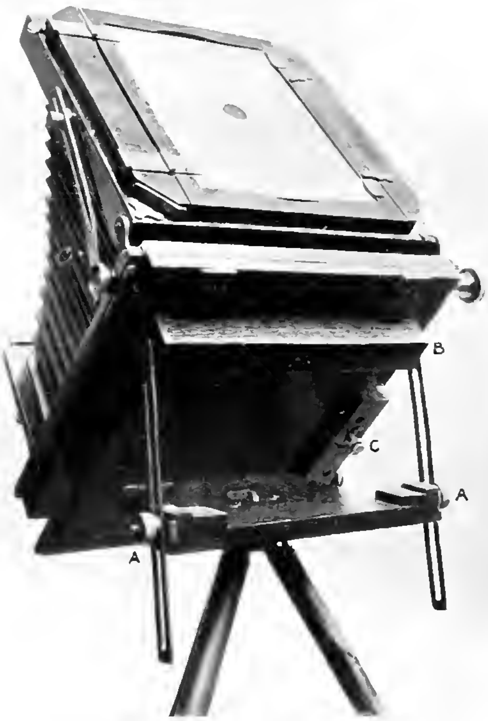


Figure 2.
The Half-plate Field Camera.

Another essential is that the whole camera should slide backward and forward on the tilting board. Suppose, for example, that we are photographing a plant, say natural size, with the camera looking obliquely down upon it, and have found a suitable view on our focussing screen, and proceed to focus. If we do this in the ordinary way, by backward or forward movement of the lens or focussing screen, the scale changes at once and we find that the flower has enlarged itself to, perhaps, twice its natural size before it is sharply in focus. If, on the other hand, we attempt to obtain correct definition by moving the camera and its stand backward and forward along the ground we either find that this is exceedingly difficult owing to the sloping bank on which the plant grows or to rocks or other obstructions, or else that, owing to the tilted position of the camera, the point of view entirely changes, for as we advance and recede, the object falls and rises on the focussing screen. It is much more convenient to focus by sliding the whole camera backward and forward on the tilting board and fixing it by a locking screw (C, Figures 2 and 3) before exposure. The tilting board on which my half-plate field camera slides has narrow brass strips on top which engage with similar brass strips screwed to the base of the camera. There is nothing striking about the little pieces of apparatus which I have had made to attach to the bases of my two field cameras, but as a diagram may perhaps be of service to some reader, I have thought best to include one with dimensions marked upon it. The half-plate size is here figured and the quarter-plate is very similar, except that the part of the tilting board which is nearest to the camera is formed of an aluminium plate instead of wood. Where, as very occasionally happens, the camera has to be directed upward instead of down, it is the easiest thing in the world to slide the instrument off the tilting base and reverse it so that the lens points upward, before replacing it.

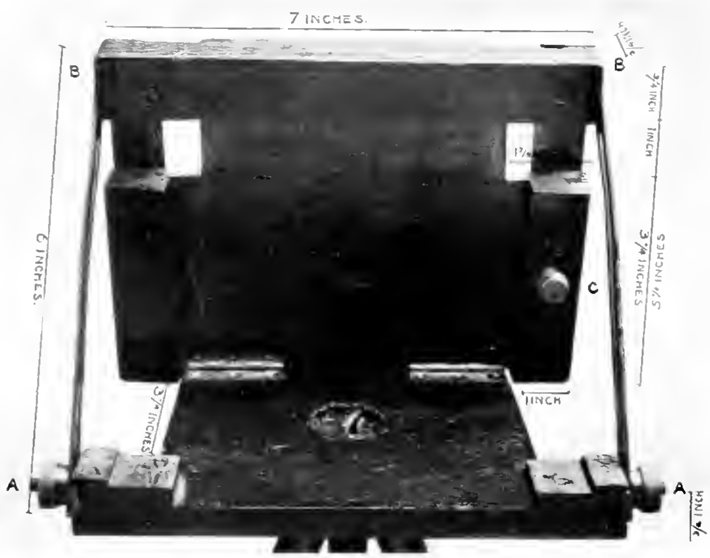


Figure 3.
The tilting base on which the Camera slides backwards and forwards.

The Stand.

There can be no possible doubt that the telescopic is by far the most convenient type of stand for work in the field. It is easily carried and adjusted, and one of the better types with six or seven sections to each leg permits of the close approximation of the camera to the ground in photographing small plants. It is rigid enough even with a half plate camera, and is very rarely used fully extended.

Where there has been a strong wind blowing I have sometimes increased the weight, and therefore the rigidity, of my whole apparatus by placing a few large stones, wherever I could find room for them on the camera base. And sometimes where the camera and stand are much tilted, a few stones piled around that leg which has a tendency to rise will make the whole thing much firmer. If you are likely to use your camera-stand more than once, get a brass or steel one and strenuously avoid those made of aluminium.

The Lens.

Turning next to the question of the lens I can again only give you my own limited experience. I have tried most makes but have got rid of all my lenses, except a Zeiss Tessar, which I use for everything. It is a delightful lens, and of especial value in autochrome work. It is certainly the best I have tried, though it is quite likely that there are others just as good. The right thing to do is clearly to try the lens you have and wait to get another till you are quite certain that your present one is deficient. I prefer a rather short focus lens, for then one can photograph an object natural size with the camera somewhat less than doubly extended, and complete double extension gives a slight magnification. Besides, it is often easier to pitch one's camera quite close to a plant than some little distance away, particularly in rocky places. There is no advantage in a wide aperture lens for plant photography. One working at F 6·5 or F 8 is quite good enough, and I never remember photographing a plant with a larger stop than F 8. Much more often one has to stop down to F 24 or 32 to obtain sufficient depth of focus. Occasionally in the field, and not infrequently in the studio, it may be desirable to photograph a plant or flower larger than natural size. This can be managed with the help of a triple extension camera, but rigidity is almost invariably lost with the greater degrees of extension, and it is much more convenient to increase the power of the lens by the addition of an ordinary convex objective. I use a simple convex lens placed in front of my camera lens. It is a corrected lens, being made up of two glasses cemented together, and is really the objective bought with a che[illegible]r-plate camera. With it I am able to obt[illegible] magnification up to six diameters. Beautif[illegible]hromes as well as ordinary photographs ca[illegible] be obtained.

Figure 4.

The Green-winged Meadow Orchis (*Orchis Morio*). Photographed natural size and magnified four diameters.

[illegible]

For all ordi[illegible] work plates are much to be preferred to films. Backed plates should always be used, and a colour sensitive plate is essential. Undoubtedly the very best results are obtained with such a plate as the Panchromatic, but these are perhaps a little troublesome to develop, and quite satisfactory pictures can be taken on any of the ordinary colour sensitive plates. I have used Barnet Chromatics for several years, and have no reason to change. There is no point in selecting an excessively rapid plate. For blue, red or orange flowers a colour screen is, of course, necessary, but it has to be remembered that the use of a colour screen, even of the palest tint, doubles or quadruples the exposure, and makes the struggle with the worst enemy of the plant photographer—wind—all the keener. Not infrequently, therefore, the colour screen will be dispensed with, and a fairly satisfactory result obtained nevertheless. Occasionally also a special point in the picture can be emphasised, or made to stand out more clearly by intentionally over- or under-correcting the colour values. For instance, the yellow stamens of a white flower are more distinctly seen when no light filter is used, but a yellow flower will stand out best against grey rock if the colour values are slightly over-corrected. Sometimes the same result can be even better obtained by the use of a filter of red, blue, or green, or some other intermediate tint, or by making part of the exposure with one filter and part with another. I have tried this with success, but have generally found that it requires too much consideration in planning and too much care in carrying out to be of much practical use in the field.

Colour Photography.

But to obtain the very best results it is necessary to photograph plants in their natural colours. Nothing can exceed the beauty and charm of a flowering plant growing in its natural home and photographed in its natural colours. Those who have once started colour work will never willingly return to the old monochrome. For myself, I can only speak of the autochrome process, but I have found this so perfect that I want nothing better. And it is really simpler than ordinary photography. A single exposure is alone required and the photograph can be finished in a quarter of an hour. With the help of a meter to calculate the exact exposure I find that I hardly ever spoil an autochrome plate except as the result of some technical error in the arrangement of the plants or on account of wind.

Figure 5.

The Wood Pink (*Dianthus sylvestris*). To show the effect of a natural background out of focus.

Selection of Subject.

It is difficult to give any useful hints as to the selection of the subject to photograph, for different people have very different ideas as to the effect they desire to obtain. With some a pleasing and natural picture is the chief aim, but others try to combine with this a botanically correct portrait of a plant or part of a plant, arranged to display its chief characteristics, such as buds, leaves, fruits, and so on. Generally, it may be said that the best results will only be obtained by those who know at least something of the subject they are trying to photograph. The individual, for instance, however proficient he may be as a photographer, who carefully arranges buttercup leaves among a group of poppies, where the foliage appears a little deficient, will not obtain a satisfactory picture. Not infrequently a small group of plants looks nicer than a single specimen, and wherever possible, it is wiser to select something compact and not very large, rather than a straggling mass. How far "faking" is permissible is a moot point. A little judicious weeding immediately around the plant to be photographed often makes it stand out much more clearly, and the same result is sometimes obtained by pushing away and pressing down the other plants which surround it. It is generally desirable also to remove any foreign plants that are growing among the group selected and sometimes the careful removal of a few dead or faded leaves, or even flowers, seems to do good. Where we find a rather straggling group of flowers with considerable depth of focus it is, I think, sometimes permissible to place a stone behind them in such a position that it cannot be seen from the front, so as to throw forward the flowers at the back and bring them more in line with the remainder.

Whether anything further is ever to be thought of is very uncertain. Whether, for instance, one or two buds should be added to a plant which is well proportioned and otherwise makes a pleasing picture but is deficient in this particular. Certainly, if Nature is to be assisted in any way, it needs to be done most carefully. Moreover, if there is the slightest breeze it will be often found that while the plant as a whole returns to its former position in the intervals, the additions do not, and a spoilt plate results. Further, where the exposures are long, as in colour work, what may be described as "fading fog" has to be reckoned with. Where the connection between the branch or flower and its root is severed, fading takes place and in plants growing in moist places this may be so rapid as to entirely spoil the picture after an exposure of five minutes. Had I not had

Figure 6.

A rare Fungus (*Hydrium erinaceum*). Photographed in a hollow tree on a foggy November day, in pouring rain, and given 15 minutes' exposure at F 11.

one or two unfortunate experiences in this way I should not have believed it possible.

Backgrounds.

Although I have repeatedly made the attempt, I have never been able to produce a satisfactory result by using an artificial background. I have tried sheets of paper of various tints, supported in various ways or kept in movement by an assistant. Even where the motion does not extend to the plant, as very easily happens, the result is, in my experience, never satisfactory. Unquestionably the best background is the natural one, which, however, can be slightly modified where necessary by the removal of anything which will too prominently strike the eye, as for instance, a single large stone or a very noticeable plant of a different species. Plants of the same species, perhaps a little out of focus, seem to me rather to improve the general effect. In colour work special care must be taken of this point. A bright yellow buttercup, even if rather blurred in outline, behind a group of blue forget-me-nots catches the eye, and directs attention to itself more than to the subject of the picture. To my mind by far the best result, both pictorially and diagramatically, is obtained by the use of a natural background rather out of focus. There are three points to be borne in mind in obtaining this desired result. With the camera looking down obliquely at the plant, and the swing-back used as described in the early part of this article, the background is almost certain to be indistinct. Where the plants to be photographed are growing amongst others, the immediately surrounding vegetation, and especially that behind them may be pushed aside with the hand or even pressed down with the foot. And lastly, by very careful focussing and the use of the largest possible stop consistent with obtaining the required depth of focus, an indistinct background is obtained. In plant portraiture, no less than in human, the most artistic results are obtained by a somewhat indefinite background.

Wind.

In connection with field-work the greatest enemy of the plant photographer is wind. However calm it may appear, there are very few occasions, except soon after dawn and just before sunset, when vegetation is absolutely at rest. Of course, tall flimsy things like sedges and grasses are most affected, and short solid things like toadstools feel it least or not at all, but there are really very few occasions in ordinary field work when the wind has not to be considered. This will be the more evident when it is remembered that the exposures in plant photography are generally long, as a small stop has to be used. Frequently, for instance, I have had to give four to five minutes on a dull day with the ordinary plates, and five to ten minutes exposure is quite the rule, even at noon in the middle of the summer, with autochromes. The simplest method of obviating the effect of wind is to make one's exposure a few seconds at a time while the plants are quiet, for wh[illegible]re has not been assisted we can safely trust [illegible]ters to return to exactly the same positions between the gusts. One must not necessarily conclude that a photograph will be entirely useless because there has been a certain amount of movement during some part of an exposure. Even where failure seems assured, it is just as well to develop, and sometimes the result will be an agreeable surprise. As a direct shield from the wind an umbrella or sunshade, preferably of a light colour, is exceedingly useful. A very little ingenuity in the placing of the camera and umbrella is sufficient to ensure that the latter does not appear in the photograph. One or more long-suffering friends who are capable of remaining in one position for several minutes, particularly if wearing overcoats or full skirts at the time, are also much to be desired. But as these aids, however desirable, are not always to be had, the plant photographer is advised to provide himself with what may be termed a "wind screen." A simple and useful form may be made as follows. Obtain a piece of stout white calico, six or eight feet long by fourteen inches wide and half-a-dozen fifteen-inch steel knitting needles. Roughen each knitting needle near one end by twisting some thin wire around it and soldering it to the knitting needle. Get someone to stitch four pieces of tape each fourteen inches long at equal distances along the strip of calico and one at each end, slip in the knitting needles and sew them firmly in place near one end so that the other end projects an inch. The apparatus is now complete. It is arranged on three sides of the plant with the camera lens looking over the middle of the enclosure and the whole thing strongly suggests a "coco-nut shy" on a small scale. It is wise to put the camera into position and roughly focus the plant before putting up the enclosure. Where a taller screen is used, it is desirable to have a slit cut in the calico near its middle, (with some hooks and eyes to close it if you like), through which the camera lens can be made to project. The only objection to such a screen that I know of is that it cuts off a certain amount of side light, and can hardly be used to completely surround the object, unless the camera is looking down on it more or less obliquely. Less light is cut off than might be expected, for the white calico reflects a good deal and is sometimes useful for this reason alone when there are heavy shadows. A more complete enclosure can be made by using a transparent material. Sheets of transparent celluloid about thirty-six inches by twenty can be obtained at any large photographic dealers for eighteenpence or thereabouts. It is easy to cement two or more of these together with collodion, which can be bought at any chemist's, allowing an overlap of half-an-inch. Strips of broad tape to enclose the steel wire standards can easily be cemented to the celluloid sheets with the same material. As the collodion softens the sheets it is best to let them dry between a couple of boards. A group of plants can be entirely surrounded by a screen of this sort, for a very pleasing effect is obtained by photographing the natural background through a celluloid sheet. Or a combination of the calico and celluloid screens is often quite successful. I generally carry a couple of spare sheets of celluloid and a dozen tie-clips, and with these it is quite easy to roof in the little enclosure, and effectively prevent any movement of any but the most fragile of plants. In calculating the exposure, it is necessary to remember that an appreciable amount of light is absorbed by the celluloid.

Lighting.

People often remark how nicely the lighting of my photographs is arranged. But I am hardly ever conscious of giving the matter any consideration at all. Certainly the calico wind screen set rather obliquely does reflect up a good deal of light. Occasionally, where there are very deep shadows, a piece of newspaper lying on the ground just in front of the plant, but so arranged that it does not appear in the picture, may also be useful. But generally speaking, seeing that our object is to obtain as natural-looking pictures as possible, the less we trouble about the lighting of our subject the closer to Nature will our result prove. Photographs should never be taken in direct sunlight, for the deep shadows are devoid of detail and mostly unsightly. Always stand between the plant and the sun or use an umbrella.

Exposure.

If you want to economise time and money, buy an exposure meter and use it. Use it at first in every case, for the difference of light value in a wood or beneath a hedge, compared with that in an open field is very considerable. Place the exposure meter as near as possible to the object to be photographed, and read off the exposure, allowing for the size of the stop and the variety of plate used. Multiply this by three if you are photographing about half natural size, by four if you are photographing, roughly, natural size, and by six if you are taking the plant a little bit enlarged with a much extended camera, but without any extra front lens. The reason for this increased exposure is that the size of the stop, as indicated on the lens, is only correct when distant objects are photographed, and when the camera is extended as in photographing an object about natural size and the distance of the plate from the lens is approximately doubled, the number representing the size of the aperture is in reality double that indicated. For instance, if we appear to be using F32 while photographing an object natural size we are in reality using F64, and as everyone knows this aperture will require four times the exposure of F32 for the same conditions of light. Unless the plant photographed is absolutely free from deep shadows, it is wise to multiply by two again. There are noteworthy exceptions, but it is a general rule that most plate makers put a very liberal estimate on the speed of the plates they manufacture, and if thirty per cent. or so is deducted from the speed given, the exposure calculated will, in most cases, be the more correct. In all cases, if we err at all, it is better to err on the side of over-exposure. Where the test paper of the exposure meter takes several minutes to change colour, as in studio work, or outside in very dull weather, it is often convenient to expose at the same time that the exposure is being calculated. I use a Wynne meter and as soon as I have started exposing I set it up so that it is receiving the same light as my subject, but is just outside the picture. Using plates of speed 100 and photographing natural size, I find that when the test paper has changed to the lighter colour my exposure is correct for a 16 stop (which is really 32 as the camera is doubly extended), and when the colour has changed to the deeper tint I am all right for F32 (really 64). In autochrome work the exposure is estimated very simply. Using the Wynne meter, we know that the time taken for the test paper to reach the darker tint is the correct exposure for a landscape at F11. For photographs of objects taken approximately natural size, we multiply by four, and if there are any shadows at all by two again. Allowance for every stop other than F11 is made according to the ordinary rules.

Figure 7.
The Studio Camera.

Studio Work.

In conclusion, may I add one or two hints as to studio work. My experience in this part of the subject has, however, been much more limited. The accompanying photograph of the apparatus I use will explain itself. It consists of a base with a slotted wooden standard some four feet long. Moving up and down on the standard, but kept in line by pieces of wood that fit into the slot, are a half-plate camera mounted on a box, and a carrier to hold a 12-in. by 10-in. sheet of glass. The carrier is open in front to avoid any shadows on the background placed below, and both carrier and camera are clamped in position on the standard by thumb screws. The tense copper wires greatly increase the rigidity of the whole thing. The apparatus is used in an ordinary room close to the window, or preferably in a bay window, porch, or greenhouse, or even outside. The plant to be photographed rests on the glass plate, and about three or four inches below it, to avoid shadows, is placed a sheet of white or grey cardboard. A very dark or black background is in this situation unsatisfactory, for the glass plate then becomes a looking glass and a double image of the plant is seen in the photograph. Where a black background is required the plant rests directly on a sheet of dull black paper which is supported on the glass plate. For colour work an interesting background is often made by a sheet of white cardboard with one or several layers of "chiffon" of different tints laid on it. Given a dozen or more pieces of "chiffon," a thin silky material, dyed half a dozen different colours, almost any tint can be built up. If the background is some three or four inches away it will be sufficiently out of focus to prevent any slight irregularities in the material appearing in the photograph. This point should be tested before exposure by a careful insp[illegible]r the lens has been stopped down sufficient[illegible] course, it is by no means always necessary [illegible] to lay the plant down to photograph it. [illegible] much more natural results are obtainable [illegible] plant is held erect in a vase of water, being [illegible] the vase does not appear, with the background su[illegible]tly far away from it to be thoroughly out of focus. Even in this position a sheet of glass immediately behind is often of value, for it limits the depth of focus of the picture and gives support to flimsy plants. In photographing plants we must remember that we are dealing with living things which actually move, especially when any change takes places in the equilibrium of their water-vascular system. Hence it is unwise to pick flowers on a hot summer day, put them in a vase of water and immediately give them a prolonged exposure. Rather should they be left in water for at least two hours so that the cells of the plant may accustom themselves to an abundant water supply. Again, when flowers are taken out of water and put into position to be photographed it is just as well to cover the cut stalk, if it does not appear in the photograph, with a small piece of moistened cotton-wool to prevent "fading fog." Where the light is poor both in the studio, and the field, focussing is greatly assisted by placing a small scrap of printed paper close to and in the same plane as the principal object to be photographed, of course removing it before the exposure is made.

SOLAR DISTURBANCES DURING AUGUST, 1911

By FRANK C. DENNETT.

During August the disc appeared to be quite free from disturbance on the 1st, 4th and 26th until 31st, whilst only faculae were seen on the 2nd, 3rd and 18th until 25th. The longitude of the central meridian at noon on August 1st was 15° 29′.

No. 32.—The most conspicuous outbreak of the month, first seen within the limb on the 5th. The umbra of the large spot was bridged on the 7th, and had an extension eastwards, with a small companion following. During the 8th and 9th other spotlets formed, and changed, indicating considerable activity, and the inner border of the penumbra of the large spot was bright from the 7th until the 10th. Only a minute pore remained as its solitary companion on the 11th, when the spot had dwindled considerably. On the 13th, there were two closely placed umbrae, and on the morning of the 14th, when last seen, only one. The maximum diameter of the spot was over ten thousand miles, and the length of the group over forty thousand miles.

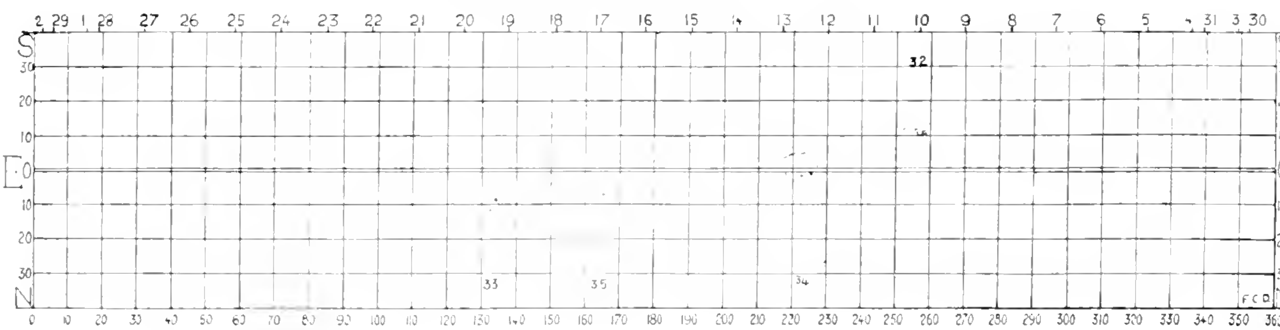
No. 33.—Two pores amid brilliant faculae had come round the limb on the 13th, the rear one being 2° farther north, and a similar distance eastward of the leader. They died away on the 15th.

No. 34.—A pair of pores three degrees apart had broken out on the 15th, next day the rear one had closed up, but the area appeared disturbed, and on the 17th, when last seen, the pore appeared cut in half by a bridge.

No. 35.—A solitary pore only seen on the 16th. There may be a very small error in its position. The dotted areas upon the chart indicate the positions of faculic areas; that around No. 34 being observed on the 7th and 8th; that at 205° from the 8th until the 10th. The group around longitude 153° on the 13th. Not the least interesting faculic disturbance, however, was a bright group on the 19th, in 60° south latitude near longitude 67°, seen until the 23rd, though its brilliance had decreased. The general granulation of the disc appeared coarse over the south-eastern quadrant on the 27th.

Our chart is constructed from combined observations of Messrs. John McHarg, E. F. Peacock, and F. C. Dennett.

DAY OF AUGUST, 1911.



THE FACE OF THE SKY FOR OCTOBER.

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

THE SUN.—On the 1st the Sun rises at 6.0 and sets at 5.40; on the 31st he rises at 6.52 and sets at 4.36. Conspicuous Sun-spots and faculae are not to be expected at this phase of the eleven-yearly cycle, but smaller displays may occasionally be visible. The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:

Date.	Axis inclined from N. point.	Centre of Disc N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Oct. 3	26° 13′E	6° 35′	203° 10′
„ 8	26 25′E	6° 18′	137 20′
„ 13	26 25′E	5 58′	131 23′
„ 18	26 14′E	5 35′	65 26′
„ 23	25° 52′E	5 10′	359° 29′
„ 28	25 10′E	4° 43′	293 33′
Nov. 2	24 33′E	4 13′	227 37′
„ 7	23 35′E	3 41′	161 41′

An Annular Eclipse of the Sun occurs on the 22nd, it is invisible in this country, but visible as a partial eclipse in India and Australia.

THE MOON:—

Date.		Phases.	H. M.
Oct. 8		Full Moon ...	4 11 a.m.
„ 14	☾	Last Quarter	11 46 p.m.
„ 22	●	New Moon	4 9 a.m.
„ 30		First Quarter	6 41 a.m.
Nov. 6		Full Moon	3 48 p.m.
Oct. 12		Perigee ...	6 30 a.m.
„ 27		Apogee	10 30 p.m.

OCCULTATIONS.—The following table gives particulars of the principal occultations visible from Greenwich:—

Date.	Star's Name	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. point. E.	Reappearance. Mean Time.	Reappearance. Angle from N. point. E.
Oct. 3	37 Capricorni ...	5·7	p.m. 11 48	355°	a.m. 0.10	306°
„ 6	ψ^1 Aquarii ...	4·5	a.m. 2 10	353	a.m. 2.43	302°
„ 6	ψ^2 Aquarii ...	4·6	a.m. 2 40	86°	a.m. —	—
„ 13	B.A.C. 1754	5·7	a.m. 1.31	110°	a.m. 2.31	226°
„ 28	B.A.C. 6628	5·9	p.m. 6.18	26	p.m. 7.10	305°

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
Sept. 29 ...	11 19	N 0° 6′
Oct. 9 ...	12 29	S 0 7′
„ 19 ...	13 23	S 7° 32′
„ 29 ...	14 25	S 14° 26′
Nov. 8 ...	15 27	S 19° 53′

Mercury is a morning star until the 23rd, when he will be in superior conjunction with the Sun. The planet may possibly be observable during the first week of the month, when he rises, almost due East, more than an hour before the Sun.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
Sept. 29	10 52	S 0° 26′
Oct. 9	10 52	N 1° 50′
„ 19	11 5	N 2° 38′
„ 29	11 28	N 2° 3′
Nov. 8	11 59	N 0° 20′

Venus is a morning star throughout the month, rising, almost due East, at 3.10 a.m., on the 15th. The planet will be at its greatest brilliancy on the 22nd, and its angular distance from the Sun will continue to increase until it reaches greatest westerly elongation, on November 26th.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
Sept. 29	4 28	N 20° 28′
Oct. 9	4 36	N 21° 3′
„ 19	4 38	N 21° 30′
„ 29	4 34	N 21° 49′
Nov. 8	4 23	N 21° 58′

Mars is now approaching opposition (November 25th), and will be well placed for observation during the later hours of the evening. The planet rises N.E. by E., about eight p.m., at the beginning, and about six p.m. towards the end, of the month. Its apparent diameter increases during the month from 14″·1 to 17″·5. The planet will be easily identified if looked for about five degrees to the North of Aldebaran. The South pole of the planet is turned towards the earth.

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
Sept. 29	14 49	S 15° 23′
Oct. 9 ...	14 57	S 15° 59′
„ 19	15 5	S 16° 35′
„ 29	15 14	S 17° 11′
Nov. 8	15 23	S 17° 45′

Jupiter is nominally an evening star throughout the month, but he is very low down in the South-Western sky at sunset, and as he sets about an hour after the sun, he can only be observed with difficulty.

The configuration of the Satellites as seen in an inverting telescope, and observing at six p.m., are as follows:—

Day.	West.		East.		Day.	West.		East.	
1	3	○	214		11	42	○	3	1●
2	31	○	24		12	41	○	23	
3	32	⊙	4		13	4	○	$\frac{1}{2}3$	
4	2	○	134		14	421	○	3	
5	1	○	234		15	$3\frac{2}{4}$	○	1	
6		○	2143		16	31	○	42	
7	214	○	3		17	32	○	14	
8	43	○	1	2●	18	$2\frac{1}{3}$	○	4	
9	431	○	2		19	1	○	234	
10	432	○	1		20		○	1234	

The circle (○) represents Jupiter; ⊙ signifies that the Satellite is on the disc: ● signifies that the Satellite is behind the disc or in the shadow. The numbers are the numbers of the Satellites.

SATURN:—

Date.	Right Ascension.	Declination.
	h. m.	
Oct. 1 ..	3 11	N 15° 12′
,, 16 ..	3 8	14° 56′
,, 31 ..	3 3	N 14° 37′

Saturn may now be conveniently observed during the evening, as he rises, in the E.N.E., at 7.8 p.m. on the 1st, and at 5.6 p.m. on the 31st. The planet is a conspicuous object, some distance to the west of Aldebaran and Mars, and cannot be mistaken. The rings are well open, the outer major and minor axes being respectively 47″ and 17″, and the inclination of the plane of the ring to our line of vision being 21°. The Southern pole of the planet is presented towards the earth. The planet has eight satellites: of these, Titan (magnitude 8·5) can be observed with a good objective of two inches aperture. Iapetus (magnitude 9–12) may be seen at westerly elongation with a telescope of three inches aperture, which is also sufficient to show Rhea (magnitude 9.5) and Tethys (magnitude 10), whilst Dione (magnitude 10·5) requires an aperture of four inches.

The three other satellites require larger telescopes since their magnitude is less than 12.

URANUS:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Oct 1 ...	19 49 57	S 21° 36′ 30″
Nov. 1 ...	19 51 10	S 21° 32′ 48″

Uranus, in Sagittarius, can only be observed in the early evening during the present month, and is too low in the sky to be well seen The planet sets about 11.14 p.m. on the first, and about 9.17 p.m. on the thirty-first. It can be distinguished from neighbouring stars by its small greenish disc of $3\frac{1}{2}''$ diameters, if viewed with sufficient magnifying power. After October 6th, when the planet is stationary, the motion will be direct, or easterly.

NEPTUNE:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Oct. 1 ..	7 41 26	N 20° 49′ 23″
Nov. 1 ..	7 42 15	N 20° 47′ 7″

Neptune is not yet very conveniently placed for observation, as he does not rise before 11 p.m. at the beginning of the month, nor before 9 p.m. at the end. The planet is located in Gemini, nearly midway between [illegible] Geminorum and ψ^2 Cancri. The motion is direct, or easterly, until the 28th, when the planet is stationary.

METEORS:—

Date.	Radiant. R.A.	Radiant. Dec.	
Oct. 2 ...	230°	N. 52	Slow, bright.
,, 4 ..	310°	N. 70°	Slowish.
,, 8 ..	77°	N. 31	Swift streaks.
,, 8-14 ..	45°	N. 58°	Small, short.
,, 14 ..	133°	N. 68°	Rather swift.
,, 15 ...	31°	N 9°	Slow.
,, 18-20...	92°	N. 15°	Swift, streaks.
,, 23 ...	100°	N. 13°	Swift, streaks.
,, 29 ..	100	N 23°	Very swift.

The principal shower is that having its radiant point near ν Orionis, and hence known as the Orionid shower; the maximum display is from the 18th to the 20th.

ALGOL.—Observable minima of Algol occur on the 12th at ten p.m., and on the 15th at seven p.m. The period is $2^d\,20^h\,49^m$.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—γ Arietis, $1^h 48^m$, N. 18° 48′, magnitudes 4·2, 4·4; separation 8″·8. Easy double, with a power of 30; the first double star telescopically observed.

γ Andromedae $1^h 58^m$, N. 41° 51′, magnitudes 2·1, 4·9; separation 10″. The brighter component is intensely yellow, whilst the other is greenish-blue. The fainter star is a binary, the components of which are now less than half a second apart.

NEBULAE.—The Great Nebula in Andromeda 31M, easily visible to the naked eye, and readily distinguished by the aid of an opera glass, in the neighbourhood of ν Andromedae. Seen with a three- or four-inch telescope, it appears as an extended oval with a bright nucleus, and has often been mistaken for a comet. Spectroscopic observations suggest that it is built up of a vast number of stars.

(32M) Nebula about 2° to the South of the Great Andromeda Nebula. It is fairly round and appears like a star out of focus.

($18\frac{H}{V}$) lies about the same distance North of the great Andromeda Nebula that 32M does South; it is faint, but large and elliptical.

COMETS.—Observers who possess a pocket spectroscope, or its equivalent, will find it of interest to examine the spectrum of Comet Brooks, even if the telescope has only an aperture of two or three inches. The three typical bands of cometary spectra, in the yellow green, green, and blue, were easily visible under these conditions at the time of writing (September 16th). The slit should first be placed at the focus of the telescope by observations of a bright star, the spectrum of which should appear as a narrow streak when the adjustment is made. The image of the comet may then be brought on the slit with the aid of the finder.

Comet Brooks (1911 *c*) is visible to the naked eye as a third magnitude star, but with a pair of binoculars the nebulosity round the nucleus may easily be seen. The comet is moving on the confines of Ursa Major and Botes towards Leo and at the beginning of the month is situated about 5° S of η and Ursa Majoris, the star at the tip of the Bear's tail.

REVIEWS.

CHEMISTRY.

New Ideas on Inorganic Chemistry. By DR. A. WERNER. Translated by E. P. HEDLEY, Ph.D. 268 pages. 9-in. × 6-in.

(Longmans, Green and Co. Price 7/6 net.)

This is among the most valuable contributions to the science of Chemistry which have been made of recent years. The first edition was published in Germany in 1905, and within three years a second edition was required. The present book is the translation, with some additions and corrections, of this second edition.

It deals, in the main, with the problem of the valency of the elements as shown in their different compounds, and while outlining the various theories that have been put forward, attempts to weave them into a consistent fabric, and discusses their relationship to the observed facts.

Although the systematic classification of inorganic compounds does not as yet rest upon so stable a basis as that of organic compounds, indications are not wanting that before long such a scheme may be devised. In fact this book goes a long way in this direction.

Both as a critical history of the doctrines of valency and a guide to unexplored fields, it should meet with a welcome from all chemists, and in particular from those whose work involves a consideration of the structural constitution of inorganic compounds. The book is excellently translated, though there are a few grammatical slips, and is clearly printed and arranged; but although there is a full table of contents at the beginning of the book, the absence of an index is a blemish. Its use as a handbook to research would also be greatly increased by repeating the references given at the foot of each page in a classified bibliography.

C. A. M.

Inorganic Chemistry.—By F. STANLEY KIPPING, D.Sc., F.R.S., and W. H. PERKIN, D.Sc., F.R.S. 751 pages. 120 illustrations. 7½-in. × 5¼-in.

(W. & R. Chambers. Price 7/6.)

So great is now the number of elementary text-books of Chemistry that any fresh addition to them needs to justify its existence by novelty of treatment or arrangement. In the present case there is undoubtedly such justification, the subject matter being so arranged as to avoid some of the pitfalls in the way of the beginner.

All who have had experience in teaching will recall the difficulty of convincing a young student of the reality of an invisible body, and of making him grasp the fact that a salt in solution has as real an existence as an insoluble compound. This was summarised by Professor Vernon Harcourt in his phrase, that "a precipitate is too often an object of superstitious veneration."

To obviate this difficulty the authors of this book have wisely postponed the consideration of the gaseous elements, with which most text-books start, until such time as the student shall have acquired a practical acquaintance with the reaction of common salts.

The first part covers the ground needed for the London Matriculation examination, while in the second part chemical and physical changes are dealt with more fully, and sections upon the determination of molecular weights, ionic dissociation, spectrum analysis, and radioactivity are included.

In this part also comes the systematic account of the elements. The interest of the student is likely to be maintained by the way in which metallic and non-metallic elements have not been isolated from one another.

Throughout the book, experiment goes hand-in-hand with theory, and although the utilitarian end of examinations is not lost sight of, it is not unduly emphasised.

We can, therefore, heartily recommend the book to any beginner who wishes to study Chemistry without the necessity of following set courses of lessons.

C. A. M.

GEOGRAPHY.

Modern Geography.—By MARION I. NEWBIGIN, D.Sc. 256 pages. 13 illustrations. 7-in. × 4-in.

(Williams & Norgate. Price 1/- net.)

This little book forms part of the Home University Library, and is an excellent compendium of the different subjects brought into relation under the head of geography. The standpoint is "frankly anthropological," geography being considered as the study of the earth in relation to its inhabitants, especially man. The chapter headings, however, raise the doubt, at least in the mind of the reviewer, whether geography is, after all, a unit of science like chemistry or zoölogy. For instance, two of the chapters are geological, others are botanical, zoölogical or ethnographical. Is not geography, therefore, rather the application of many sciences to the description of the earth in relation to its inhabitants? Be that as it may, we have read Miss Newbigin's work with great pleasure, and believe that it will give similar pleasure to that section of the public which desires popular accounts by competent specialists of the latest developments in knowledge. A note on the literature and a good index is provided.

G. W. T.

GEOLOGY.

Characteristics of Existing Glaciers.—By W. H. HOBBS. 301 pages. 34 plates. 140 figures. 9-in. × 6-in.

(New York: The Macmillan Co. Price 13/6 net.)

This important and authoritative work is by a distinguished American glacialist whose mind has not been unduly obsessed by the importance of the alpine type of glacier. Throughout the book emphasis is placed on the contrast between mountain glaciers—the alpine type—and continental glaciers, such as those which cover Greenland and the Antarctic Continent. Hitherto, despite the enormous disparity in size and shape, the practice has been to treat these types together as if they obeyed the same laws and accomplished the same work. This book takes the view that mountain and continental glaciers are different in kind rather than in degree. In accordance with this view, most space is allotted to the continental type as being by far the largest and most important masses of ice. The ice-caps covering small elevated areas, such as those of Iceland, are regarded as in some measure intermediate between the two types; but physiographically they are allied to the continental ice-sheets, and have few affinities with mountain glaciers.

Professor Hobbs is a convinced upholder of the excavating and eroding power of glaciers, in opposition to the school which claims that glaciers exercise a more or less protective influence on their beds. We think, however, that the author assigns too little weight to the maturely considered views of such authors as Bonney and Garwood as to the protective influence of glaciers. In regard to mountain glaciation, much importance is given to cirque-recession as one of the chief erosional methods of small bodies of ice, in strong contrast to continental ice-masses, whose chief method of erosion is by abrasion of their floors.

One of the most useful features of the book is the way it summarises and collates the ice-observations of numerous recent Arctic and Antarctic expeditions, down to those of Peary and Shackleton.

The book is excellently and profusely illustrated. Each chapter is accompanied by a full list of references, and an adequate index is provided. We welcome it as an excellent reference work to modern views of glaciation, the literature of which is widely scattered, enormous in its extent, and to many workers rather inaccessible. G. W. T.

The History of Geology.—By H. B. Woodward, F.R.S., F.G.S. History of Science Series. 154 pages. 14 plates. $6\frac{1}{2}$-in. × 5-in.

(Watts & Co. Price 1/- net.)

As a science, geology dates from the close of the eighteenth century, although many vague and curious notions as to the constitution and structure of the earth were current before this time. These ideas were originated by speculation about earthquakes, volcanoes, springs, landslips, and other natural phenomena. Mr. Woodward goes as far back as the philosophers of Greece and Rome. [illegible] [illegible] quotations which seem to prove that the [illegible] [illegible] modern geological ideas originated in very early times [illegible] [illegible] chapter on these early notions, the author passes on [illegible] [illegible] work of the founders of modern geology, Hutton [illegible] [illegible] and their contemporaries, whose work made possible the [illegible] "golden era" of geology, the giants of which were Sed[illegible] [illegible] [illegible] Lyell, Von Buch, and Elie de Beaumont. It [illegible] [illegible] to note the predominance of British names in t[illegible] [illegible] of geology. So much has the pioneer work of British [illegible] [illegible] impressed itself on the science that the common [illegible] [illegible] graphical terms, such as Lias, Devonian, Silurian, [illegible] [illegible] in this country, are now used all over the world. In regard to petrology we miss a reference to the recent work of Whitman Cross on the history of that branch of the science. Mr. Woodward is to be congratulated on this thoroughly readable and useful little book, which supplies an undoubted want in the literature of geology. It is illustrated by fourteen excellent portraits of famous geologists, including Miss Etheldred Benett (1770–1845), the first lady to distinguish herself by a systematic study of the science. G. W. T.

METEORIC PHENOMENA OF SEPTEMBER 2nd, 1911.

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

There were some beautiful fireballs observed on September 2nd, and the date was already known as one on which these objects are apt to appear with unusual abundance.

In the sunshine of the afternoon, at 3.45 p.m., a splendid meteor was seen from various stations in Cornwall and Devon. Situated beyond the Bristol Channel, it could not be well observed from N.E. counties. Observed from Newquay, it was described as being like an elongated or pear-shaped electric bulb with a tail, travelling at great speed and emitting a brilliant white light.

At Launceston the meteor fell in the north, being directed from the west, at an angle of about 45°.

At Redruth "a brilliant star with a tail" was observed running to the N.N.E.

At Polzeath it surprised some golf players, who noticed its brilliant flash of silver light in the sky. Its direction was from S. to N. At Barnstaple it was alluded to as a meteor of great lustre, travelling from S.W. to W. at fifty degrees above horizon.

At Fowey it was seen as "a brilliant kite with sparks issuing from the tail and travelling from N.N.W. to N.N.E." Unfortunately these and other accounts are not sufficiently exact—but it is hoped that descriptions will yet be forthcoming and allow the real path of this daylight fireball to be well determined.

On the same date, but when darkness had nearly closed in, and the stars were shining as brightly as they well could with the presence of a gibbous moon in the southern sky, another grand meteor appeared, and the number of its observers seem to have been legion. This time the locality favoured was transferred to the North Sea and Scotland, for the meteor took a long and rather slow flight over Berwick, Edinburgh, and Stirling, finally disappearing over Argyle when N. of Inverary.

The spectators of it were distributed over a wide area, for descriptions of its aspect and position have come from Leeds, Manchester and North Wales in the South, from Dungannon, Tyrone in the West, and from Rothes and Rothiemay in the North.

All classes of people saw it, from the untutored agricultural labourer to the cultured *savant*, and some of the reports are very good, though others are not without rather serious discordances.

The meteor was one of the finest kind, for at Edinburgh, Glasgow and other places not very far from its track its light burst with astonishing brilliancy over the sky and landscape, and some people mistook it at first for a very prolonged lightning flash, while others thought it due to the explosion of a monster rocket. The light of a nine-day old moon seemed pale and insignificant beside the splendour of the meteor when it momentarily shone at its best.

It is not feasible to refer to the individual observations. The statements as to colour differ but the nucleus appears to have been of an electric blue, while the tail following it was reddish-yellow.

I have compared about fifty observations of the object, and find that its height was from about eighty-eight to twenty-six miles, directed from E.S.E. to W.N.W., along a path of one hundred and ninety-six miles, traversed at a velocity of nineteen miles per second. It was a member of a well-known meteoric shower in Pisces at $348° + 3°$, which supplies many beautiful fireballs during the last half of August and first half of September.

Some of the observers did not witness the whole of the luminous course. Many of them only looked up to the heavens when the meteor's startling lustre attracted their attention, and after it had already completed a large section of its trajectory.

The meteor was probably the most brilliant object which passed over Scotland since the great Leonid fireball of November 16th, 1910, described in "Knowledge" for March, 1911, page 116.

The radiant South of the Square of Pegasus, in Pisces, has previously furnished many fine meteors, and the following is a summary of a few of the more interesting:—

Date.			Mag.		Radiant.
1900, Aug. 19	...	...	3 · ♀	...	$340° \pm 0°$
1901, ,, 21	...	...	1st	...	$341 + 5$
1899, ,, 24	...	...	$\frac{1}{2}$	...	$345 + 14°$
1899, Sep. 8	...	...	> ♀	...	$347° + 3°$
1875, ,, 14	...	...	>	...	$348 \pm 0°$
1901, ,, 14	...	...	♀	...	$345 + 1°$
1898, ,, 17	...	...	1st	...	$343° \pm 0$
1906, ,, 27	...	...	♀	...	$345° + 2°$

This year I saw several small meteors early in September from this shower, but the fireball was too far north to be visible at Bristol.

We have had here in Bristol a magnificent summer for observing purposes. Between July 1st and September 22nd (eighty-four nights) there were only two nights on which the stars were invisible.

"SWEEPINGS."

By FRED ENOCK, F.L.S.

August 22nd, 1911, will long be remembered by Mr. Chas. O. Waterhouse and myself as a "red letter day," for we had swept the grass and herbage in and about Richmond Park *so* often without capturing anything particular, though we have both swept many localities in the hope of a prize, and we have taken several firsts, as well as specials, offered to all who will enter the arena open to every one so inclined.

The day opened threateningly, the clouds looked as though they had a thunderstorm in hand, but it cleared off and bright sunshine appeared.

We swept our crossing backwards and forwards for a couple of hours without much luck, just a few of our favourite *Cosmocoma fumipennis* (females), the male of which we had searched for for many years. I captured my first female at Woking, in 1885, and have been looking for the male ever since. I intended to go on sweeping for another ten minutes. Mr. Waterhouse had gone on about a mile, when, on taking my seat to examine the contents of my net, I ran my eyes over the grass seeds, bits of sharp-pointed rushes, tumbling out the numerous spiders, when my eye was caught by the long filiform antennae of a Cosmocomid with hairy wings. My phial was ready to be popped over it, when a great fat spider intervened and I lost sight of my quarry—but found it again and succeeded in getting it into my phial, and corking it up. *Then* I saw that after twenty-five years "keepin' on," I had captured the male of *Cosmocoma fumipennis!*

FIGURE 1.
Elenchus tenuicornis, larval stage, $\frac{1}{120}$ of an inch long.

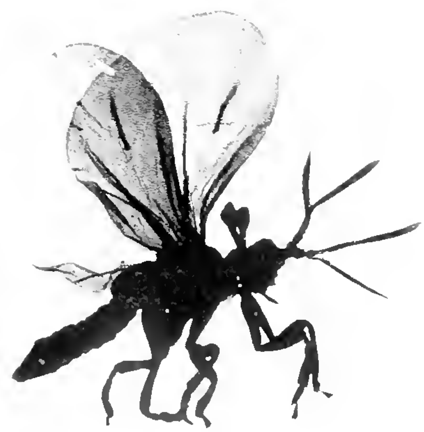


FIGURE 2.
Elenchus tenuicornis (female).

Thinking there might be another prize in my net, I soon had my lens in position, when I saw a tiny insect buzzing about in the net. I instantly thought—"Why! it's a *Stylops* or its relative *Halictophagus*." As soon as the cork closed on it I confirmed this. My ten minutes was now up, but I could not leave without telling Mr. Waterhouse, so I hurried across in the direction he had taken, and as I neared the wood I shouted, "Waterhouse, I've got it!" "Waterhouse, I've got it!" At last I heard the response, "Is that you shouting, Enock. What have you got?" Then the two old boys camp-stooled together and revelled in examining my captures.

When I reached home my buzzing *Halictophagus* was dead and mounted as soon as possible.

I had turned and killed my other captures, among which were several Frog-hoppers, and close to one, an egg-like body, with black eyes, just one hundred and twentieth part of an inch long. Thinking it an egg containing a Mymarid, I put it under the quarter-inch lens, and immediately recognised it as the hexapod larva of one of the Strepsiptera, and no doubt, as I at first imagined, of *Halictophagus*. But on reference to Westwood's "Modern Classification of Insects," I identified my capture as *Elenchus tenuicornis* (Templeton), of which but one example had hitherto been recorded, over fifty years ago.

I am now searching for missing links in the life-history of this strange insect.

NOTES.

ASTRONOMY.

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

STELLAR PARALLAXES.—*The Astrophysical Journal* for July contains an interesting paper by Frank Schlesinger on the photographic determination of stellar parallaxes with the Yerkes' refractor. There has been a great advance in accuracy in recent years, and the probable error of determination is of the order 0″·02. One general result derived is the great distance of the helium stars; four fourth-magnitude stars of this type are of sensibly the same distance as the ninth-magnitude comparison stars. The following table gives the parallaxes deduced where they exceed 0″·1 :—

Star.	Prop. Motion.	Parallax
Struve 2398	2″·28	″·29
Groombr 34	2″·85	″·27
BD + 56 2783	0″·92	″·25
WB V 592	2″·23	″·19
Lal 25372	2″·33	″·15
Lal 46650	1″·40	″·15
Lal(F)1457,1458	1″·69	″·15
WB XVII 322	1″·36	″·14
μ Cassiop.	3″·75	″·11
b Aquilae	0″·96	″·10

Where the parallax star was much brighter than the comparison stars, its light was reduced by a rotating disc, to keep its image small and measurable. This plan worked very successfully. He estimates that the number of parallaxes that can be determined per annum with this telescope is equal to the number of fine nights, about thirteen plates being taken on each night, and thirteen of each star during the year.

COMETS. The following revised elements of Comets 1911*b* (Kiess) and 1911c (Brooks) are by Dr. Kobold :—

Comet.	Kiess.	Brooks.
T in Berlin M.T....	1911, June 30·3093	1911, Oct. 27·7623
Omega	110 33′ 50″ ...	152° 44′ 18″
Node	157 26′ 21″ ...	293° 10′ 6″
Inclination... ...	148 27′ 25″ ...	34 0′ 3″
Equinox	1911·0	1911·0
Log q.	9·83565	9·69936

Both comets were evidently difficult objects to observe accurately, as there are large discordances which, in the case of Kiess, suggest that the orbit differs sensibly from a parabola. This comet is now too far South to be seen in England, and has also sunk to the tenth magnitude, but Brooks' will be a conspicuous naked-eye object in the evening sky early in October. It was half a magnitude fainter than the Andromeda nebula on August 29th, and its intrinsic brightness is likely to increase considerably as it approaches the Sun, so that it may reach the second magnitude.

Ephemeris for 11 p.m. :—

	R.A. h. m. s.	N.Dec.		R.A. h. m. s.	N.Dec.
Oct. 1...	14 7 2	43° 10′	Oct. 9...	13 19 56	32 50′
,, 3...	13 53 35	40 44′	,, 11...	13 10 46	30 2′
,, 5...	13 41 18	38 11′	,, 13...	13 2 34	27° 11′
,, 7...	13 30 6	35 33′	,, 15...	12 55 22	24° 14′

On September 30th it is 2° South of λ Bootis, and forms a continuation of the tail of the Great Bear.

On October 4th it is 10° East of Cor Caroli (Canum Venat.).

On October 12th it is near β Comae. On this day it is in conjunction with the Sun, 36° North of it, so that it may be best seen in the morning, though visible in the evening for a few nights longer.

ENCKE'S COMET. M. Gonnessiat gives in *Astr. Nachr.* 4518, particulars of his observations of Encke's Comet on July 31st and August 1st. Its finding was the result of

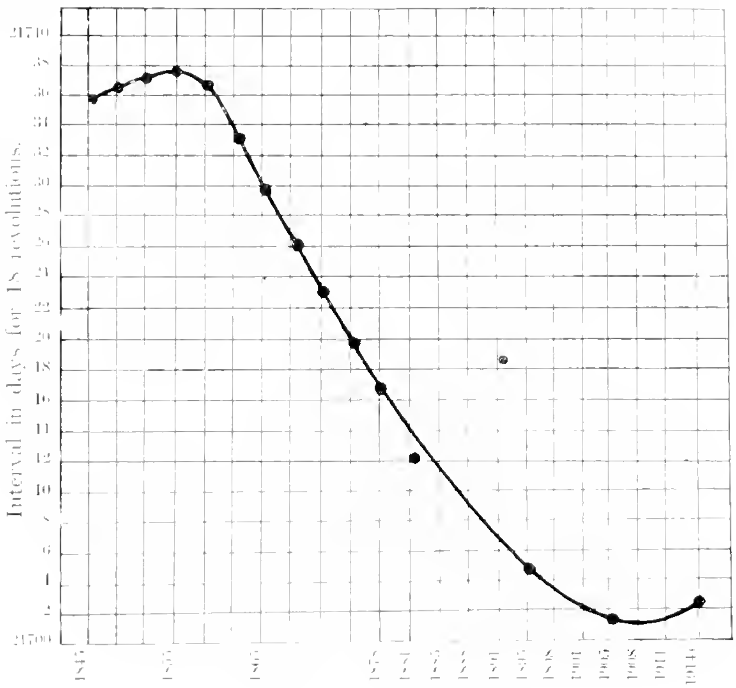


Figure 1. Encke's Comet.

patient search, and it could only be seen on these two mornings, and then only for a few minutes between its rising and the dawn. On August 1st it was thought to be of magnitude seven-and-a-half.

The predicted date of perihelion was 1911, August 19·0656, Berlin M.T. The observation of R.A. indicates that this should be increased by $0^d·178$, that of declination by $0^d·128$. Giving the R.A. greater weight, we may take August 19·23 as a close approximation to the actual date. The error of the predicted value is larger than Professor Backlund expected; he notes in *Astr. Nachr.*, 4518, that it is not due either to errors in the computed perturbations or to a wrong mass of Mercury. Presumably, it arises from an alteration in its rate of acceleration, which has taken place several times before. There is a simple way of making pretty accurate forecasts of the dates of perihelion of this comet by taking advantage of the fact that eighteen revolutions of the comet are nearly equal to five of Jupiter, and consequently the perturbations nearly repeat themselves after this interval. Table A gives all the observed perihelion and the interval in days between each perihelion and the one eighteen revolutions later.

These are plotted in the diagram above (Figure 1) and it will be seen that they lie on a sinuous curve, from which the next return (that of 1914) has been predicted. It will probably not be much more than a day in error. The return of 1911 was predicted from the curve 0·8 days too late. The comet is most conspicuous at winter returns. Those of 1786, 1795, 1805–1819 were all winter returns, at all of which the comet was independently discovered, its periodicity not being detected till after the 1819 return.

Five revolutions of Jupiter are equal to 21662·94 days.

Perihelion	Interval.	Perihelion	Interval.	Perihelion
1786—Jan. 30·88	$21739^d·7$	1845—Aug. 9·61	$21704^d·3$	1905—Jan. 11·88
...	...	1848—Nov. 26·09	$21704^d·8$	1908—Apr. 30·91
...	...	1852—Mar. 14·71	$21705^d·5$	1911—Aug. 19·20
1795—Dec. 21·45	$21740^d·6$	1855—July 1·04	$(21706^d·0)$	(1914—Dec. 5·0)
...	...	1858—Oct. 18·37		
...	...	1862—Feb. 6·25		
1805—Nov. 21·51	$21737^d·4$	1865—May 27·93		
...	...	1868—Sept. 14·62		
...	...	1871—Dec. 28·81		
...	...	1875—Apr. 12·99		
1819—Jan. 27·26	$21729^d·9$	1878—July 26·17		
1822—May 23·97	$21725^d·3$	1881—Nov. 15·30		
1825—Sept. 16·28	$21722^d·4$	1885—Mar. 7·64		
1829—Jan. 9·75	$21719^d·2$	1888—June 28·00		
1832—May 5·09	$21716^d·0$	1891—Oct. 17·09		
1835—Aug. 26·37	$21712^d·4$	1895—Feb. 4·75		
1838—Dec. 19·02	$21708^d·8$	1898—May 26·86		
1842—Apr. 12·03	$21705^d·4$	1901—Sept. 15·47		

TABLE A.

MARS. The season for this planet is again coming on. The opposition of November, though at a greater distance than the two last, is favourable on account of the planet's north declination. Work has already begun: Professor Lowell notes that successful photographs of the canals were taken in August, and that the two canals near Syrtis Major, announced as new at the last apparition, have again been seen. M. Jarry Desloges notes Mare Cimmerium and Lacus Solis as pale, while Trivium Charontis, Mare Sirenum, Titanum Sinus are dark. He sees many canals, broad and pale, but easy to distinguish, in spite of the planet's distance. Bathys appears as in 1909, but quite different from its 1907 aspect. The South Polar Cap is very small, and apparently often veiled by cloud or mist.

"Lowell Bulletin 50" contains a determination of the relative brightness of Mars' satellites. On 1909, September 16th, both were seen with aperture reduced to six inches, and it was estimated that as regards ease of seeing, Phobos was intermediate between Tethys and Enceladus. When at the same distance from the limb, Phobos was considered to be one and a-half magnitudes brighter than Deimos; the ratio of diameters is deduced as two and a-half to one, of volumes and masses fifteen to one. There was some evidence of variable brightness on the two sides of Mars, as in the case of Japetus. A Washington paper has lately appeared containing a determination of the orbits of these satellites in 1907, by Professor H. L. Rice. The epoch is 1907, July 0·0, G.M.T., and the elements are referred to the earth's equator. In each element the first value belongs to Deimos, the second to Phobos. Node 43°·42, 49°·70; Inclination 37°·75, 36°·42; Perimars 251°·0, 213°·0; ecc^y 0·0205, 0·0068.

It is interesting to compare these results with those deduced by Dr. Hermann Struve in 1898. He showed that under the joint influence of the equatorial protuberance of Mars and solar perturbation the pole of each orbit plane would describe a circle about a fixed point which, in the case of Phobos, is sensibly the same as Mars' North Pole, but in the case of Deimos is about 1° distant from it in the direction of the North Pole of Mars' orbit. The radii of the circles described by the poles of Deimos and Phobos are respectively 1¾° and 1°, and the amount of annual movement about 6°·7 and 162°. The perimars of each orbit advances at a rate sensibly equal to the retrogression of its pole. The R.A. of the pole of each orbit is Node $-90°$, and its North Polar distance is equal to inclination of orbit.

In the diagram P_1 P_2 . . . P_7, D_1 D_2 . . . D_7 indicate the apparent positions of the poles of the orbits at the epochs 1877·7, 1879·8, 1892·6, 1894·7, 1896·9, 1907·5 all reduced to the equinox of the last date. Π, Δ are the fixed points of the two orbits, according to Struve, Π^1, Δ^1 those revised by the 1907 observation. It will be seen that the alteration is small. The new positions should not be taken as definitive, since theory indicates that Π^1 Δ^1 should be parallel to Π Δ. Π is only 0°·01 from the North Pole of Mars' equator, which is on the line Δ Π produced. The diagram also shows N, the North Pole of Mars deduced by Professor Lowell from his own observations of the Polar caps combined with those of Schiaparelli, Lohse and Cerulli, and adopted in the Physical Ephemeris in the Nautical Almanac. N^1, the position recently given by Lowell from his own observations alone, is also shown. The agreement of N with Π is good in R.A., but there is a puzzling difference of 2° in N.P.D.

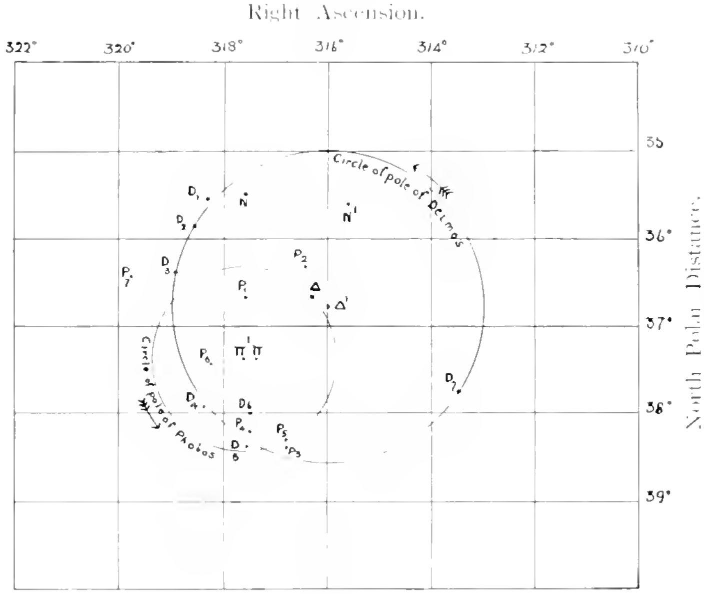


FIGURE 2.

Diagrams showing the positions of the poles of the orbits of Phobos and Deimos and of the planet Mars.

I think that ultimately the Satellite method will prevail, for their apparent orbits are much larger than the disc of Mars, and stellar points can be more accurately located than a large patch of irregular shape like the Polar cap. The fact that the accuracy increases with the apparent size of orbit is vividly shown by the much wider departures of the points marked P from the Phobos circle than of those marked D from the Deimos one. The pole of Deimos' orbit, will have been observed for a complete revolution about 1931, and after that the deduced position of the pole of Mars will probably have nearly reached finality.

VARIABLE STARS.—Mr. Joel Stebbins, who lately detected the secondary minimum of Algol with the selenium photometer, has detected a small variation of light in β Aurigae, a spectroscopic binary, showing that each star partially eclipses the other in the course of a revolution. The radius of each component is deduced as 2·6 that of the sun, the mass of each two and one-third that of the sun, and density one-third of his. Assuming a parallax of 0″·03, each component gives eighty times as much light as the sun at the same distance, while their intrinsic surface brightness is twelve times his. According to the diagram given, about one quarter of the diameter of each star is covered by the other at mid-eclipse. Mr. Stebbins has also discovered variability in δ Orionis, but his discussion on this is not yet complete. He proposes to examine other spectroscopic binaries, as, owing to their close proximity, partial eclipses must occur in a considerable proportion of them (*Astrophys. Journ.*, September).

Dr. Ejner Hertzsprung (*Astr. Nachr.* 4518) has detected a variation in Polaris of 0·17 magnitude in a period 3·9681 days, the same as that of its orbital motion given by the spectroscope. This is not, however, considered to belong to the Algol but to the Cepheid class, the variation being due to the different presentations of an elongated spheroid.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

BOTANY AT THE BRITISH ASSOCIATION.—The meetings of Section K (Botany) at Portsmouth this year were of unusual interest owing to the presence of a large contingent of Continental and American botanists. During the four weeks preceding the commencement of the Portsmouth meeting these distinguished visitors, along with a number of British botanists, had made an extensive tour of this country, specially arranged for them by the International Phytogeographical Excursion Committee.

As might have been expected in the circumstances, Ecology formed an outstanding feature of the meetings, perhaps to the exclusion of other departments of Botany, so that the papers read were not quite so representative as usual of the science as a whole. Two entire days were devoted to Ecology, and several ecological papers were also given on the other days.

PRESIDENTIAL ADDRESS.—In his Presidential Address to the Section, Professor F. E. Weiss, of Manchester University, devoted himself mainly to the consideration of certain problems in Fossil Botany, not omitting that attractive phase of the subject, the Ecology of fossil plants. He pointed out that the possibilities of vegetable fossils preserved only as *impressions* in the rocks had been practically exhausted in 1870, when Sachs published his fascinating History of Botany, and dwelt upon the debt which botanists owe to the pioneers of modern Palaeobotany—Binney, Williamson, Renault, and others—who first showed that the *structure* of fossil plants is in certain cases preserved in the most remarkable manner by petrifaction and can be studied in microscopic preparations as effectively as has been the case with recent plants since the days of Grew and Malpighi.

After dealing with the question of the homology of the well-known *Stigmaria*, and reviewing the various explanations that have been put forward regarding the nature of the Stigmarian axis and its appendages, Professor Weiss concluded that various recent observations strongly support Williamson's view that *Stigmaria* was a down-growing prolongation of the stem of the *Lepidodendron* and *Sigillaria* to which it belonged, corresponding to the lower part of the stem of the present-day plant *Isoëtes*, the Stigmarian appendages answering to the roots given off by this portion of the plant in *Isoëtes*. Apparently the one thing now lacking to complete the chain of evidence in favour of Williamson's theory is the discovery of tips of *Stigmaria* rootlets showing structure.

Passing on to the remarkable Pteridosperms, which combine the characters of Ferns and C[illegible] Weiss called attention to the criticisms whi[illegible] as recently put forward against the too wholesal[illegible] f the view that these seed-bearing, yet fern-like, [illegible] the "missing link" between Ferns and Cycads. [illegible] to Chodat the stem of a typical Pteridosperm like *L*[illegible]*ron* presents purely fern-like characters in its struc[illegible] ing that the bundles of primary wood are *not* "[illegible] the leaf-bundles of Cycads, but have only centr[illegible] while the presence of secondary growth in thickne[illegible] indication of Cycad affinity, but is merely comparable t[illegible] is found in various other fossil Ferns and Fern-allies. C[illegible] gards the "seed" of *Lygniodendron* as being merely [illegible] specialised development of the megaspore, corresponding to the seed-like organ found in the extinct Lycopod genus *Lepidocarpon*, and considers that the origin and the biology of this kind of "s[illegible]" must have been very different from those of the seeds of the Gymnosperms. In bringing forward Chodat's views, which run counter to those generally accepted in this country, on the nature of the Pteridosperms as the result of the brilliant discoveries of Oliver and Scott, Professor Weiss disclaimed any desire to urge their acceptance, but considered that Chodat's criticisms are sufficiently weighty to demand careful reinvestigation of the structure of some of the Pteridosperms.

Professor Weiss proceeded to make some criticisms of his own regarding recent theories on the origin of the Angiosperms from the Mesozoic group Bennettitales, pointing out that some botanists have "exceeded the speed-limit" in too rapid formulation and acceptance of such theories, and expressing his desire "to walk circumspectly in the very alluring paths by which they have sought to explore the primaeval forest, and not to emulate those rapid but hazardous flights which have become so fashionable of late."

In the latter part of his address, Professor Weiss dealt with the biology and ecology of fossil plants, a wide and promising field of research, of which only the fringe has yet been touched. Since the remains of plants are sometimes continuous through adjacent coal-balls ("calcareous nodules") it is clear that these concretions were mainly formed *in situ*, and that the plant remains they contain represent samples of the vegetable débris of which the coal-seam consists, giving us an epitome of the vegetation existing in Palaeozoic times on the area occupied by the coal-seam; while the Stigmarian rootlets in the underclay help to prove that the seam usually represents the remains of the Coal Measure forest carbonised *in situ*. This raises the question: What were the physical and climatic conditions of these primaeval forests? The structure of the roots of Calamites, Lepidodendra, and so on, with their large air-spaces, leads us to believe that, like many of their existing relatives, these plants were rooted under water or in water-logged soil; while the narrowness and the xerophilous structure of the leaves of these plants closely resembles the modifications met with in our marsh plants. None of the living Equisetales or Lycopodiales—the groups to which belong the Calamites, Lepidodendrons, and Sigillarias of the Coal Period—grow in salt marshes. Nor is it necessary to invoke the salinity of the marsh to explain the good preservation of the tissues of the plant remains, in view of the well-known power of humic substances to retard decay of vegetable tissues. Again, certain fungi found as parasites in coal plants seem to support the fresh-water nature of the swamp, just as the occurrence of a mycorhiza or "fungus servant" in some coal plants seems to indicate the presence of a peaty substratum. In some cases, millipedes and fresh-water shells occur in the Coal Measures among the plants; and the possible presence of marine organisms may be accounted for by occasional invasions of the Coal Measure swamps by the sea, especially as these swamps may well have been estuarine or formed near the sea.

Since so many types of vegetation are found in the Coal Measures, it is somewhat difficult to explain the occurrence, side by side, of land-plants and marsh-plants, though in certain cases it is clear that the remains of land-plants were carried into the swamp after its submergence below the sea. However, we can at the present day trace the gradual development of a lake type of vegetation from the reed-swamp through the marsh type to the peat-moor type, noting how one plant association makes place in its turn for another. Possibly the mixture of various types of vegetation found in coal-seams represents the transition from the open Calamitean or Lepidodendroid swamp to a fen or marsh with plentiful peat-formation, due to the gradual filling up of the stagnant water with plant-remains. In this transition from aquatic to more terrestrial types of vegetation, the tree-like forms rooted in the deeper water would continue to flourish, while there would be a luxuriant undergrowth of Ferns and Pteridosperms this undergrowth being placed in excellent conditions owing to the narrow-leaved nature of the canopy of trees under which it grew, apart from the provision of a suitable substratum for its roots. This would explain the striking difference between the narrow-leaved tall Calamites and Lepidodendraceae, and the large-leaved Ferns and Pteridosperms, which spread out their foliage from short stems under the shade of the former.

CHEMISTRY.

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

DISTRIBUTION OF SUGAR IN THE BEET ROOT. —The distribution of sugar and non-sugar substances in the beet root has considerable importance, both from the point of view of vegetable physiology and of sampling for commercial purposes. Some work has already been done in this direction, but in the opinion of Messrs. Floderer and Herke (*Zeit. Zuckerind. u. Landw.*, 1911, XL, 385) its accuracy is open to question, owing to the defective methods of dividing the roots for the analysis. Accordingly, they have made a fresh investigation, using for the purpose fifty roots of uniform size, which they divided into ten transverse sections and sub-divided into concentric rings in the manner shown in the diagram. The respective corresponding pieces from each of the roots were mixed together so that in all nineteen separate lots were obtained for the analysis.

The results showed that the sugar (sucrose) was present in the greatest proportion in the innermost portion of the root, those sections between the middle axis and the part where the root began to taper being the richest. Thus the most sugar was found in the following sections, 14, 15, 19, 13, 12, 18, 17 and 16; and then in decreasing quantities in 11, 6, 8, 5, 4, 3, 7, 9, 2, 10 and 1. Whence it appears that the body of the root is richest in sugar and the crown the poorest.

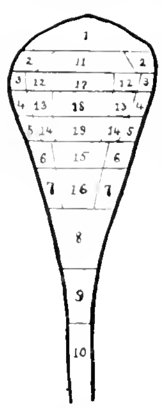


FIGURE 1.

A diagram illustrating the distribution of Sugar in the Beet-root.

With regard to the other constituents it was found that the total solid substances varied but little in any part of the root, with the result that a rise in the proportion of sugar was accompanied by a decrease in the amount of non-sugar substances. In fresh beet roots the proportion of soluble nitrogenous bodies was lower in the interior parts, while the mineral constituents (ash) varied inversely with the amount of sugar. A decrease in the amounts of potash and magnesia was observed on proceeding from 1 down to 15, where the sugar was present in greatest proportion, after which both substances increased with the fall in the sugar. It was not possible, however, to establish any relationship between the amounts of sugar and phosphoric acid.

"NON-INFLAMMABLE" FLANNELETTE. —*The Power Laundry*, of August, 1911, publishes the results of an investigation of the alleged non-inflammability of various kinds of flannelette on the market, which has recently been made in *The Lancet* laboratory.

In the case of some of the samples of material examined, the claim of non-inflammability was an obvious fraud, but in others the problem had been solved by loading the fabric with mineral salts. One of the principal dangers of flannelette is the tendency of the fine loose fluff, which becomes detached from the fibres, to flare up on contact with a flame. This tendency has been greatly reduced in certain products by weaving the fabrics with a much finer mesh, but it would seem that this only affords partial protection, and the risk of their catching fire increases after every washing.

Even in the case of materials rendered fireproof with mineral salts, a large proportion of the ash is washed out, and this may be sufficient to render the washed fabric unsafe. It is interesting to note, however, that in the opinion of *The Lancet* chemist, a definite compound appears to be formed between the cellulose and the mineral compound—apparently a salt of tin. This would explain the retention of a high proportion of the mineral constituents even after repeated washings with soap and water.

The results obtained with twelve specimens of typical commercial flannelette and the conclusions drawn from them, are summarised in the following table :—

Fabric.	Original Ash. Per cent.	Ash after washing. Per cent.	Percentage of Residual Ash.	Percentage of Ash washed out.	Conclusion.
A	5·61	0·21	3·75	96·25	Unsafe
B	2·41	0·18	7·50	92·50	,,
C	2·18	0·81	37·16	62·84	Doubtful
D1	11·49	9·83	85·86	14·44	Safe
D2	11·69	7·66	65·53	34·47	,,
D3	12·49	9·00	72·00	28·00	,,
D4	18·73	8·86	47·30	52·70	,,
D6	20·77	17·50	84·26	15·74	,,
D7	21·35	15·15	70·20	29·80	,,
E	0·68	0·52	76·50	23·50	,,
F1	8·86	0·20	4·50	95·50	Unsafe
F2	1·87	*Nil*	*Nil*	100·00	,,

The reduction in inflammability corresponded with the increase of mineral matter, the samples "D6" and "D7," for instance, being the most resistant of all. Although fabrics treated with a sufficient proportion of suitable salts may thus be rendered fireproof, yet the question arises whether the natural properties of the cotton fibre may not be impaired by the presence of as much as a fifth part of mineral matter in the fabric, even though it is in combination with the cellulose. One point that is brought into prominence by this investigation is the unsatisfactory state of the law, which permits highly inflammable material to be sold at a higher price under the description "non-inflammable," and thus lulls the purchaser into a condition of false security. So far from reducing the death rate from this cause the sale of much of the "non-inflammable" flannelette on the market appears to have led to an increase of fatalities.

GEOLOGY.

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

THE FLOWING WELLS OF CENTRAL AUSTRALIA.—A paper by Professor J. W. Gregory, F.R.S., in the July and August numbers of *The Geographical Journal*, renews interest in these remarkable wells. This paper is by way of answer to the strictures of Mr. E. Pittman and others on Professor Gregory's views on the subject, as expressed in his book "The Dead Heart of Australia." In the latter he criticised the wasteful methods of utilizing the water from the wells, and combated the current view as to the origin of the supply, by which this wastefulness was excused. The water ranges through an area of some five hundred and eighty thousand square miles in Central Australia. The general view is that it is derived from the Eastern Highlands of Australia, and is continually replenished by percolation into water-bearing beds, from rainfall and rivers in that region. The wasteful methods of use are justified on the ground that the replenishment so greatly exceeds the flow that the loss of water is unimportant. After a careful examination of the available evidence, Professor Gregory entirely rejects the view that the wells are supplied by rainfall, and are, in fact, of the normal artesian type. He holds that the water is derived from three main sources: (1) plutonic water from the interior of the earth; (2) residual water enclosed in the rocks at the time of their formation; (3) rainfall which percolated into the sandstones at an earlier geological period. If this is the case the supply is not unlimited, as is maintained by those who support the older theory, and a diminution of yield is to be expected; so much so that in the near future pumping may have to be resorted to in order to keep up the supply. According to Professor Gregory, this diminution has already begun in most parts of Queensland, South Australia and New South Wales.

The question is obviously of vast importance to Australia. If Professor Gregory's views are correct, the present waste is deplorable, and should be stopped as soon as possible. Fortunately, if it does become necessary to resort to pumping, the waste of water will be much lessened, and the decline of the water-level will become correspondingly slower.

PORPHYRITIC MONCHIQUITES IN BRITAIN.—Several very typical monchiquites have now been described from these islands, especially from Scotland. The monchiquites are characterised by their abundance of ferro-magnesian minerals, their groundmass of analcite, and frequently by the presence of remarkable ocelli, composed of radially arranged augite prisms surrounding a nucleus of analcite. A remarkable variety has recently been described by Professor W. S. Boulton, in a communication to the Geological Society. This rock is intrusive into the Old Red Sandstone of Monmouthshire, between Chepstow and Usk, and contains huge phenocrysts, attaining five or six inches in size, of augite and biotite. Nodules of olivine-augite rock are also described. This rock is compared with the monchiquites of Colonsay and Argyllshire. It is remarkably similar to a dyke-rock from Kilchattan in Colonsay, which carries enormous crystals of hornblende, biotite and augite. This rock, described in the Summary of Progress of the Geological Survey for 1909, page 52, is distinguished by containing nepheline, thus belonging to the rare group of nepheline-monchiquite. The writer of this column has discovered a third example of porphyritic monchiquite in Ayrshire. It occurs as part of an intricate complex intruding the agglomerate of a volcanic rock of Late Palaeozoic ("Permian") age, at Carskeoch Hill, near Patna. This rock carries huge phenocrysts of red barkevicitic hornblende, and biotite. Purple augite and olivine occur as a second and smaller generation of phenocrysts in the usual monchiquitic groundmass. The rock forms part of a complex in which, teschenite, teschenite-picrite, essexite, and a new ijolitic rock containing much analcite, also occur. The age of this monchiquite is definitely fixed by its mode of occurrence. It belongs to the widespread suite of alkaline igneous rocks of Late Palaeozoic age so abundant in the West of Scotland. The Argyll, Mull and Colonsay examples are believed to be of Tertiary age, but may well be older. They have the usual north-west trend of the Tertiary suite, and cut the east-west dykes of quartz-dolerite which are of Late Carboniferous age. The Monmouthshire occurrence is at least post-Old Red Sandstone, and it is noteworthy that it is regarded either as a dyke with a north-westerly trend or as a volcanic plug. Another significant point is that the only other intrusion into the Old Red Sandstone of this district, that of Bartestree, near Hereford, has been described by Professor S. H. Reynolds, as teschenite, an analcite-bearing dolerite.

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

The weather of the week ended August 19th, as set out in the "Weekly Weather Report" issued by the Meteorological Office, was very fine generally, though thunderstorms were reported on the 13th and 19th. T[illegible]ture was above the average in all districts, the depa[illegible] the mean rising to 7·8 in England, S.W. The hi[illegible]dings were 92 at Tottenham, Cambridge, Raunds an[illegible] on the 13th. In the extreme North it was much co[illegible] Baltasound and Lerwick the maximum for the we[illegible]. In the West the heat was not excessive, the [illegible] Scilly being 76, and at Falmouth 74. The lowest [illegible]ere 37° at Balmoral and at West Linton, and 39° [illegible] Wick. These were the only stations with minima be[illegible] many stations the minimum was not below 50, and [illegible]ations not below 60. The temperature on the grass [illegible]2° at Llangammarch Wells and to 33 at Crathes.

Rainfall was greatly in defect everywhere, except in [illegible], where it was slightly above the normal. At many stations the week was rainless.

Bright sunshine was in excess of the average except in Scotland, E., where it was normal. In England, N.W., it was twice as much as usual, 72 hours (70%), while in England, S.E., the value was still higher, 77 hours (76%). The highest individual amounts reported were 88·9 hours (88%) at Brighton, 85·1 hours (84%) at Hastings, and 84·7 hours (84%) at Eastbourne.

The temperature of the sea water round the costs ranged from 54 at Lerwick to 72 at Margate.

The week ended August 26th was unsettled all over the country. Rain fell on several days and thunderstorms were experienced in almost all parts.

Temperature was still high, however, though the excess above the average was nowhere so great as in the preceding week. The highest readings were 86° at Wisley, and 85 at Cambridge and Raunds. In Scotland the maximum was only 73°, while in Ireland, at Killarney, it was 74°.

The lowest readings were 35° at Balmoral, and 36° at Markree Castle, Co. Sligo. At Westminster the temperature ranged between 56 and 81°. On the grass, however, frost was observed, the readings falling to 30° at Markree, and to 32 at Balmoral and at Llangammarch.

The rainfall varied a good deal. It was slightly above the average in Scotland, N., the Midland Counties, and England, S.E., and considerably above in England, N.E. In all other districts it was in defect. At several stations falls exceeding an inch in 24 hours were reported; at Portsmouth the amount on the 21st was 1·40 inches, 1·00 of which fell in half-an-hour.

Bright sunshine was in defect in all the Eastern Districts, and in excess in the Western parts. The most sunny district was the English Channel with 48 hours (49% and the sunniest stations were Guernsey 55·7 hours (57%) and Pembroke 55·1 hours (56%).

The mean temperature of the sea water ranged from 54·8° at Berwick to 68·5° at Margate.

The week ended September 2nd, was fine as a whole, but in Scotland and the North of England rain fell rather frequently. Thunderstorms occurred at various stations during the earlier part of the week. Temperature was still high, the excess above average in England, E., amounting to more than 5°. The highest readings were 90 at Camden Square, Cromer and Hillington, with 89 at Greenwich, Cambridge and Norwich. The lowest readings were 34 at Marlborough, and 37 at Nairn and Balmoral. On the grass the temperature fell to 30 at Crathes and to 28° at Llangammarch.

Rainfall was in defect in all Districts except Scotland, N., and Scotland, W. At Glencarron the total fall for the week was 3·61 inches, and at Fort William 4·16 inches, which in each case was more than twice the average.

Bright sunshine was in excess in all the Districts, the district means varying from 40 hours, (40%) in Scotland, N., to 62 hours (65%) in the English Channel. The sunniest station was Jersey, 69·8 hours (74%). At Westminster the total duration for the week was 54·9 hours (58%).

The temperature of the sea water varied from 53° at Scarborough, to 70° at Margate.

The weather of the week ended September 9th was very fine and dry generally, but with thunderstorms on the 4th and 8th. Temperature was again above the average, the excess in most parts of England being large, as much as 7°·8 in England, S.W., and 9°·3 in the English Channel. The highest readings were again very high, over 90° in many cases, and reaching 93° at Bath and Cambridge and 94° at Greenwich and Raunds. In the extreme North, however, the temperature was low: at Lerwick the maximum was only 59°. The lowest readings were 31° at West Linton, and 32° at Balmoral. On the grass the temperature was very low for the time of year, falling to 26° at Llangammarch, 27° at Crathes, and 30° at Balmoral and Colmonell.

Rainfall was again greatly deficient in all districts, and except in Scotland, N., the total fall was almost negligible. At many stations the week was rainless.

Bright sunshine was in excess except in Scotland, N., where it was just below the normal. The district means varied from 25 hours (26%) in Scotland, N., to 68 hours (73%) in Ireland, S. The sunniest stations werre Valencia 78·1 hours (84%), Jersey 77·3 hours (84%) and Tenby 74·9 hours (81%).

The mean temperature of the sea water varied from 54°·0 at Lerwick to 68°·0 at Eastbourne.

The week ended September 16th, was cooler and less settled than those immediately preceding it, with thunderstorms on the 11th and 12th. Temperature in many parts differed but little from the average, but in the Southern districts it was still above the normal. The highest readings were 88° at Greenwich, 87° at Margate and Tunbridge Wells, and 86° at Westminster, Cambridge and Geldeston. The minima fell below the freezing point on the 16th, to 31° at Colmonell, and to 28° at Llangammarch Wells. On the same day 33° was recorded at Hereford, while on the 13th the minimum at Balmoral was 32°. On the grass, temperature fell very low, to 14° at Llangammarch, 22° at Hereford and 27° at Colmonell.

Rainfall was considerably in excess in England, N.W., where it was more than double the average. In Scotland, N., it was dry, and only one-third of the usual amount was collected.

Bright sunshine exceeded the average, except in Scotland E. and in Ireland, the excess in England S.E. exceeding two hours per day. The sunniest stations were Eastbourne 59·5 hours (67%), Hastings 58·8 hours, (66%), and Guernsey 58·9 hours (66%). At Westminster the total duration was 48·3 hours (54%).

The temperature of the sea water was as low as 49° at Scarborough, and rose to 68° at Margate and at the Shipwash Lightship.

MICROSCOPY.

By A. W. Sheppard, F.R.M.S.,

with the assistance of the following microscopists:—

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

MACROSPORIUM (FRIES).—The large compound spores of this fungus form handsome micro-objects, even for low powers, and are by no means difficult to obtain, especially in the autumn. The genus contains both saprophytic and parasitic species, though there is much doubt as to their exact limitations. Some are found growing on decaying cabbage leaves, bean pods and other vegetable refuse; a fine species *M. sarcinula* (Figure 1) is not at all uncommon on over-ripe melons, where it appears as black velvety patches, sometimes of considerable extent. It would be difficult, perhaps, to decide in many cases whether the fungus is a saprophyte or a true parasite. Another example, more frequent than welcome, is well-known to growers of tomatoes. It occurs both on the plant and on the fruit, but chiefly on the latter, and anyone wishing to obtain specimens for examination should look over some poor samples, when the parasite—as it almost certainly is in this case—will be found as black or olive-green patches of various sizes, usually sunk a little below the general surface. On cutting a thin slice from the region, it will be discovered that the underlying tissue is permeated by the somewhat coarse thread-like mycelium of the fungus, and occasionally the spores are developed in this situation. One species, named *M. solani*, attacks potatoes and may do much damage, particularly to the foliage and stems, though it also attacks the tubers, and may be transmitted, by means of the "seed" (dormant buds) used for planting, to a subsequent crop. This is now believed by competent authorities to be the same species as that found on tomatoes, *M. tomato* (Cooke), which appears likely, as the hosts are so closely related. There is a great similarity between all the species of the genus; the vegetative body consists of a web of mycelium ramifying in the substratum, but usually not very large in amount; this approaches the surface and there throws up short, jointed, mostly simple stems, which bear the large many septate spores. These vary a good deal in shape and size within the same species, and

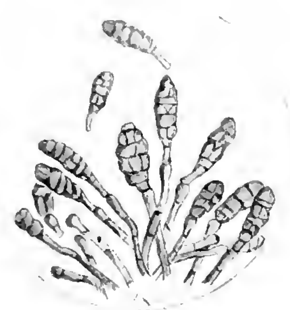


Figure 1.

Figure 2.

each division—which is in effect a distinct spore—may under favourable circumstances put out a tube (hypha) which gives rise to a new fungus plant. An interesting experiment may easily be made with the tomato species. If some of the spores are placed on a fruit with uninjured cuticle, it will be found they are unable to penetrate it; but if a wound is made or they are placed on a cut surface, they quickly germinate and in a short time a fresh crop of the fungus and a plentiful supply of spores is obtained. It is necessary to keep the host in a suitable condition of warmth and moisture, which may be achieved by placing it in a saucer with a little water, covered by a tumbler, in a warm situation. The experiment illustrates the danger of infection through abrasions of the resisting outer surface, by what are known as "wound-parasites." Some of the species are known to be the conidia-bearing stage of an ascomycetous fungus. Dr. Cooke says that such is the case with *M. sarcinula*, and that it is a condition of the common little fungus *Sphaeria herbarum*, which is plentiful on various herbaceous plants, and looks—under moderate magnification — like little black wine flagons. Figure 1 is a representation of *M. sarcinula*. In Figure 2*a* are seen the spores of a species which was found growing inside a Tangerine orange. The hyphae appeared to be unable to emerge through the thick peel, but when a part of this was removed, the spores were produced in great quantity. At *b* is figured an example of *M. tomato*, on the right hand are shown some spores commencing to germinate. At *c* part of a spore is represented emitting a mycelium tube from nearly every division and is taken from Professor Massee's "Text Book of Plant Diseases." The species is *M. nobile*, which occurs on carnations.

J. B.

NOTE.—The figure of Anabaena—"Knowledge," September, page 354—was unfortunately wrongly placed. To agree with the text it should be turned till the part towards the *North* is at the *South-east*. J. B.

EXOASCUS DEFORMANS BERK. (PEACH CURL).—This fungus is the cause of a remarkable disease in Peach trees often proving fatal to young stock. Although the mycelium is perennial in the branches, the disease first becomes evident in early spring when the trees are producing their first leaves. Many of the leaves are at once virulently attacked and as a result they assume the remarkably thickened and curled appearance as seen in the first photograph. In colour they are yellowish-green splashed with red, probably due to the decomposition of the chlorophyll. As a consequence of this, photosynthesis is inhibited, resulting in a poor development of the plant. After a period of vegetation the fungus reproduces itself asexually. On certain localised areas of the leaf minute club-shaped bodies appear. These organs are asci, a reproductive structure typical of the large order of fungi—the Ascomycetes—of which *Exoascus* is the simplest representative. The contents of each ascus divides to form eight spores—ascospores, which again undergo division resulting in the formation of a large number of minute spores (see photograph) which on liberation carry on the work of destruction. Owing to the fact that the mycelium is perennial the disease is not easily eradicated. The usual method adopted by the nurseryman is the picking off and burning of all infected leaves.

FIGURE 1. A Peach branch attacked by peach curl, *Exoascus deformans*.

CYSTOPUS CANDIDUS PERS. (WHITE RUST) ON *CAPSELLA BURSA PASTORIS* (SHEPHERD'S PURSE).—Figure 3. *Cystopus candidus* is an interesting member of the Oömycetes, a sub-class of the Phycomycetes or algal fungi—a name given to the group on account of the structure of the sexual organs, which are strikingly similar to those of the Siphonae, of which Vaucheria is an excellent type. The Phycomycetes are considered to be derived from the Siphonae.

FIGURE 3. Stems of Shepherd's Purse attacked by white rust, *Cystopus candidus*.

The white patches well seen in the photograph are the sporangia of the fungus, the structure of which is demonstrated in Figure 4. The mycelium ramifies throughout the tissues of the stem, leaf and fruit, and eventually breaks through the epidermis giving rise to pustules of sporangia. These sporangia are produced in chains and on germination give rise to numerous swarm spores, which, given moist conditions, rapidly infect neighbouring plants. The sexual organs are antheridia and oögonia—arising *within* the host plant. The oögonia are spherical swellings formed at the ends of the hyphae, or intercalated throughout their length. The contents of the oögonium become differentiated into an oöspore and peripheral periplasm. The antheridia are tubular outgrowths, cut off from the parent hypha by a cell wall. After fertilisation the oöspore surrounds itself with a thick wall of a brownish colour, the surface of which is covered with irregular warts. After a period of rest the oöspores germinate. In the hard spore walls a fissure appears, and the contents of the spore, surrounded by the inner membrane, are pressed through the orifice. The protoplasm divides

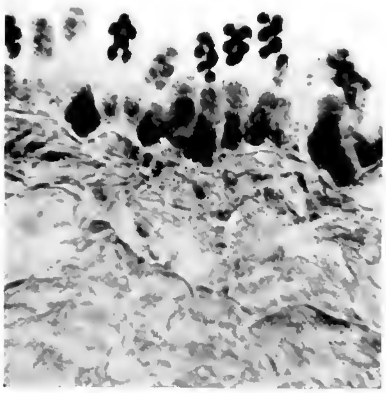


FIGURE 2. Vertical section of a leaf of Peach infected with *Exoascus deformans*, × 500.

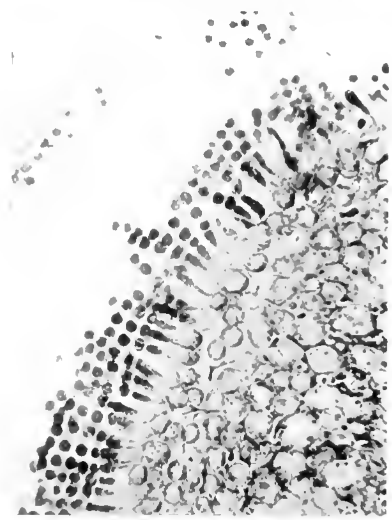


FIGURE 4. Vertical section of the stem of Shepherd's Purse infected with *Cystopus candidus*. × 200.

into a number of zoöspores, which are liberated by the dissolution of the membrane. H. Gunnery.

QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE.—In the August number (Vol. V, Part 1) of the above journal there are one or two papers which may be of interest to our readers. The first to which we would draw attention is the interesting paper by Dr. W. E. Agar, devoted to the Spermatogenesis of *Lepidosiren paradoxa*. In the course of the research most attention was paid to the method by which the numerical reduction of the chromosomes takes place—owing to its importance in connecting the experimental knowledge of heredity with the structure and history of the germ cells. The sections of the testes for examination were mounted between two cover-slips instead of between cover-slip and slide. This allowed of the nuclei being examined and drawn from both sides. The advantages of this method are well shown in one of the beautiful plates illustrating this paper, where two figures of the same section are given, but drawn from opposite sides. The other paper we would draw attention to is by C. H. Martin, M.A., and Muriel Robertson, M.A., under the title of "Further Observations on the Caecal Parasites of Fowls, with some reference to the Rectal Fauna of other Vertebrates." Four new species are described and figured:—*Chilomastix gallinarum*, *Trichomonas gallinarum*, *T. eberthi*, *Trichomastix gallinarum*. The authors say that until the whole life-cycle of these animals are known the breaking-up of the complex series of forms inhabiting the caeca of fowls into good species is a matter of great difficulty. The Trichomonas affinities of these forms were disregarded by Saville Kent (Manual of Infusoria, 1881), who named them *Trypanosoma eberthi*. The plates illustrating this paper are deserving of very high praise. They show the nuclear changes that take place during division and the formation and development of the flagella.

MICROSCOPY IN THE NEW "ENCYCLOPAEDIA BRITANNICA."—The article devoted to the Microscope in previous editions of the "Encyclopaedia Britannica" now gives place to one by Dr. Otto Henker. The author first deals with the different forms of the simple Microscope and the optical theory relating to the use of a simple lens as a magnifier. The Compound Instrument is dealt with more fully. A short history precedes the more detailed treatment of the physical theory of the instrument, the diffraction problems underlying Abbe's theory of microscopic vision being fully explained and illustrated. A short paragraph is devoted to ultra-microscopy. The illuminating systems are next treated and here mention is made of some old methods revived for the production of dark field illumination. Special attention is here given to Siedentopf's Cardioid Condenser for use in this form of illumination. The various methods of obtaining binocular vision with the microscope are explained, and a section is devoted to mechanical arrangements under which heading Micrometry is dealt with. The article concludes with the methods of testing the instrument.

A special article is devoted to Microtomy by G. H. Fowler, Ph.D., F.L.S., F.Z.S., and this appears to be the only one having micro-technique for its subject. In it we have the theory of staining and the methods adopted for cutting sections and ribbon-sections. For Photomicrography we have to look under Metallography, where the method of obtaining photographs of the surface of metals is given. This subject has assumed such importance of late years that an article devoted to its methods would have been better than relegating it to the heading Metallography, which, of course, is but one of its many applications. The preparation of rock-sections and their examination by means of the micro-polariscope is fully and clearly explained under the heading of Petrology. This account of micro-technique, as applied to the examination of rock-sections, is excellent. Attention is drawn to the further refinement of microscopical method, consisting in the use of strongly convergent polarized light (konoscopic methods). This is obtained by using a wide-angled achromatic condenser above the polariser and a high-power microscopic objective.

ORNITHOLOGY.

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

BITTERN NESTING IN ENGLAND.—The belief that the Bittern (*Botaurus stellaris*), if given fair opportunity, would resume breeding in England has, happily, been substantiated this season. Miss E. L. Turner, when in Norfolk in July, was so fortunate as to assist in finding a young bird which she considered to be from four to five weeks old, and the Rev. M. C. H. Bird, in the course of a joint search, discovered the vacated nest. From its condition Miss Turner judges that more than one inmate must have been successfully reared. She gives a detailed account of her experiences in *British Birds* (September, 1911, pages 90-97), illustrated by photographs of the young bird and the nest.

The last eggs discovered in Norfolk were at Upton, near Acle, in 1868, and a young bird was killed at Reedham in August, 1886. Since then, although Bitterns have not infrequently appeared near their old nesting-places, they have not managed to breed. It seems not much more than a counsel of hope to wish that this bird may now re-establish itself as a regular nesting species, however greatly this is desired by bird-lovers.

BIRDS NEW TO SCOTLAND IN 1910.—The excellent and full reports on Scottish ornithology appearing annually in the *Annals of Scottish Natural History* are indicative of the enthusiasm with which bird-study is pursued in Scotland, and of the fresh discoveries and good results which reward the observers. In the July number of the *Annals* (No. 79, pages 133–149) the first instalment of the Report for 1910 is given by Misses E. V. Baxter and L. J. Rintoul, who draw attention to the number of species and sub-species added to the Scottish list during the year. These are eleven in all, and are as follows:—

1. Rock-thrush (*Monticola saxitilis*). One adult male: Pentland Skerries; Orkney, 17th May. Second occurrence of species in Britain.
2. Blyth's Reed-warbler (*Acrocephalus dumentorum*). One; Fair Isle; September. First record for Western Europe.
3. Marsh Warbler (*A. palustris*). One; St. Kilda; autumn. First time in Scotland.
4. Temminck's Grasshopper, or the Lanceolated Warbler (*Locustella lanceolata*). One; Pentland Skerries; 26th October. First record for Scotland and second for Britain.
5. American Pipit (*Anthus spinoletta pensilvanica*). One; St. Kilda; autumn. New to Britain. Only two other European records.
6. Hoary Redpoll (*Acanthis hornemanni exilipes*) Fair Isle, no data given. First record for Scotland.
7. Holboll's Redpoll (*A. linaria holboellii*). Occurred in some numbers in different places in eastern Scotland.
8. Yellowshank (*Totanus flavipes*). One; Fair Isle; no data given. First record for Scotland.

The undernamed are continental forms of birds of which there are British sub-species.

1. Redbreast (*Eritacus rubecula rubecula*). One; Isle of May; 22nd October.
2. Goldcrest (*Regulus regulus regulus*). Seven; Isle of May; between 10th September and 17th October.
3. Great Tit (*Parus major major*). One: Isle of May; 15th October. Another; Fair Isle; 17th November.

Note.—The first Scottish records of the Continental Song-Thrush (*Turdus philomelos philomelos*) and the northern Willow Warbler (*Phylloscopus trochilus eversmanni*) came both from the Isle of May, in the year 1909.

It will be noticed that practically all these new records are obtained from islands, an illustration of the importance of such outposts as bird-observatories, when watched with vigilance, carefulness and continuity. The records of Heligoland by Gätke are still unrivalled.

GROUSE AND DISEASE.—Supplementing the note on page 355 *ante*, it should perhaps be said that Dr. Shipley, in the Report, explains that in the course of their researches during the inquiry, the investigators did not come across the "disease," which is so firmly believed in by sportsmen and gamekeepers. Twenty-three parasites of the grouse were found, and Dr. Shipley writes of the worm *Trichostrongylus pergracilis* as follows:—"The eggs give rise to larvae in about two days. The larvae surround themselves about the eighth day with a capsule or cyst, and undergo a 'rest cure.' After a period of quiescence they quickly change into second and active larval forms, which are minute, transparent, and quite invisible. These lead a perfectly free life, and in wet weather gradually squirm and crawl up among the leaves and flowers of the heather, where they remain until swallowed by the grouse. When once inside the bird, the larvae make their way along the alimentary track, and enter the caeca, where they rapidly develop into adults." Dr. Shipley also presents a word-picture of what would be seen, if, by means of a gigantic lens, a square yard of grouse moor were magnified a hundred times:—"The heather plants would be as tall as lofty elms, their flowers as big as cabbages, the grouse would be six or seven times the size of 'Chantecler' at the Porte St. Martin. Creeping and wriggling up the stem and over the leaves, and gradually yet surely making their way towards the flowers, would be seen hundreds and thousands of silvery white worms about the size of young earth-worms. Lying on the leaves and on the plant generally would be seen thousands of spherical bodies the size of grains of wheat, the cysts of the coccidium; and on the ground and on the plants, as large as split peas, would be seen the tapeworm eggs patiently awaiting the advent of their second host. It is perhaps a picture that will not appeal to all, yet it represents what, unseen and unsuspected, is always going on upon a grouse moor."—See "The Grouse in Health and Disease; being the final Report of the Committee of Inquiry on Grouse Disease." Two volumes. Illustrated. London, 1911.

MORE ABOUT THE CORN-CRAKE.—The distribution of this species (*Crex pratensis*), in England continues to call forth observations, and Mr. F. J. Stubbs has some apt remarks in *The Zoölogist* for August, 1911 (page 315). He points out that the disappearance of the species from the south-eastern counties of England dates from about 1850, and ascribes this to the change in agricultural methods that was in course then. The bird formerly bred in the corn-fields of the southern counties, which, under the old system of broadcast sowing, would be a real sanctuary. In a drilled cornfield this is not so; the nest could not be hidden and would be an easy prey to stoats. For this reason, and as the meadows are also unsafe and pasture fields inadequate, the bird has practically vanished as a nesting species.

The curious annual fluctuations of the bird are commented on by Mr. Stubbs, who says that the present year must be reckoned a corn-crake year in Lancashire, the species having been commoner than for many seasons.

In the recently published "Fauna of the Tweed Area" (1911), Mr. A. H. Evans reports that the bird is stated to be decreasing in some localities there, but that it is sufficiently plentiful in most parts. It is somewhat local, and almost absent from the coast-lands where there are few grass fields, but is common, not only in the lower valleys, but among the hills in "Tweed."

PHYSICS.

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

INAUDIBLE SOUNDS.—The limit of perception of sounds of high pitch varies with the person. In general, persons lose their hearing for very high notes as they get older, and it appears that slight loss of hearing in the region of these upper frequencies begins to occur during quite an early age. Many cannot hear the sound of the bat squeaking, or of certain insects. Very acute sounds are audible up to thirty-eight thousand vibrations per second. Helmholtz gave as the lower limit, thirty vibrations per second, and a regular wave train of forty vibrations per second was the lowest musical note. Thus the ear can perceive vibrations ranging from thirty to thirty-eight thousand per second. No doubt higher sounds are common in nature and it is probable that animals have different ranges of perception. Many persons with average powers of hearing may be [illegible] vibrations of thirteen thousand per second. In this connection it is interesting to note that old people often lack the ability to distinguish the letter "s" distinctly; the telephone and the phonograph also have difficulty in transmitting that letter. Now, the hissing sound when analysed into a wave form is a succession of waves with very minute irregularities on the face of the waves, and thus is equivalent in its facility to detection to a sound of very high pitch. Campbell and Dye have published, in *The Electrician*, an account of some work on the detection of inaudible sounds. The electric spark gives out waves of sound which are exceedingly short and far too high-pitched to be audible. The means by which the frequencies of these sound waves are measured are very simple. The oscillatory spark is arranged at the open end of a long horizontal glass tube along which is shaken out a little clyopodium powder. As the sound waves progress along the tube they set the lycopodium in motion, taking it away from the positions of least movement (the nodes) and laying it about where the air is in a greater state of turmoil. It is, in fact, the "Kundt's tube" arrangement which has been used to find the velocity of sound in various gases; for, by measuring the distance between the small heaps of dust produced by the particular note, the wave lengths can be found and hence the velocity (for the velocity equals the product of the frequency of vibration and the wave length). The method has various applications, for, from the velocity, the ratio of the amount of heat a gas can take up when free to expand and when confined can be found, and from this again whether the gas consists of a molecule possessing internal energy besides translation, or merely energy of translation: in the latter case the molecule consists of one atom. In this way the molecules of argon, helium, krypton, xenon, neon and mercury have been found to be monatomic. That is, the molecular weights equal the atomic weights. Campbell and Dye measured the distance between the striations produced in the lycopodium dust along the tube and found that they could measure in this way sounds of a frequency up to eight hundred thousand per second; their results seem to show that, since two sound waves are given out for each oscillation, the sound vibrations are double the frequency of the electrical oscillations.

THE AMPALL.—A few months back I mentioned this as one of the novelties in electrical instrument design which have been elaborated by Messrs. Paul. The instrument consists of a moving coil unipivot galvanometer connected to a pair of contact points a definite distance apart, such that if placed on a copper conductor of one square inch in cross section a reading of one thousand (= 2 millivolts) is obtained, if one thousand ampères are flowing through the wire. The contact block is strapped to the conductor, the cross section of which multiplied by the deflection of the unipivot millivoltmeter gives the current in ampères. The instrument can be used to measure direct currents up to any value and can be instantly applied without breaking the circuit; it also provides a means of testing the conductivity of joints, fuses and so on.

The unipivot system of suspension of the galvanometer needle is very satisfactory, as it allows of great sensitiveness with perfect portability. The moving coil has one pivot only in the centre of a sphere of iron. The circular coil swings freely about this sphere without touching the magnetic system. A circular well aged magnet is so situated that the field is concentrated across the gap where the sphere resides. The pivot is situated at the geometric centre of the coil, which is also the centre of gravity of the moving system. The arrangement, residing on the one pivot and held in position only by a hair spring, is thus capable of considerable sensitiveness; while the protection afforded by the sphere to the coil, pivot and rod bearing the pivot insures the safety of the moving coil system against a great deal of rough usage.

THE LUMINOSITY OF THE FIREFLY.—Coblentz and Ives have made an investigation of the light emitted by the firefly (*Photinus pyralis*). They find that the radiation controlled by the fly is all in the visible region of the spectrum—there appears to be very little ultra-violet radiation and no infra-red. The light is under control of the insect and does not appear to be stimulated by previous exposure to light, as with true phosphorescent substances. It is more probable that the light is due to oxidation of some complicated unstable fatty substance, the decomposition of which can be accelerated at will by the insect, perhaps by a catalytic agent.

MAGNETIC ALLOYS.—An alloy of 62·0 per cent. of copper, 25·0 per cent. of manganese, and 12·5 per cent. of aluminium, and also another alloy 43·4 per cent. of copper, 18·1 per cent. of manganese, and 40·0 per cent. of tin are the two most strongly magnetic of the non-ferrous alloys. Ross and Gray have recently studied the effect of annealing and quenching of these alloys and of such simpler and less magnetic alloys as copper manganese, manganese antimony, and manganese bismuth. They find that cooling to a very low temperature increases their susceptibility. Annealing improves their stability and quenching reduces the hysteresis (or lag of induced magnetism after the magnetising force). It appears to be difficult to explain why such alloys should be magnetic, though in most cases the magnetic properties seem to be due to the formation of solid solutions of binary systems (such as Mn_3Al_2) in the rest of the material.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A.

MAGNALIA NATURAE; OR, THE GREATER PROBLEMS OF BIOLOGY.—This was the title of the notable address which Professor D'Arcy Wentworth Thompson, C.B., gave as President of the Zoölogical Section of the British Association. From its earliest beginnings, he said, Biology has been a great and complex and many-sided thing. Aristotle was all that we mean by naturalist and biologist; he gathered up and wove into his great web the varied lore of fishermen and bee-keeping peasants, as well as the learning of the Hippocratic and other schools of physicians and anatomists; but "every here and there, in words that are unmistakably the master's own, we hear him speak of what are still the great problems and even the hidden mysteries of our science," the magnalia naturae, inquiry into which is characteristic of the spirit of our time. The old questions of vital activity and organic form, of growth and reproduction, of heredity and variation, and the like, are being re-discussed, and many sciences are now being brought to the aid of biology. Very noteworthy is the renewed interest in the validity of the rival interpretations offered by the mechanistic and the vitalistic schools, whose antithetic views recall those of Democritus and Aristotle respectively. But whether we lean to the one side or the other, we must agree in the use of physical methods, and Professor Thompson devoted a considerable part of his address to showing that these are of service in studying form as well as function. Surface-tension, for instance, must count for much in determining form; it is one of the "means of morphogenesis," to use Driesch's phrase. After giving interesting examples, Professor Thompson expressed his belief that "the forces of surface-tension, elasticity and pressure are adequate to account for a great multitude of the simpler phenomena, and the permutations and combinations thereof, that are illustrated in organic form." . . . But "though we push such explanations to the uttermost, and learn much in so doing, they will not touch the heart of the great problems that lie deeper than the physical plane. Over the ultimate problems and causes of vitality, over what is implied in the organization of the living organism, we shall be left wondering still."

MOMENTUM IN EVOLUTION.—Professor Arthur Dendy made an interesting suggestion at the British Association in regard to cases where animals or parts of animals seem to have acquired some sort of momentum, by virtue of which they grow far beyond the limit of utility. Is there any constitutional brake on growth, and, if so, are there occasions on which the brake may be removed with results which ultimately prove fatal? Professor Dendy asks us to consider the internal secretions or "hormones" which in some cases act as a check on over-growth. If it were advantageous for a structure to grow big, and if that structure were one which grew abnormally big when a particular internal secretion was absent, then natural selection would favour those individuals in which the relevant glands were least developed or least efficient. The glands might disappear, or might cease to produce the particular hormone in question. The organ would go on growing larger; it would in the course of time reach its optimum; but the brake having been removed, further growth would proceed irrespective of utility. And as to exaggerated structures which never had any value as adaptations, Professor Dendy appeals to correlation. The removal of a gland which controlled the development of a frontal horn might be followed by the exuberant growth of an entirely useless excrescence.

ARISTOTLE'S LANTERN AS AN ORGAN OF LOCOMOTION.—Dr. James F. Gemmill communicated to the British Association a most interesting study of this wonderful piece of mechanism which Aristotle saw over two thousand years ago. There is a rhythmic swinging movement of the lantern, and progression is by a series of steps or lurches which are more or less sharply defined. In each step the urchin is raised on the tips of the teeth and a forward impulse is given, (*a*) by strong pushing or poling on the part of the lantern, (*b*) by similar but usually less effective pushing on the part of the spines, and (*c*), after a certain stage, by the influence of gravity. The lantern is then retracted and the teeth swing forward into position for initiating a new lurch. For ordinary locomotion over more or less horizontal surfaces under water the lantern is not needed, but Dr. Gemmill indicated various conditions, normal and experimental, in which it may be employed with effect. "The locomotor action of the lantern is a particular manifestation of a rhythmic functional activity, which can also subserve feeding, boring, respiration, and possibly also the maintenance of physiological turgescence in various internal cavities."

FOOD SUPPLY OF AQUATIC ANIMALS.—Dr. W. J. Dakin brought forward at the British Association some interesting corroborations of Pütter's theory that sea or fresh water is more or less a nutrient fluid, there being more organic carbon present in solution in the water than there is in the multitudinous plankton that swarms there. Dr. Dakin has tried to estimate the amount of carbon and oxygen required by certain aquatic animals per day to cover the loss due to metabolism. On the basis of this estimate, which is probably very approximate, a sponge 60 grammes in weight would require to filter several thousand times its own volume of water per hour in order to obtain sufficient food—"an altogether unthinkable piece of work." A big jelly fish (*Rhizostoma*) would require over seven millions of nauplius larvae per day. "It is quite impossible for such large quantities to be caught, and equally strange that remains of the creatures are so rarely found if they have been captured as food." Another striking fact, or result of calculations at all events, is that the "producers" (the plant-plankton), are insufficient for the "consumers" (the animal plankton). High alpine lakes, for instance, in which there is an outstanding production of animal plankton, are almost deserts as far as plant-plankton is concerned. What do these alpine crustaceans and rotifers feed on? Pütter's theory is the only solution of the riddle. We come to the idea that the water in lake and sea is food as well as drink. There is bread in the waters—according to the ingenious showing of Dr. Dakin.

CORRESPONDENCE.

ASTRONOMICAL QUERIES.

To the Editors of "KNOWLEDGE."

SIRS,—I.—The subject of the brightness of a surface is one presenting various problems which it is impossible to discuss here. Mr. Bartrum will find a few of these in Parkinson's "Treatise on Optics," Chapters II and X. In estimating the brightness of Venus, Godfray assumes that the illuminated surface appears uniformly bright and of the same degree of brightness in all aspects. As this is not true, the results obtained are only approximate.

It is interesting to notice, although bearing only indirectly on the subject, that the half Moon does not give half as much light as the full Moon. The visible surface, except at full Moon, is darkened by shadows cast by the irregularities, and so the amount of light is diminished.

II.—The major semi-axis is called the mean distance, and must not be confounded with the average distance. This latter depends upon what is taken as the independent variable.

The mean distance of a planet from the Sun can be easily found by taking the Arithmetical Mean of the greatest and least distances. The former is $a + ae$, and the latter is $a - ae$; the Arithmetical Mean of these two is a, the Major Semi-Axis.

III.—The gradual decrease of the eccentricity of the Earth's orbit which has been going on for thousands of years, and which will continue for a long time yet, causes the mean motion of the Moon to increase. It is difficult to explain this in ordinary language, and a mathematical investigation is necessary.

Let S denote the mass of the Sun, R his distance from the Earth, and r the distance between the Earth and the Moon. When the three bodies are in a line the disturbing component of the Sun upon the Moon is

$$D = \mu S\left[\frac{1}{(R-r)^2} - \frac{1}{R^2}\right] = \mu S\left[\frac{r(2R-r)}{R^2(R-r)^2}\right]$$

where μ is a constant. This is evident, since the disturbing effect of the Sun upon the motion of the Moon is the difference of its acceleration upon the Earth and Moon.

Now r is very small compared with R, so that the above equation becomes $D = \frac{2\mu Sr}{R^3}$.

The disturbing acceleration in any part of the orbit of the Moon depends upon the distance of the Sun from the Earth, varying inversely as the third power of this distance. Let us find the average for a whole revolution of the Earth, which we may take to be performed in a time T, say. Let D^1 be the average disturbing effect $\therefore D^1 = \frac{4\mu Sr}{T}\int_0^{\frac{T}{2}} \frac{dt}{R^3}$

From Kepler's Law that the radius vector sweeps out equal areas in equal times, we obtain $\frac{1}{2} R^2 \frac{d\theta}{dt}$ = area described in unit time = $\frac{1}{2}$ h say.

$$\therefore R^2\, d\theta = h\, dt, \text{ or } \frac{dt}{R^3} = \frac{d\theta}{Rh}$$

$$\therefore D^1 = \frac{4\mu Sr}{Th}\int_0^{\pi} \frac{d\theta}{R}$$

The polar equation of a conic $\frac{L}{R} = 1 + e\cos\theta$, where L is the semi latus rectum $= \frac{b^2}{a}$ gives $\frac{1}{R} = \frac{a}{b^2}(1 + e\cos\theta)$.

$$\therefore D^1 = \frac{4\mu Sra}{Thb^2}\int_0^{\pi}(1 + e\cos\theta)\,d\theta.$$

Now $\int (1 + e\cos\theta)\,d\theta = \theta + e\sin\theta = \pi$, taking π and o as limits

$$\therefore D^1 = \frac{4\mu Sra\pi}{Thb^2} = \frac{4\mu Sr\pi}{Tha(1-e^2)}$$

It is easily proved that

$$h^2 = \mu L C \text{ and } T \text{ [illegible]}$$

where C is a constant. (See Willi[illegible] Lalton's Dynamics, Chapter VII, Equations 30 a[illegible] simple proof.)

$$\therefore Th = 2\pi a^{\frac{3}{2}}\sqrt{L} = 2\pi a^{\frac{3}{2}}\sqrt{a(1-e^2)} \text{ [illegible]}$$

$$\therefore D^1 = \frac{2\mu Sr}{a^2(1-e^2)^{\frac{3}{2}}}$$

It is easily seen that as e decreases, the denominator increases, and therefore D^1 decreases. The efficiency of the Sun in decreasing the attraction of the Earth for the Moon therefore decreases, and the mean motion of the Moon increases.

It should be said that the amount of variation calculated in this way, about six seconds a century, does not agree with the amount of acceleration obtained by comparing ancient with modern eclipses. It has been supposed that the discrepancy arose from a lengthening of the day, due to a retardation of the Earth's rotation from friction of the tides. The subject is, however, too long to discuss here.

(REV.) M. DAVIDSON.

THE FOURTH DIMENSION.

To the Editors of "KNOWLEDGE."

SIRS,—I was greatly interested in Mr. A. L. Annison's paper on "The Fourth Dimension" which appeared in the June number of "KNOWLEDGE," and I have been expectantly looking for the corollary to his useful piece of analytical reasoning; I may have missed it, but I certainly have not noticed it.

It appears to me that the logical deduction from his series of analogies is that the Fourth Dimension is Density (δ); I believe you will find that this fits in completely, and satisfactorily answers the demands of a Fourth Dimension.

Hence all physical substances could be expressed completely in terms of $L \times B \times H \times \delta$.

As this Dimension seems to have been overlooked because so well-known under the term of "weight," it appears to me probable that other dimensions may perhaps be recognisable as yet other well-known physical or chemical properties of matter.

ALFRED J. MULLINS.

COMETS 1911 *a* AND *c*.

To the Editors of "KNOWLEDGE."

SIRS,—The following observations of Wolf's and Brooks' comets, respectively 1911 *a* and *c*, were made on the evening of August 20th, 1911, by the aid of the forty-inch refractor of this observatory (Yerkes).

Wolf's comet (periodic), was very apparent in the forty-inch and was in a rich field. Small. Slight indication of a nuclear condensation. Near a small star.

Brooks' comet was observed, first with the four-inch finder of the great telescope. The nuclear condensation was a little more apparent than in previous evenings, but the comet was generally about the same. The nucleus and matter extending in all directions from it were all that were visible at one time, on account of the size of the field of view; the former, however, presented a fairly large disc and was nebulous in appearance. The light of the nucleus was practically white. There were several comparatively bright stars in the same field, which were actually visible through the head of the comet, apparently undergoing no loss in brilliancy whatsoever. The field itself was very luminous, and in some parts the nebulosity was more apparent than in others, which fact indicated the presence of a tail extending out into space, beyond the head of the comet.

FREDERICK C. LEONARD.

THE VELOCITY OF LIGHT.

To the Editors of "Knowledge."

Sirs,—A flash of "forked" lightning is visible to the eye, and seems to take an appreciable time to pass from the thundercloud to the earth. As the human eye is said not to be able to see anything that takes less than about one-tenth of a second to pass the line of vision, a flash of "forked" lightning must take more than one-tenth of a second to pass from cloud to earth, a distance of a mile or two, which would be equivalent to a velocity of about twenty miles per second.

If this be so, is there not a very great retardation in the velocity of light, at or near the level of the earth? If light travel at the average rate of one hundred and eighty-six thousand miles per second, and so great a retardation is caused by the density of the atmosphere near the earth's surface, may not light travel at a very much greater rate in space than one hundred and eighty-six thousand miles per second?

The experiments and observations for the calculation of the velocity of light were made at or near the surface of the earth; and if the earth's atmosphere does in any way reduce the velocity of light, would it not be possible and advisable to recalculate that velocity from experiments and observations made at observatories situated from five thousand feet to fifteen thousand feet above sea level?

G. R. GIBBS.

CLUSTERS AND NEBULAE.

To the Editors of "Knowledge."

Sirs,—September number, page 345, 1st column: "Clusters and groups of stars . . . which seem to be connected . . . by a force acting far more powerfully and at greater distances than gravitation."

I understand that gravitation balances the members of the Solar system with each other, and inferred that it has a similar effect in all other systems and on every system with every other. But Mr. Henkel suggests some other force which seems unnecessary.

G. M.

QUERIES AND ANSWERS.

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

QUESTIONS.

51. GEOLOGY OF SOUTH DORSET.—Would one of your readers give me a few facts about the Geology of South Dorset—the strata, fossils and minerals. The region of greatest interest is the Swanage neighbourhood.

S. P. R.

52. GENIUS AND ISOLATION.—I have a theory that social isolation in youth is one of the primary causes of genius. Can some one quote me proverbs and facts in the lives of such men as Shakespeare and Napoleon, tending to demonstrate this hypothesis?

S. H. R.

53. STRANGE STARS.—Can any of your readers give me particulars as to the three strange stars seen last month on the right hand of the moon when nearly at the full in the South-East.

I am told they only appear once in one hundred years: is this so?

Some reference was made to these in a Scotch paper, but I have seen no mention in any of ours, or "Knowledge."

The stars are not now to be seen.

Walter Bradshaw.

REPLIES.

45. HEAT AND VACUUM.—The loss of heat by a liquid contained in an ordinary vessel is due mainly to conduction. Defining heat (in the sense of a high temperature possessed by a body relative to its surroundings), as a state of increased molecular motion, cooling results from conduction by surrounding matter. If, now, such conduction be almost wholly prevented by a vacuum jacket, the most potent cause of loss is removed, and cooling proceeds by radiation. This introduces the conception of *radiant* heat, which is quite distinct. Radiant heat is a wave disturbance which is radiated through space like light, and which produces a condition of increased molecular motion (heat) in any absorbing matter on which it falls. The spectral location of the radiant heat rays is in the infra-red. The full efficiency of a vacuum vessel can be obtained by making the walls highly reflecting.

Charles W. Raffety.

47. GRAVITY.—It is impossible for the atmosphere of our earth or of any of the Planets to prevent bodies flying off into space. If the absence of an atmosphere would mean that heavenly bodies could not retain anything on their surfaces, we might expect pieces of the Moon to be continually breaking off; for it is generally admitted that the Moon is practically devoid of an atmosphere. Of course, the resistance of the atmosphere will always diminish the velocity of a moving body, but this cannot have any connection with the point raised by "Ignoramus." For instance, if we could fire a bullet from the Earth with a velocity of about seven miles per second, it would fly off into space, the Earth losing control over it. This is based on the assumption that there is no atmosphere to hinder its motion; the presence of the atmosphere, however, would necessitate a velocity of projection greater than seven miles a second, in order that the bullet might not return. Evidently, however, "Ignoramus" is not considering such extreme cases as this, but seems to be under the impression that bodies would rise spontaneously in the absence of an atmosphere, and pass off into space. Not only is this a false idea, but bodies would actually weigh *more* if our atmosphere disappeared. The weight of one cubic foot of air at sea level and at normal temperature and pressure is ·0807 pounds. In accordance with the well-known law, that bodies immersed in a fluid lose a weight equal to the weight of fluid displaced, a body of volume one cubic foot would weigh ·0807 pounds less in air at sea level than in a vacuum. Evidently, then, there would be less tendency to fly off, generally speaking, if we had no atmosphere. The simple experiment of placing a few bodies under the receiver of an air pump, and then producing a vacuum, will show that there is no tendency for these bodies to fly off.

Whatever explanations may be given of the causes of Gravity, whether due to Etherial Tension or to any other cause, the fact that such a force exists cannot be denied. It surely cannot have been seriously advocated in the sermon referred to, that the earth retained bodies on its surface by atmospheric pressure without the force of Gravity!

Henry F. Crick.

NOTICE.

ARTIFICIAL RAIN.—In a little pamphlet under this title Mr. Emilio Olsson describes a sprinkling apparatus for crops which he claims will take the place of rain in times of drought, and he gives an account also of some experiments carried out in the way of electrifying the water used. A certificate from two engineers that the electrifying of the water reduced the total hardness and that it was able to kill locusts perfectly is included. Mr. Olsson's address is 19, Southampton Buildings.

Knowledge.

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

A Monthly Record of Science.

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

NOVEMBER, 1911.

THE NEW ASTRONOMY.

III.—STAR CLUSTERS AND NEBULAE.

By PROFESSOR A. W. BICKERTON.

With illustrations from photographs by G. W. Ritchey.

It seems strange that astronomy, with all the marvels revealed by the modern methods, has not a greater hold on the human mind. But doubtless the wondrous beauty of the heavens appeals far more to a shepherd folk, with their ample night leisure, their clear sky, their serene minds, than to city people. The brilliantly lighted streets of London outshine even Sirius or the brightest comet. I have seen the moon herself showing over the house tops as a feeble kind of large artificial light. In a big city, music hall stars are far more effectively attractive than a shining star cluster or even the whole galaxy of the heavens. Astronomy too, has become somewhat dry and arid. Official astronomers do not care for theories, for the linking silken cords of correllation, that will weave together their wonderful isolated threads of facts and convert them into the shimmering fabric of a beautiful and consistent scheme of creation so grand and glorious as to be capable of giving hope and energy to human thought, and high purpose to human aims. Nevertheless the neglected celestial vault is the stage of much romance and beauty. The moon under a telescope of moderate power is an exquisite object, and so is the crescent of Venus, the ringed planet Saturn, or the spiral nebulae. But perhaps, as I said in *Harper's Magazine*, September number, imagination is wanted: "Were we to picture time as passing so swiftly that centuries were as seconds, to the eye of the mind we should see the star clusters appearing as moving masses of many-hued fireflies, the planets as rings of silver light, and we should see the whole stellar heavens astir as a swarm of shining bees." No imagination seems to be required when star clusters are seen through giant telescopes, they appear to eclipse everything else for brilliant magnificence.

The Wonder and Beauty of Star Clusters.

These groups of celestial gems may sparkle like diamonds of the first water, or they may shine with many a varied tint, some blue beyond the Oriental sapphire, some vivid green, or red, or purple. Some of the groups are all white: some, as in the constellation of the Southern Cross, are white, interspersed with red, blue, and green stars: while the most wonderful of all the clusters, that in the Toucan, is of an exquisite rose tint. Then the number of component stars is wonderful: in most clusters they may be counted by hundreds, in some there are many thousand independent points of light, every point of light a sun perchance bearing a planetary system with it. What possibilities unfold themselves. Think of any one of those solar systems threading its way through the maze of the other suns. What vicissitudes it must encounter. For hundreds of years it might revolve amongst the densities at the centre of the system: then its orbit might be deflected and for thousands of years it might travel towards the exterior of the cluster. With the sudden effect of natural selection, on the satellites of such a sun, the changes from tropic to arctic during the great glacial epochs of the earth would hardly compare. Then, again, how the heavens must alter in aspect within those wondrous coloured clusters, where in one part the emerald and the ruby enhance their mutual beauty, and in another the topaz and the sapphire outglow each other. Imagine oneself the inhabitant of a planet lit by a ruby sun and an emerald sun. Consider the brilliant pictures and the shadows, every shadow double, one coloured red and the other green. These wonders seem too much for full description. So I will not try to describe the effects as seen by the inhabitants of planets within a coloured star cluster: I leave it to the readers of "Knowledge" to imagine the scenery for themselves.

Collisions in Clusters.

The great Humboldt asked this most suggestive question: "How can these systems be maintained—how can the suns, crowding at the interior of star clusters, fulfil their revolutions freely and without clashing." Do they revolve without clashing? The answer is: Almost certainly they occasionally clash.

Novae sometimes occur in star clusters as do many variables. We have already proved that the impact of suns absolutely must produce new stars, and Nature seems to offer no other suggestion of their origin. Every such impact must strew the space about the point of collision with meteoric and gaseous matter, which must exercise a retarding effect upon the suns passing through it, and produce other impacts strewing variable stars over the cluster. Every such collision lessens the motive energy of the cluster, and helps to weld it together, until finally, after eons have passed, a vast nebulous sun may result.

The Genesis of Clusters.

How do star clusters originate? Possibly they are the nuclei of vast third bodies that have been struck from gigantic suns, or perhaps the result of whirling coalescence, where great angular motion prevented condensation to a centre. We have already seen that selective molecular escape must rob the bodies at unstable temperatures of their light gases, whilst a vast expanding rotating mass of elements of greater atomic weight will be left behind, that is a rotating meteoric swarm. Such a rotating mass will not quickly tend to concentrate to a centre, the angular velocity will keep the particles in orbits. These orbits must be continually crossing one another, and although the general rotation of the mass will be in one direction, as the swarm will be roughly spherical, the individual particles will be in orbits in all azimuths. Hence, instead of concentrating to a plane as they would probably do were they subject to a great central controlling force, they will tend to aggregate into larger and larger fragments, the whole retaining somewhat of a globular form. Small swarms of this character would probably give rise to some of the comets, but it would not be the only method of their formation, as impact shows us, many modes by which dust swarms may originate. Very gigantic swarms would, as the ages rolled on by continued coalescence gradually form star clusters in which the constituent suns would be somewhat similar in mass.

Taken at Yerkes Observatory *April 9th, 1910.*

Figure 1. Star Cluster M.3. Canes Venatici.

A typical star cluster with a condensed centre; a more diffused one, that of ω Centauri, was shown on page 343 of the September issue.

Impacts within star clusters would not be so liable to produce double stars as under ordinary circumstances, because in proportion to the mass there must be a very considerable orbital proper motion. Hence, although we should expect a fair number of very transitory novae and a great number of variables in special parts of star clusters, or in special clusters, we should not expect a great number of double stars. The whole subject of the internal motions of star clusters is one worthy of very careful study on the part of the astronomer. We shall require to know much more than we do about these motions, before there can be any certainty as to the origin of clusters.

The suggestion here made as to their genesis has considerable elements of probability, but is certainly not an absolutely demonstrated deduction, as is the partial impact origin of new stars by the formation of the third body. Nor does it compare in

probability with the impact origin of variable and double stars: in both of which cases the evidence is so conclusive that it is certain that a very large number of the wonder and double stars of the heavens did actually originate from the grazing impact of suns.

PLANETARY NEBULAE.

There is very strong evidence, indeed, that most, if not the whole of the so-called planetary nebulae, originated from the impact of suns. It is almost certain that Herschel's wonderful suggestion as to the physical character of these bodies is true. He examined these circular discs of faint even light with great care and he tells us that only one possible suggestion of their character offers itself. They cannot really be discs, or they would sometimes be shown to us more or less edge on: they cannot be continuous spheres of gas, or the edges would be much less brilliant than the central portions. The only explanation left, inconceivable as it may seem, is that they are hollow shells of gas. How such bodies could be formed appeared to him a mystery, but it is obviously a clear and simple deduction, when we study the properties of the third body and apply to it the principle of atom sorting.

FIGURE 3. Webb's Nebula.

Diagram showing by the continuous spectrum the meteoric nuclei within the ensphering shells.

FIGURE 4. Struve's Nebula.

Diagram showing in spectrogram that concentric layers are of different elements.

THE ORIGIN OF PLANETARY NEBULAE.

We have already shown that the high kinetol of the light gases, must under many and varied circumstances cause such elements as helium, hydrogen, nebulium, and so on, to leave systems. We have also seen that on the birth of the third body, the atmospheres of the suns must be at the centre of the mass, and as expansion occurs these light gases gradually make their way out. By taking energy from heavier elements these light atoms attain an escaping velocity. It is clear that this inversion of the position of the elements could not occur suddenly. At the birth of the third body, the light elements do not move faster than the heavier ones. This increase of speed is obtained as the temperatures tend to become equal, consequently much of the later escaping hydrogen will not possess anything like the speed that some of the light material, better situated, will attain, and hence some of it may only have a velocity approximately that of the critical velocity. The whole third body is rotating, and hence particles with slightly less than the critical velocity will be carried to enormous distances, and will not tend to concentrate back again, because the rotation will give them an orbital power.

In every stage of atom sorting there will tend to be ensphering shells, in which the lighter gases will be the outer ones, and consequently many of the planetary nebulae will have a sphere in sphere structure.

THE CENTRE OF THE PLANETARY NEBULAE.

They should also often have centres consisting of material of greater density. Sometimes this centre would be a rare meteoric swarm, such as seems to be the case with Struve's and Webb's planetary nebulae. Both of these nebulae, as shown by Keeler's drawings, exhibit also the sphere in sphere structure. (Figures 3 and 4.) Sometimes the meteoric swarm would be dense enough to appear stellar, perhaps with a velvety structure. Some of the planetary nebulae actually do exhibit such a star. In some cases the two suns would be entrapped into a double star the distance of whose constituents from one another might be very small compared with the dimensions of the planetary nebula, for some of these extraordinary bodies have dimensions that are inconceivably stupendous. The orbit of the earth would be as a child's hoop in a continent, compared with the vast dimensions of some of these celestial shells of luminous gas.

I think it extremely probable that every planetary nebula is gas that has been produced by an impact of suns, gas that has sorted itself, by selective escape, into a condition of practical stability. The planetary nebulae that are known to result as the final stage of many temporary stars need not necessarily be permanent shells; the speed may be so great that the material may be carried on into distant space, or not great enough to form permanent gas shells. The width of the lines in the spectrograms would tell much as to this velocity.

The same remark applies to planetary nebulae as was made regarding star clusters. Their character and motions should be studied in the light of the new astronomy of impact, to ascertain how far they tend to give solidity to this new theory, or to modify some of its conclusions.

WHITE NEBULAE.

Covering vast regions at the two poles of the

Galactic circle are hundreds of thousands of nebulae. An immense number of them are of an exquisite double spiral structure. In the next article, in describing the origin of the Galaxy, we shall attempt to show that these nebulae were extruded during the coalescence of the two cosmic systems which this theory suggests went to the formation of the system of stars that is commonly known as the Universe. It will be explained that the Milky Way is the result of what we have called "Whirling Coalescence," and that the two great sheets of nebulous matter that now clothe the two poles of the Galaxy were ejected during the earlier periods of coalescence by the agency we have named "Axial extrusion." In studying, then, the origin of these double spiral and other white nebulae, we have to assume that the two poles of the Galaxy were at one time covered with vast continuous sheets of nebulous matter which the action of "selective molecular escape" had largely robbed of its light gases. Into such a sheet of material, the many errant masses that are sent out of systems by the agencies described in "The Birth of Worlds and Systems" would penetrate, and would gradually be volatilised by friction, and would form cometic nebulae, developing into roughly globular nebulous condensations. These portions would be denser than the general sheet of nebulae. Any condensed masses that were near one another would be influenced by mutual attraction, and approach one another. Lateral attraction of other nebulae would, as a rule, prevent direct impact, and hence the approaching pair would move in curved orbits and come into grazing impact. This graze may, of course, be of any depth, as already suggested in the case of grazing suns.

Taken at Yerkes' Observatory *February 7–8, 1910.*

Figure 5. Spiral Nebula, Canes Venatici.

A probable case of oblique impact between two nebulae of extremely different volumes. A considerable portion of the large nebula remains at the end of the spiral.

Taken at Yerkes' Observatory *May 5–8, 1910.*

Figure 6. Spiral Nebula, M.64. Comae Beren.

A probable case of whirling coalescence of two previously existing nebulae.

The Effects of Depths of Graze.

The mere margins may collide and, as they do so, the impact would greatly increase the temperature, and hence the luminosity, of the colliding margin, and then, after a long period, a streak of light would exist between a pair of more or less globular nebulae—a condition that not infrequently shows itself in connection with double nebulae. In certain positions we should obviously have a nebula somewhat of a dumb-bell shape.

If the graze be deeper, we should have a vast spindle-shaped nebula produced as a third body, only, unlike that of the suns, it would be of extreme tenuity. But the kinematics of the two are the same and hence rotation will ensue, and a spiral begin to show itself in the centre of such nebulae. We know of many examples of this, that of Leo being very beautiful. As time rolled on such an incipient spiral would complete itself, and we should have a double spiral structure. Such a definite structure as this would not be possible in the case of the grazing impact of dense bodies like suns, because the explosion of the third body would be of such thermodynamic intensity as to blow the spiral to pieces.

Whirling Coalescence of Nebulae.

Again, imagine that the globular nebulae strike so deeply as to give us cases of whirling coalescence. On the grounds of both deduction and observation, this would seem to be the general case of nebular collisions. When we look at the kinetics of this special class of impact, this deduction is very strongly supported. Let us examine such a case of the coalescent collision of globular nebulae. The pair have penetrated deeply the one into the other, the portions outside the range of actual collision would be carried forward by their own momentum, but would be subjected to the attraction of the vast third body produced by actual collision. The capturing power of the third body would curve these portions into a double spiral. The middle portion would, however, be so intensely heated that a good deal of it would be expelled both by selective molecular escape, and by axial extrusion. Consequently the attraction would weaken, permitting centrifugal force to act and allowing the two great tongues of fire to proceed outward, as two giant arms of an immense double spiral nebula.

Taken at Yerkes Observatory *March 6—7. 1910.*

Figure 7. Nebula, ♅.V.24. Comae Beren.

Probably a high velocity case of whirling coalescence, in which the outer parts that have not come into collision still remain as non-luminous dust, and so obstruct the light of the spiral

Agents Modifying the Spiral.

All kinds of modifications of the form of this double spiral may be due to differences of size, or difference of density, of the impacting nebulae. One or both of the two colliding masses may already be made up of more than one centre of condensation. In this way the two arms may differ so much in volume from one another, that it may form a vast almost independent nebula at the end of one of the arms: such as we see so strikingly in the great nebula in Canes Venatici, (Figure 5).

In the case of previous rotation, the original motion would give great irregularity to the arms of the spiral, and even tend to give it a multiple appearance. Of this resultant motion we have very many examples. Hence it seems that we have but to study the kinetics and kinematics of the various impacts of nebulae, and every element of mystery in the origin of their form and structure disappears. When we take into account differences of density, differences of volume, differences of depths of encounter, differences in the stage of impact, there is possibly no single form amongst the hundreds of thousands of those photographed, but we have a clear dynamical account of their evolution. Thus we are presented with a set of principles that absolutely explain the origin of each and every one of these exquisite celestial flowers, the glowing nebulae that we find in every stage of bloom in the celestial fields.

In our next article we shall attempt to show that by applying the same reasoning, as here given to nebulae, to the impacts of systems similar to the great clouds of Magellan, the mystery surrounding the birth of the grand Galactic system we call the visible universe is in like manner completely dissipated, and the whole cycle of the eternal heavens is revealed to our mental gaze.

FOURIER'S SERIES IN THE "ENCYCLOPAEDIA BRITANNICA."

To those with a taste for mathematics here is fine food. Fourier's invention of the series bearing his name formed a landmark in Mathematical Science at the beginning of last century. He shewed by their means that it was possible under certain circumstances to represent any discontinuous or arbitrary valued function by an even series.

Interest is added to the study of these by knowing that they have considerable application in physical science, especially in the theory of heat.

The article in the Encyclopaedia treats the subject very ably and explicitly, and gives a few well-chosen simple graphical examples.

Preceding the article on Fourier's Mathematical work is one giving a short history of his political life, from which we learn that Fourier, in addition to belonging to the company of illustrious men of science that France has given to the world, also achieved uncommon success as a politician.

T. W. K. C.

PSYCHICAL RESEARCH.

By J. ARTHUR HILL.

It is related of Mme. de Staël that she did not believe in ghosts, but that she was afraid of them all the same—"*je ne les crois pas, mais je les crains.*" The witty Frenchwoman's epigram contains deep psychological truth: for our emotions are not ruled by our reasoned beliefs. And, in addition to its true psychology, it accurately describes the attitude of the average man, though he may not confess it so frankly. We don't believe in ghosts—oh, no, not really *believe* in them. But we are at times a little—just a little—afraid of them: say, for instance, when going to bed at two in the morning (at which hour, according to Napoleon, courage is at its lowest ebb) up the gloomy staircases and in the draughty corridors of an old and lonely house, with the wind soughing and sobbing and wailing in the trees outside—like the wraith of poor Cathy in "Wuthering Heights." At such times, we have inner qualms, step we never so boldly.

The recent advance in certain by-paths of science, however, seems likely to go far towards effecting a change in popular opinion and popular feeling. The ghosts, like everything else in this extremely scientific age, are now being studied and examined, and photographed and dissected (or would be, if they had any insides to dissect), and the prospects are that before very long, we may get so well acquainted with these *animulae vagulae* that we shall no longer be afraid of them. Then we shall be able to reverse the epigram; instead of disbelieving yet fearing, we shall believe but shall not fear. This consummation may be displeasing to the orthodox haunting ghost, whose business is (like the Fat Boy's in "Pickwick)," to make our flesh creep; but, on the other hand, it will meet with the approval of all sensible and well-disposed spirits, such—for example—as Mr. Stead's friend Julia, of whom we have lately been hearing so much.

The "spirit" question, however, is the wrong end of the subject to attack. Of course, when an apparition does turn up it is the percipient's scientific duty (if he can keep his wits about him sufficiently to do it well) to observe it, to make careful notes at once, and to get them signed—along with a doctor's certificate of sobriety—by corroborating friends. Then, if the person represented by the spook is afterwards found to have died at the time of the vision, we have good evidence for some kind of supernormal agency. Or if—as is most likely—he did not die; if, indeed, he was in specially good health and spirits at the time: if, in short, our hallucination was due to indigestion (as the doctor probably assured us), we naturally feel a mild regret that the Society for Psychical Research should have lost a promising "case." But, on the other hand, we have at least retained our friend, who—perhaps equally naturally—will be apt to regard our aforementioned regret with a feeling akin to resentment. But, even in cases of veridical hallucination—*i.e.*, hallucinations which seem somehow connected with distantly-occurring events, and which are therefore "truth-telling"—even in these cases, the scientific value of the phenomenon itself is perhaps less than that of many apparently less important happenings. For it is not the mere establishing of the actuality of an alleged phenomenon, that constitutes its value to pure science. It is the linking of it up with facts already known; the fitting of it into the mosaic of already organized knowledge; the bringing of it into the domain of law;—it is here that the main business and interest of the philosophical scientific man are to be found. And, in the case of ghosts, this linking up, and fitting in, does not seem likely to be an easy matter, even if the facts are satisfactorily established.

It was therefore with deep wisdom that Sir Oliver Lodge, in "The Survival of Man," which is the latest important pronouncement on the subject, decided to begin at the other end. Instead of plunging into the description of phenomena which puzzle us because they seem so out of relation with our scientific knowledge, he starts by giving a lengthy and careful description of some experiments of his own which seem to establish the fact of thought-transference or "telepathy." In these very matter-of-fact and unghostly experiments, the chief parts were played by two young ladies who were employed by a Liverpool firm, of which Mr. Malcolm Guthrie, J.P., was head. One of them—the receiver or "percipient"—was blindfolded, though as an aid to passivity of mind rather than as a precaution. The other—the "agent"—concentrated her mind on an object selected by Sir Oliver, trying to impress the idea of it on the mind of her friend. Care was taken, of course, that the latter was afforded no opportunity of seeing the object, or of gleaning any information of its nature by normal means. Many of the experiments were made with ordinary playing cards; for, by this means, the likelihood of chance coincidence could be mathematically determined. In one series which Sir Oliver quotes, the successes were ten out of sixteen. The chance of this occurring by accident can be shown to be less than one in ten million.

From this we go on to telepathy at a distance. Recent experiments between Miss Miles and Miss Ramsden, carried out in accordance with suggestions made by Professor Barrett, indicated clearly that some supernormal agency was at work. The distance between the experimenters varied, as one of them was travelling about: during part of the time it was about four hundred miles. Often, the exact idea sent by the agent was received by the percipient, who sat alone, at a specified hour, waiting passively for ideas to drift into her mind. At other times, the message received was not that which had been consciously sent, but nevertheless represented something which had been occupying the agent's mind during the day. From this it appears that the agent's subconsciousness, as well as the ordinary conscious level of the mind, may have something to do with the process.

With this in mind, we go on to consider a different class of phenomena, *viz.*, what is called by spiritualists "trance - mediumship," and by psychical researchers "motor automatism with obscuration of the supraliminal consciousness," or other terms to that effect.

It is a common thing for a sitter with a trance medium to be told the most astonishingly correct and intimate details of his family life, the names of his relatives, and so on, although, so far as he knows, he is an entire stranger to the medium. The intelligence, or control, purports to be a guardian-angel sort of spirit, who habitually speaks through this medium, and who says that he or she is getting the information from spirits who are the sitter's deceased friends or relatives. Sometimes one of these latter is allowed by the "guardian-angel spirit" to take personal possession of the medium's body, and thus to speak directly. In such a case the astonished sitter (*i.e.* if he is a novice) finds himself addressed in characteristic fashion by some dead person, reminded of little experiences which they had shared in life, and is perhaps ultimately convinced that he is veritably in direct communion with the disembodied mind of his relative or friend. When the medium wakes up, she (it is usually a "she") has absolutely no knowledge of what her vocal organs have been saying.

Now how are we to set about explaining all this?

The first thing to make sure of is, of course, that ordinary fraud is excluded. This is usually a fairly easy matter. When the sitter can question the "spirit" (as in these cases he always can) it is easy enough to get satisfactory assurance that common trickery is not the correct explanation; for questions can be asked concerning family matters, or mutual experiences, of which the medium could not be normally aware, even assuming the employment of skilful and energetic detectives. Moreover, in several cases known to me, the sitter gave either a false name, or no name at all. In one of these cases, the sitter was a friend of mine, living two hundred miles from London, where the sittings took place, and there is no reason to suppose that he was in the least degree known to the medium. He was not a spiritualist, had no spiritualistic friends, and had never sat with a medium before. Yet the guardian or "guide" gave my friend's two Christian names, with a good deal of true detail about his life, and at the second sitting, two days later, he was greeted by an intelligence purporting to be his recently-deceased mother, who alluded by name to all the near surviving relatives, with appropriate comment and attitude, and gave other evidence of a characteristic and convincing nature. My friend had gone into that room a sceptic, bent on "showing up" these tricky mediums; he came out absolutely convinced that he had spoken with his deceased mother. I express no opinion, except that some supernormal explanation seems to be required. (I may also remark that this case, considered in full detail, is much more evidential than this necessarily short description can indicate. It is described in full in my just-published book, "New Evidences in Psychical Research." (William Rider & Son, Ltd. 3s. 6d.)

Fraud being excluded, we turn to other possible theories; and, bearing in mind the fact of thought-transference or "telepathy"—already established by experimental methods—we surmise that the medium has somehow read the sitter's thoughts. The fact that the trance-control's remarks do not coincide with what we were thinking of at the time, is no obstacle, for, as we saw in the case of Miss Ramsden, it is not always the agent's *conscious* thought that is reproduced. The medium's trance-consciousness may be able to rummage among our memories, selecting those which stick together round a given personality. As to the verisimilitude of the characterisation, this is easily comprehensible; for it is a well-known and continually-observed fact that in the hypnotic state many subjects are excellent mimics, and hypnosis is undoubtedly related to "mediumistic" trance.

It follows, then, that nothing more than thought-transference need be supposed, so long as the medium tells us nothing except what we already know. But what shall we say if things are told us—things characteristic of the *soi-disant* spirit—which have never been known to us, but which on investigation turn out to be true? Well, this certainly complicates matters, but, knowing that telepathy can be effected over great distances, as in Miss Miles' and Miss Ramsden's experiments, we are able to suppose that the fact in question has been somehow telepathically gleaned from some distant mind. It is, however, clear that in making this supposition we are treating two cases as analogous, which differ in important features. Miss Miles and Miss Ramsden are well known to each other, are, in fact, friends; and, though the consciously-attempted message sometimes failed, another (which was not "sent") taking its place, it must nevertheless be borne in mind that the two experimenters were thinking of each other frequently, and that there was thus a certain *rapport* between them. Whereas, in some of these trance messages, the person whose mind must be supposed to have supplied the information is a person who has never seen the medium; is not known by the medium; is unaware of a sitting being in progress, and therefore is not thinking of anything of the kind; is indeed perhaps unaware of the medium's existence, and hostile to psychical research and all its works. The conditions are therefore very different from those of experimental thought-transference. Still, this latter fact having been established, and its possible range not yet being satisfactorily defined, we are bound by the law of parsimony to work telepathy for all it is worth, before turning to other and more far-fetched-seeming hypotheses. So long, therefore, as any living mind contains a fact which is retailed by a control as evidence of its identity, we must suppose that it may be a case of telepathy from that living mind.

I say we must suppose that it *may* be. It does not by any means follow that it *is*. Some of the cases quoted by Sir Oliver Lodge as occurring in his own experience with Mrs. Piper, though possibly explicable by telepathy, are nevertheless strongly suggestive of the action of a disembodied intelligence. For example, a "spirit-communicator" in Mrs. Piper's trance claimed to be the deceased son of Mr. Rich, the then Postmaster at Liverpool. This entity wished a message to be sent to his father, who was said to be worrying specially about his son's death. The sitters knew Mr. Rich slightly, but knew nothing about the matter dealt with in the message. This latter, however, was duly delivered, and turned out to be appropriate to, and characteristic of, the deceased young man. The exceptional worry or grief was due to a slight estrangement, which would have been only temporary. If we are to invoke telepathy in this case (and it is only one of many similar ones) we are driven to the curious supposition that Mr. Rich subconsciously sent a telepathic message to Mrs. Piper (whom he did not know, and who did not know him) and that this message was dramatized and returned. In other words, that he sent a deceptive message to himself—*via* Mrs. Piper, and by means unknown to science—without knowing anything at all about it! It seems almost as easy to believe in the *prima facie* explanation (*i.e.* genuine spirit communication) as in such marvellous telepathic exploits as this.

But is there—it may be asked—any way of putting it to the proof? Cannot telepathy be shut out, somehow? Cannot crucial tests be devised? On this very important point several acute brains have been cudgelling themselves for many years.

It was at one time thought that the best test would be the posthumous reading—through a mediumistic communication—of a sealed letter left in the keeping of a friend. Such a letter was left with Sir Oliver Lodge by Mr. Myers; but the attempt by a *soi-disant* Myers-communicator to give, through Mrs. Verrall's automatic writing, a reproduction of its contents, was a complete failure. It is now recognized that the test is not a good one; for, even if it succeeded, it would not yield proof. It would still be possible to suppose that the deceased had, before dying, subconsciously "telepathed" the contents of his letter to some person or other, and that, when a medium afterwards produced the message correctly, it was through telepathy from the subconsciousness of this hypothetical person. Or, again, the letter, though sealed, might be read "clairvoyantly." Some such power is often alleged, and there is a good deal of evidence in its support. Further, is it not too much to expect that a spirit will remember what the letter contains? Sir Oliver Lodge has not prepared such a letter, for he is quite sure that he would forget what he had written. Probably most people will feel similar doubts about their *post-mortem* recollection of such matters.

The sealed-letter test, then, is given up as unsatisfactory. What shall we turn to next?

It was thought by Mr. Myers and Professor Sidgwick that it would be rather good evidence if the same message could be obtained from the same spirit through two or more mediums. Some experiments in this direction were made, but apparently without much success. After the death of these two leaders in the research, it was natural to expect that they would themselves try something of the kind from "the other side," in order to give us evidence of their continued existence. And, as a matter of fact, this seems to have happened. The same message, almost word for word, was received from a Sidgwick-control through Mrs. Thompson, in London (sitter, Mr. Piddington, Hon. Sec. of the Society for Psychical Research), and Miss Rawson, in the South of France. But the telepathic difficulty again arises. The two messages were not exactly simultaneous. Is it not possible that Miss Rawson's subconsciousness made up the message (it was one giving some instructions to Mrs. Sidgwick about the preparation of her husband's "Life"), and then telepathed it to Mrs. Thompson? It is of course necessary to suppose, also, that the subconsciousnesses of the two mediums were in league to represent the message as coming from Dr. Sidgwick. But if the heart of man is deceitful above all things, and desperately wicked, there is no knowing to what depth of sin these newly-discovered "subliminals" may descend. We must hold them guilty until we have proved them innocent. In this case, once more, then, telepathy is not excluded.

At this point the ingenuity of the earthly investigators seemed to come to a stand. There seemed no way of getting round this omniscient and omnipotent telepathy. It seemed impossible to devise any experiment which should shut out with reasonable certitude the agency of minds still in the body. Just about this time, however, a curious thing happened.

For some years after Mr. Myers's death in 1901, automatic writing had been regularly produced by several people of social and educational standing—not professional mediums, or even spiritualists—who were more or less in touch with the Society for Psychical Research, and whose script purported to emanate partly from the surviving mind of F. W. H. Myers. Chief among these automatists is Mrs. Verrall, Classical Lecturer at Newnham; others are Mrs. Holland (an Anglo-Indian lady, who did not know Mr. Myers) and Mrs. Forbes, the widow of a well-known judge. These scripts contained much evidential matter, but it was usually open to the telepathic explanation, though some of it admittedly strained that explanation rather severely. Still, telepathy was *possibly* the true theory. But, in 1906, it was discovered by Miss Johnson (the Research Officer of the Society for Psychical Research) that there were curious concordances in these scripts, concordances which apparently had been going on for some time. It was found that one script, say Mrs. Verrall's, would contain a piece of writing which was apparently meaningless, and which was so treated by the automatist, while another script, say Mrs. Holland's, written about the same date, would contain a message equally meaningless in itself, but which, when compared with the similar one in Mr. Verrall's script, produced the most startlingly good sense. Here, then, apparently, was found evidence of initiative "on the other side," for none of the living investigators had thought of this plan of splitting a communication up and giving it piecemeal through different automatists. (See *Proceedings of the Society for Psychical Research*, Vols. XXI and XXII).

These remarkable phenomena are, however, still not quite conclusive. Perhaps the ingenious and sportive subliminals of the automatists concerned have arranged an elaborate system of impersonation, telepathing these message-fragments to each other, while the normal consciousnesses remain ignorant of all this below-decks cross-firing. The hypothesis cannot be entirely put aside: though it seems very improbable to those who have made a careful study of the whole mass of evidence. As Sir Oliver Lodge has said, it is too early to formulate dogmas, or even to express opinions (on the spiritualistic question) except in hesitating and tentative fashion. But the evidence now certainly seems sufficient to justify the holding of at least a working hypothesis that in these experiments the minds of "dead" persons are really playing a part.

This, however, is a very different thing from an acceptance of "spiritualism," with all its crudenesses and follies. The spiritualists—or most of them—accept any sort of trance-ravings or automatic scrawlings, as genuine "messages" from "the beyond." Psychical research, on the other hand, critically examines the content of the messages, applying the most drastic tests before even admitting other than known causes. If the communications contain nothing that is not known to the medium, psychical researchers dismiss them as of no interest; unless, indeed, there is a cross-correspondence involved—*i.e.*, the same message, or a related one, being given through another medium. If the medium's own knowledge is undeniably insufficient to account for the facts, then telepathy is invoked, and is stretched to a fearsome extent, amidst the violent diatribes of the spiritualistic press, which stigmatizes the Society for Psychical Research as a Society for Suppressing Knowledge. If telepathy begins to seem insufficient, some few bolder spirits of the Society (incarnate ones) venture on the tentative hypothesis of "telepathy from the dead;" but with careful hesitancy, leaving the door open behind them in order that they may flee back to the safety of former and more orthodox views, if further investigation should render the new tentative hypothesis untenable. This perhaps undignified but certainly wise position is that which is at present occupied by Mrs. Sidgwick (the ex-President of the Society), Sir Oliver Lodge, and other leading members of the Society for Psychical Research. The present writer, who is also a member of the Society in question, adopts a similar attitude. Personal investigation has convinced him of the truth of Hamlet's well-worn remark to Horatio, and he is even inclined to think that some of the evidence justifies us in thinking that (to be Shakespearian once more) not only can we call spirits from the vasty deep, but that sometimes they will *come* (though of their own free will) when we do call for them.

It is a difficult subject, not suitable for everyone. Emotional and unbalanced people should be warned off. Even religious people are doubtfully desirable: the investigation should be carried on, as far as possible, in the pure dry light of science, as it has been in the past, by men like Sidgwick, Gurney, Myers, and Hodgson. We want no recurrence of witchcraft and superstition, of which, perhaps—after the materialistic extremes of nineteenth century science—there is some danger, the pendulum of popular opinion being apt to swing from one side to the other. But, this said, we may follow up our researches with an easy mind. We are certainly on the track of something, whether (in Professor Barrett's phrase) it be a "new world" of being, or not. Careful and honest and patient investigation will no doubt yield its reward; but no sudden revelation is to be expected or desired. It may require the labours of many generations to unfold the full significance of the discoveries which are now being made. For it is not only in the (possibly) spiritistic direction that our pioneers are making progress; we are also finding out much concerning the unsuspected powers of the human mind (telepathy, clairvoyance, and so on), while it is still manifesting itself through a material brain in the ordinary earthly life.

ON ADJUSTING AN EQUATORIAL BY MEANS OF CIRCUMPOLARS.

By E. ARDRON HUTTON, M.A.

THE average amateur astronomer usually suffers from the complaint of a holy discontent. He gets first of all a three-inch instrument on a tripod. He finds that he cannot conveniently use a power of more than one hundred and twenty, and so procures an equatorial stand and a couple of clasps, and then, by the aid of the usual text books, sets about its, or rather, their, adjustment. It must be confessed that the result is not always satisfactory, and in many cases a low power eyepiece is first used as a finder, a higher power being afterwards substituted. The object has then disappeared from the field before the new focus is found, and has to be "fished" for by the Right Ascension screw. Many of the objects in Webb cannot be seen at all with a low power, or at least cannot be distinguished when the field is crowded with stars, and thus much time is lost and many objects too. No amateur ought to be satisfied until he can infallibly pick up any object desired in a field of fifty to the inch of aperture.

The want of a sidereal watch can be easily supplied by obtaining a cheap Waterbury at the cost of half a guinea. Its adjustment to sidereal time, by aid of the "Sidereal time at Noon" given in Whitaker, is the work of a few days only, especially where a good clock is at hand. The first stroke of the hour from a public clock will usually be the best to adjust by, and if the time by the watch is put down on paper, the rate is easy to determine, but patience should be exercised, and the *exact* three minutes fifty-six seconds gain per day striven after. The subsequent rate may usually be relied upon to within very few seconds a day.

The adjustment of the clasps to the stand and to the telescope may then be seen to. The holes in the Declination plate should just fit the lugs of the clasp, and if there is any play wedges of thin zinc or tin (not wood), must be used. Two large washers for the screws to work against should also be provided, and everything should be screwed up well and firmly.

If the clasps are not quite right in size, two pieces of sheet lead of suitable thickness should be wrapped round the telescope, and then screw on the clasps. No wedges of irregular size and thickness must on any account be used. The telescope should, of course, be clasped tightly, and no play of any kind should be even suspected.

The adjustment of the instrument may then be taken in hand, and for this the method given in Chambers and Loomis leaves nothing to be desired, if faithfully and thoroughly carried out. Few, however, amongst amateurs do this, and hence a final testing by means of circumpolar stars is desirable and often essential.

For this purpose, either the upper or lower culmination of any circumpolar will suffice, but α and λ Ursae minoris are far the best, and the following method may be adopted.

A quarter of an hour or so before the actual culmination, the Declination circle should be brought to read the true Declination as given in the "Nautical Almanac," minus the correction for refraction. The R.A. circles should be set to the true R.A., and to time respectively, and the screws at the bottom of the Polar axis adjusted so as to bring the star exactly in the centre of the field of an eyepiece of not less than fifty to the inch of aperture, the telescope being East. Every care should be taken to perfect this adjustment and not to be content with mere approximation only. Exactness in this point is essential.

The telescope should then be swung over to the Western side and the circles re-fixed anew. If the star is too high or too low it is probably the Declination vernier that is wrong, and the star should be again centred by the Declination slow adjustment and the new reading taken. Half of this will be the error of the Declination vernier, and it must be altered accordingly. If the star is right in this respect, but appears to the East or West of the centre, a packing of thin metal must be put under one of the clasps until the error is halved. This is the commonest fault, and though it ought to have been detected before in the observation of six-hour stars, yet, too often, it is passed over as "near enough." A very small amount of packing will suffice, and nothing is more convenient than a sheet of thin lead from a tea chest, to be obtained at the grocer's for the asking. Again, however, we must insist on exactness, for nothing else will suffice. A second, or even a third, testing will be amply repaid. The time vernier may then be finally adjusted in the meridian by transit of an equatorial star, as given in the text books.

The consequence will be that powers of one hundred and fifty or two hundred may be used, with the assurance that the object will be in the very centre of the field of view with ordinary care in setting the circles. There will be no "fishing" or waiting, and above all there will be no mistaking one object for another, or concluding that it is beyond the power of the instrument. Six-hour stars will be equally easy, allowing, of course, for refraction, and the alteration of eyepieces will be speedily dispensed with. Above all, the amount of work done will be immensely increased, and the comfort of an exactly-adjusted instrument the better appreciated.

The larger the instrument the smaller the objects attacked, and the more necessary the exactness required, since oftentimes two or three doubles will be found in the field, and to know one from the other is by no means easy. A little care thus bestowed will be amply rewarded, and the observer will become the more satisfied with his hobby, and instead of *selecting* objects from Webb, will *work through* the book with ever-increasing satisfaction and delight.

CORRESPONDENCE.

THUNDERSTORMS IN GARESSIO.

To the Editors of "Knowledge."

Sirs,—The following notes and accompanying sketches were made at Garessio, a small town in the Ligurian Alps, about thirty kilometres inland from Alassio, and at an altitude of six hundred metres above the sea.

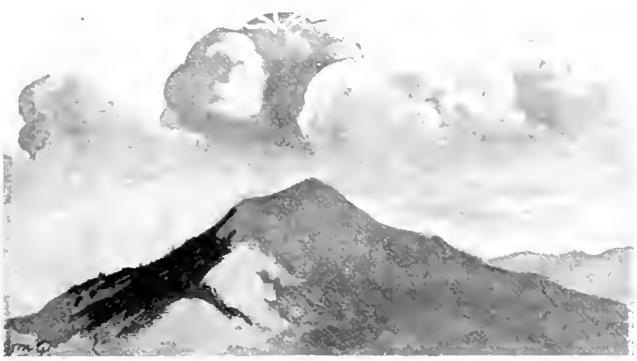


Figure 1.

Five long ribbons of Lightning.

The summer in that part of Italy has been a remarkable one, not as has been the case in England and Northern Europe, on account of the heat and drought, for our maximum temperature never exceeded 29° C. (84·1 F.), and the first part of the summer was so exceptionally wet that crops and flower gardens suffered greatly. The characteristic of this summer which has made it a remarkable one was the extraordinary prevalence of thunderstorms, and the unusual intensity of the electricity developed. There were thunderstorms, either close at hand, or within visible and audible distance, on twelve days in June, twelve days in July, and sixteen in August.

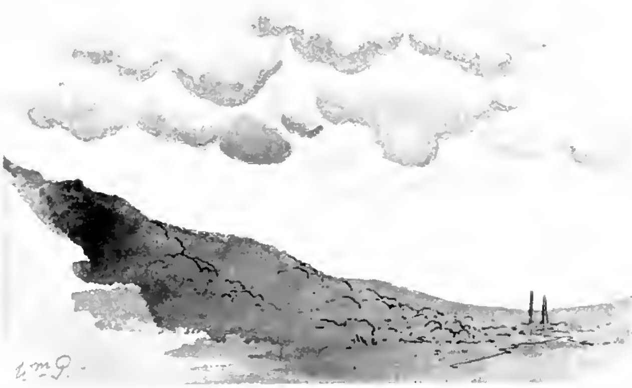


Figure 2.

Mamillated cloud after a thunderstorm, looking north. August 29th, 1911. 1.0 p.m. Garessio, Italy.

In these storms, which usually culminated between one p.m. and four p.m., the lightning was magnificent, ribbons of fire running across the sky for miles, accompanied by a continuous roar of thunder. Usually the flashes leapt from one towering cumulus to another at an enormous height, and almost always without rain. Only on one occasion was there a little hail. I have endeavoured to sketch one remarkable flash, because neither I nor any of those who witnessed it can recall ever having seen a similar phenomenon. The sky had been dotted for several hours with curious irregular-shaped cumuli of extraordinary hardness and compactness, evidently highly charged with electricity, and ascending in tall columnar masses much like the steam from a locomotive's funnel. Suddenly one of these seemed to become over-charged, and a violent and very rapid discharge commenced, one flash of which I have endeavoured to depict. (Figure 1.) From a distinct centre of the cloud there burst simultaneously five long ribbons of lightning, which traversed a space of absolutely blue and cloudless sky, and ended abruptly in the blue, as shown in the sketch. There was no other cloud above or near the thundercloud, and the five streams appeared all of equal length. The sun had recently set behind the hills shown on the right, and the sky was still luminous and blue. I have never observed such a thing before, and should be interested to know whether it is a well-known phenomenon—that is to say, the lightning travelling out of a cloud into space and there terminating.

Figure 3.

Mamillated cloud after a thunderstorm, looking south. August 29th, 1911. 1.15 p.m. Garessio, Italy.

The two other sketches I send because I remember seeing a letter and illustration some time ago in "Knowledge," recording a mamillated cloud. These mamillated clouds are not by any means uncommon amongst the Ligurian Alps, but I have never observed them except immediately after a thunderstorm, and they are apparently developed in that part of the thunder-cloud which represents the pointed end of the "Thor's Anvil," as it is sometimes called,—the long smudge which streams out behind at the opposite extremity to the advancing cauliflower-like front of the cumulus.

On the occasion on which the two sketches (Figures 2 and 3) were made, the whole sky was covered with these clouds. I took a photograph of part of it, but the result was too uniform in tone to come out well in reproduction. In my sketches I have slightly exaggerated the light and shade, but the forms were drawn with all possible care and accuracy. The rounded out lines of the pendant clouds appear to be due to the fact that the clouds are *descending*—that they are, in fact, cumuli upside down. After one of these storms we had the rather rare pleasure of seeing a perfect and very beautiful lunar rainbow (July 11th).

WM. PARKINSON (M.A., Oxon.)

OVIPOSITION OF TACHINIDAE.

To the Editors of "KNOWLEDGE."

SIRS,—I observed two of these flies the other day (July 25th, 1911) while attempting to lay eggs on the larvae of *Glottula dominica*, which were feeding on the leaves (and inside them, under the epidermis) of a species of Crinum.

One of them was feeling a larva near the head with its front pair of legs, as it now and again extended its ovipositor forwards under the thorax (I saw no eggs actually deposited).

The other saw the movements of a larva which was feeding under the transparent epidermis while about two inches off, and rapidly making its way there apparently succeeded in laying its eggs through the epidermis of the leaf on to the caterpillar, but of this I cannot be certain. The former larva was crawling on a neighbouring leaf and was not under cover, but it defended itself by swinging its tail round and discharging some liquid at the offending irritation.

I have noticed that a Tachinid is usually recognisable by the way in which the antennae stick out from the head during life, but the antennae of these two flies seemed to be in danger of getting broken off, and they reminded me irresistibly of a terrier's tail when he smells a rat!

L. G. GILPIN-BROWN.

STANDARD TIME IN PORTUGUESE TERRITORIES.

To the Editors of "KNOWLEDGE."

SIRS,—I beg to inform you that Standard Time will be in use from 1912, January 1st, throughout Portuguese territories, as follows:—

$8^h\ 0^m$ E.	Macao, Portuguese Timor.
$5^h\ 0^m$ E.	Portuguese India (provisionally $5^h\ 30^m$ E.).
$2^h\ 0^m$ E.	Portuguese East Africa.
$1^h\ 0^m$ E.	Portuguese West Africa.
$0^h\ 0^m$	(Greenwich, or West Europe).—Portugal, St. Thomé and Principe Islands, Whydah.
$1^h\ 0^m$ W.	Madeira, Portuguese Guinea.
$2^h\ 0^m$ W.	Açores, and Cape Verde Islands.

This Observatory remains entrusted with the determination and the telegraphic transmission of Standard Time to the whole country, to the Lisbon Time-ball, and to the Time Stations at the Meteorological Observatory, Ponta Delgada (St. Miguel, Açores).

I take this opportunity to state also that the most reliable geographical latitude of this Observatory is:

Lat. N. 38° 42′ 30″·5 (prime vertical, meridian, and zenith telescope series of observations from 1872 to the present, printed or unprinted),

and that the name "Lisbon, Tapada" is now the most suitable for it, like, for instance, "Florence, Arcetri," or "Naples, Capodimonte."

There has been built, and has now been working for two years a new astronomical observat[illegible] Lourenço Marques, whose geographical coördinates ar[illegible]:

Lat. S. 25° 58′ 1″·9 ± 0″·2 (Me[illegible] observations by C[illegible] Coutinho.)

Long. E. 32° 35′ 30″·4 ± 0″·05 (Me[illegible] simultane[illegible] and geodetic c[illegible] the Cape.)

Altitude (top of pier) 59 metres.

CAMPOS RODR[illegible],
Vice-Admiral, [illegible] Director.

Observatorio Astronomico de Lisboa.

DARK-GROUND ILLUMINATION AND ULTRA-MICROSCOPIC VISION.

To the Editors of "KNOWLEDGE."

SIRS,—In view of the great number and variety of dark-ground illuminators and appliances for ultra-microscopic observation which have come into existence, it is a matter for regret that makers have not always been felicitous in the choice of descriptive terms, and it is not improbable that in many cases this may have encouraged a pretty widely spread tendency on the part of users of the microscope to confound enhanced visibility with increased resolving power, with the result that a considerable amount of confusion has arisen respecting the fundamental aspect of the two modes of observation.

Neither the method of dark-ground illumination nor the so-called ultra-microscope can in any true sense of the term be regarded as a means of enhancing the resolving power of the microscope. In accordance with the undulatory theory of light this can only be accomplished by increasing the aperture of the optical system or by diminishing the wave length of the light. In their fundamental physical aspects the method of dark-ground illumination and the observation with the ultra-microscope are identical, and both serve to enhance the visibility of an object.

At the bottom of the secret which underlies these methods is the simple and familiar fact that brightly illuminated objects can be seen more distinctly on a dark back-ground than on one which is itself bright. Two things happen when a bright object is seen on a black ground; objects which were visible on a bright ground become much more distinct, and other particles which could not be seen before will come into view.

When this principle is applied to the microscope it is found that in the field furnished by the method of dark-ground illumination details can be observed, especially in preparations containing micro-organisms, which cannot be recognised under ordinary circumstances, though dimensionally they are well within the resolving power of the microscope. In addition, particles become so far visible that their presence can be perceived, and this despite the fact that their dimensions may be considerably smaller than the wave length by which they are seen, and accordingly beyond the resolving power of the microscope.

So long as the objects as seen in a dark field exhibit structural details and well defined contours we are dealing with simple dark-ground illumination. When, on the other hand, the field is seen to contain particles in which there is not a visible trace of detail and which accordingly present the appearance of bright point-like discs, generally surrounded by bright and dark rings, the case is one of ultra-microscopic observation, and the particles whose presence is thus perceived are ultra-microscopic.

It will thus be seen that the difference lies solely in the manner of observation and not in the nature of the apparatus. On the other hand, ultra-microscopic observation implies dark-ground illumination, whilst it is not every form of dark-ground illumination that constitutes an ultra-microscope. For this reason it is most desirable that the various appliances should bear appellations from which it is at once apparent that they are primarily intended for dark-ground illumination, pure and simple, or for ultra-microscopy, as the case may be, *i.e.*, dark-ground illuminators should be named so as to distinguish them from ultra-microscopes.

It should, however, not be overlooked that in practice it frequently happens that a dark-ground illuminator, *i.e.*, a condenser primarily devised for ordinary microscopic observation in a dark field, is available for ultra-microscopic observation: indeed, in many cases both kinds of observation are made concurrently. The examination of a preparation of saliva furnishes an instance of this. With our concentric condenser (after Dr. Jentzsch of our Scientific Department) one can see in this medium a few organisms moving across the field in snake-like fashion, and others of a rod-like shape, whilst in addition to these there are to be seen bright discs surrounded by one or several bright rings and executing quivering movements. The latter come into view by an ultra-microscopic process, whilst the others are seen under simple dark-ground illumination, though sometimes their transverse dimensions are of the ultra-microscopic order.

It is to be hoped that in future, makers as well as users of these optical instruments will endeavour to prevent a continuance of the misunderstanding at present existing, by employing the correct term, especially when referring to dark-ground illumination of micro-organisms.

E. LEITZ.

THE NEW ASTRONOMY.

To the Editors of "KNOWLEDGE."

SIRS,—I was delighted to see your able statement of the facts confirming Professor Bickerton's theory in your August issue, and still further pleased to read his remarkable articles, on the story of Nova Persei, and on double and wonder stars.

I have always loved astronomy, and for thirty years I have been a Fellow of the Royal Astronomical Society, and during all that time nothing has interested me so much as this beautiful theory of the third body.

At Professor Bickerton's lecture at the Royal Colonial Institute, I heard Mr. Knobel, who has been twice President of the Royal Astronomical Society, express his opinion so strongly, that I was delighted. He said: "It has been an extreme pleasure to me to listen to Professor Bickerton's eloquent address. I have given some attention to astronomy myself, and I can say, that the basis of Professor Bickerton's theory is such, that it must command, not only the attention and consideration, but I think, the assent of the majority of astronomers."

Since this lecture, as I have gradually realized how far-reaching is the scope of the principle of the third body, with its power to capture, its explosive energy, and its capacity to sort its atoms, I have come to believe that this generalization marks an epoch in astronomy. I heard Professor Bickerton debate the subject, at the British Astronomical Association, and was struck with the ease with which he confuted the objections of able astronomers. Hence I felt assured that the theory had come to stay, and subsequently his letters in *The Times* confirmed this impression. I have read and re-read his book, "The Birth of Worlds and Systems" published in "Harper's Library of Living Thought." Its study convinces me that the theory of Professor Bickerton's is the only one that corresponds with the facts of observational astronomy. With regard to novae, the question so ably discussed in the September number of "KNOWLEDGE," I have personally compared the light-curve, and series of spectrograms of Nova Persei, with the complex deductions made from the dynamical study of the third body, and they fit perfectly. I believe that the Southern Astronomers are right when they say that, "had the idea been used from its inception, merely as a working hypothesis to guide celestial observations, astronomy would have been years ago where it is now." The Government of New Zealand has shown its deep interest in basic science, and deserves the gratitude of the learned societies, in sending Professor Bickerton to explain his New Astronomy to the scientific world.

J. McCARTHY, F.R.A.S.

TO FIND APPROXIMATELY SIDEREAL TIME.

To the Editors of "KNOWLEDGE."

SIRS,—The state of the sky at a particular hour may be approximately ascertained by the use of the simple equation R.A. = h + 2m + 5, where h is the hour counting from midnight, and m the number of the month.

This will give the R.A. of the zenith, or Sidereal Time on the 7th of the month, within a few minutes. By the daily allowance of four minutes the R.A. on any other day of the month may be determined. Thus, on the 22nd of the month the R.A. will = h + 2m + 6.

N.B.—For greater accuracy in January and February the dates should be the 6th and 21st, and in March, May and July the 8th and 23rd.

Example: At noon on November 29th, seven days after the 22nd; R.A. = 12 + 22 + 6h. 28m. = XVI.28′. The correct time, as shown by *Whitaker's Almanack* is XVI.29′ 1″.

Again, if the R.A. of a particular star or constellation is known, its position in the sky at any date and hour may be calculated.

Example: The R.A. of Sirius is VI.41′. To find the time of its southing on 15th March, seven days after the 8th.

R.A. = VI.41 = h + 6 + 5h. 28m.

∴ h = −5h. 47m., which signifies 5 hours 47 minutes before 24 o'clock or midnight; which will be XIX. 13 o'clock, or 7.13 p.m.

Again, to find the date on which a given meridian will be south at a particular hour.

Example: When will Altair, R.A. XIX.46, be south at 9.30 p.m.?

R.A. = XIX.46 = 21h. 30m. + 2m + 6h. 16m.

(The last figure must be chosen, so that the value of 2m will be even.)

∴ 2m = XIX.46 − XXVII.46 = −8, = +16, ∴ m = 8.

The date will be August 26th, four days after the 22nd. By Whitaker, R.A. at noon on August 26th is X.14; at 9.30 p.m. it is XIX.44.

In the absence of a Star Atlas or Map, the following lines may be useful:

MEMORIA TECHNICA*

showing the position of the principal stars in the sky.

Sedes, Andromeda, et PISCES, et Cetus, Achernar,
Perseus, Pleiadesque, ARIES, Mira, Eridanusque.
Auriga, Orion, TAURUSque, Lepusque, Columba.
Tum GEMINI, Procyon, et Sirius, atque Canopus.
CANCER, et Hydra, Argo, cui puppim vela sequuntur.
Indicat Ursa Polum coeli, tergumque LEONIS.
Cauda, Canes, VIRGO, Corvus, Crux, et Centaurus.
Ursa, Draco, Arcturusque, Corona, et LIBRA, Lupusque.
Etanin, Heracles, Ophiuchus, SCORPIO, et Ara.
Vega, Caput Cygni, Volucerque Tonantis, et ARCUS.
Cepheus, et Cygnus, Pavo, CAPRICORNUS, et Indus.
Pegasus, Australis quoque Piscis, AQUARIUS, et Grus.

These lines, taken in order, give the constellations found in the segments of the sky contained between the R.A. meridians XXIV and II, II and IV, IV and VI, and so on.

FRED B. TAYLOR.

THE PURKINJE PHENOMENON.

To the Editors of "KNOWLEDGE."

SIRS,—It is a matter of common observation that coloured objects change their aspect in a remarkable manner just after sunset. If, for instance, when twilight has set in, we look about us in a garden containing flowers of various hues, or in a library full of many coloured books, we soon become aware of a striking change which has taken place in the relative brightness of the tints surrounding us. We notice that the blues are much lighter, and the reds much darker than when they are seen in ordinary daylight. So marked is this phenomenon at times, that certain blue tints appear almost white, while red tints, on the other hand, become so dark that they might be mistaken for black, if, indeed, they do not entirely pass unnoticed. The cause of this well-known effect, which bears the name of the Bohemian physiologist Purkinje (1787–1869), who first described it, generally receives its explanation in the peculiar differential colour sensitiveness of the eye, which loses sight of a red sooner than a green ray.

*Note.—Line 1: Sedes is Cassiopeia's Chair; line 5: Argo rises stern first; line 7: Cauda is the Bear's Tail; line 10: Volucer Tonantis is Aquila.

when adapted to twilight vision. The eye, in fact, according to this view, *must* be adapted to twilight, or must have the so-called "Dark-adaptation," before the phenomenon can be produced. The retinal apparatus of the eye undergoes a certain change when dark-adaptation occurs, the rods of the retina, which are distinguished from the cones by the possession of a substance peculiarly sensitive to the action of light known as "visual purple," being more particularly involved in the process.

So much, then, for the *physiological* explanation of those curious changes in the relative brightness of colours at dusk, known as the "Purkinje Phenomenon," and this is, in essence, the explanation given by Dr. Charles S. Myers in his recent science manual "An Introduction to Experimental Psychology"*; but it appears to me that there are other factors of a purely *physical* character—factors which I have so far never seen adduced—which also conspire to bring about the remarkable effects observed.

Every photographer must be familiar with the extraordinary change of aspect which coloured objects suffer when seen under the red rays of the dark room. Reds appear very bright, and blues correspondingly dark, for he is regarding them by what is practically monochromatic light of a red hue, and only those objects whose surfaces are capable of reflecting the red light waves will show brightly; all others must appear dark in comparison. Now, when the Sun has set, we have the reverse phenomenon, for our source of illumination is the blue sky only. The Sun, which sends us rays of all wave-lengths, being below the horizon, surrounding objects can only be rendered visible by the sunlight reflected from the minute particles of the atmosphere, and these, as we know, send us predominantly light of short wave-length, so that we here again have a quasi-monochromatic effect. This bluish light, therefore, will be strongly reflected by all objects of a blue tint, rendering them brightly conspicuous, while, conversely, all red objects will appear correspondingly dark—we shall have, in point of fact, a display of the Purkinje Phenomenon.

While in no way venturing to impugn the validity of the physiological interpretation of the phenomenon, as first described, it seems to me that we possess in the purely physical aspect of the question an equally powerful, if generally neglected, factor contributing towards the identical result.

W. ALFRED PARR.

NAKED-EYE COMETS.

To the Editors of "KNOWLEDGE."

SIRS,—The fact that four comets have been visible to the naked eye within two months must furnish a fact of exceptional rarity. I saw Kiess's comet on August 3rd without telescopic aid, Brooks's on August 15th, and Quénisset's on September 28th. And during the past few mornings Beljawsky's comet has been very generally seen as a conspicuous object in Leo.

Bristol, *October 8th*.

W. F. DENNING.

ASTRONOMICAL QUERIES.

To the Editors of "KNOWLEDGE."

SIRS,—May I be allowed to thank Dr. Crommelin and the Rev. M. Davidson for their lucid replies to my questions in your issue of August, and to add some further remarks?

On the first two questions I have nothing further to say, except to express surprise that the *Nautical Almanac* should publish the time of greatest brilliancy of Venus to the nearest hour when such accuracy is of no significance. In this connection I should like to refer to the ease with which the planet was seen at Hampstead at inferior conjunction on September 15th, when within nine degrees of the Sun himself.

With reference to my third question, dealing with the Moon's secular acceleration, I had no intention of submitting an astronomical catch but was in a real difficulty, though I found the fallacy in my own argument shortly afterwards. My solution, which agrees in its results with that of Mr. Davidson, is as follows:

Taking D, the disturbing acceleration (using the same notation as Mr. Davidson), as proportional to the reciprocal of the third power of the earth's radius vector.

Then the average value of D throughout a complete revolution of the earth is

$$D' = K \frac{2}{T} \int_0^{\frac{T}{2}} \frac{dt}{R^3}, \text{ where [illegible]}$$

From Kepler's Law, $R^2 \frac{d\theta}{dt} = C$, a constant.

$$\text{Hence, } D' = \frac{K}{C} \frac{2}{T} \int_0^{\pi} \frac{d\theta}{R}.$$

$$\text{From the equation to an ellipse, } R = \frac{b}{a(1 + e\cos\theta)}.$$

$$\text{Hence, } D' = \frac{K}{C} \frac{a}{b^2} \frac{2}{T} \int_0^{\pi} (1 + e\cos\theta)\, d\theta.$$

$$= \frac{K}{C} \frac{a}{b^2} \frac{2\pi}{T}.$$

$$\text{Also, } T = 2\int_0^{\frac{T}{2}} dt = \frac{2}{C}\int_0^{\pi} R^2\, d\theta;$$

But $d\theta = \frac{b}{R}\, d\varphi$, where φ is the complement of the eccentric angle.

And $R = a(1 + e\sin\varphi)$.

$$\text{Hence, } T = \frac{2ab}{C} \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} (1 + e\sin\varphi)\, d\varphi$$

$$= \frac{2ab\pi}{C}.$$

$$\text{Hence, } D' = K\frac{1}{b^3} = K\frac{1}{a^3(1 - e^2)^{\frac{3}{2}}}.$$

From this it *appears* that, as e decreases and D' consequently decreases, the Moon will be accelerated. But yet I am not satisfied. The problem is to show that the *average* angular velocity of the Moon in her orbit increases as the eccentricity of the Earth's orbit decreases. The above shows that the *average* perturbing acceleration decreases with the eccentricity, and we know that the angular velocity increases with decrease of perturbing acceleration; but I submit that these are not sufficient to prove the proposition. It seems possible that there may lurk here a fallacy similar to that with which I began this correspondence.

Perhaps my meaning will be clearer if I put the matter into symbolic form. The angular velocity, ω, being a function of D, we have $\omega = \psi(D)$ say.

$$\text{We know that } \frac{d\,\psi(D)}{dD} \text{ is negative.} \qquad (1)$$

$$\text{We have found that } \frac{d\left(\int_0^T D\, dt\right)}{de} \text{ is positive } (2)$$

But does it necessarily follow that

$$\frac{d\left(\int_0^T \psi(D)\, dt\right)}{de} \text{ is negative?} \qquad (3)$$

We still require to know the relationship $\omega = \psi(D)$.

I do not, of course, doubt the well-recognised truth of (3), but I venture to think that it does not follow from (1) and (2).

C. O. BARTRUM.

* Cambridge University Press, 1911.

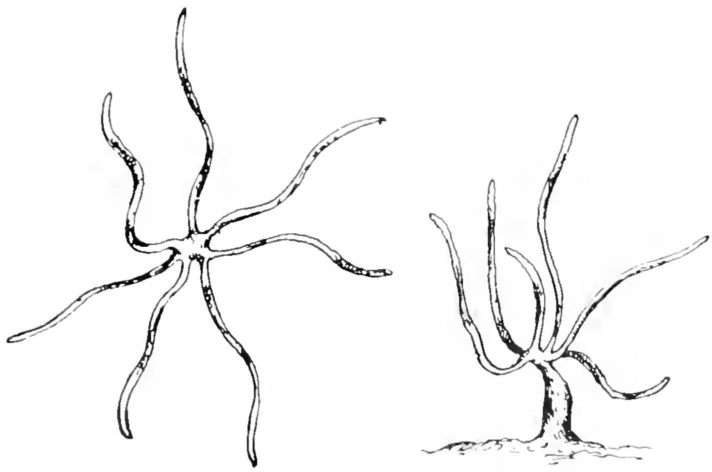
PLANT HAIRS.

By K. E. STYAN.

(Continued from Page 218).

IV.—(*a*) Stellate and (*b*) Peltate Plant Hairs.

As the word implies, stellate hairs are rayed and

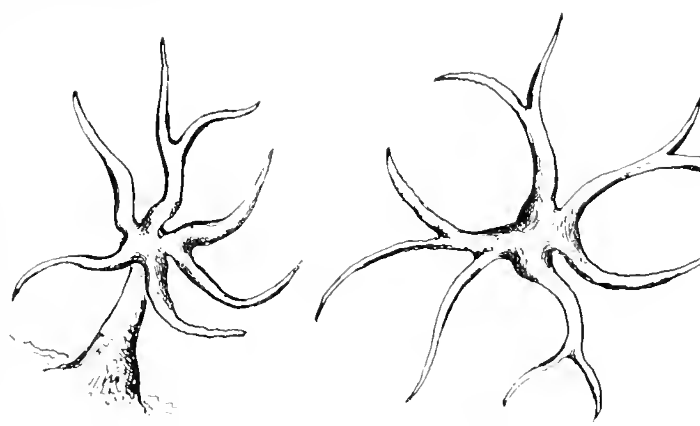


Front View. Side View.

Figure 1.

Stellate Hairs from the Stem and involucral bracts of Mouse-ear Hawkweed.

starlike, though the rays spread out in all manner of strange ways (some of them being simple, others branched into two or more arms) and are very irregularly placed at the tip of the pedicel from which they spring. So strange are they that, when first seen under the microscope, one finds it hard to realise that such structures are *hairs*. Yet they are so, and to their presence on a plant is due much of the external beauty that we see so clearly with the naked eye, for they often grow in such dense masses and are so soft, woolly, silky or scaly that a thick network, "felt" or "down" is formed, and this woven, silvery-white dress, on the surface of many leaves and other plant organs, is something really charming to behold. The wanderer on a lone tract of open salt marsh stands entranced—if he be either botanist or artist—at the glory of a mass of Sea Wormwood, decked in silvery sheen, glistening in the sunshine, yet equally exquisite in shadow. The beauty of this plant lies in its "felt-like" covering, every particle of which is made up of stellate hairs! Our garden Lavender (see Figure 3) is covered with a greyish "bloom" by which means the foliage forms such a perfect setting for the lilac of the blossoms. Every atom of this "bloom" is nothing less than myriads of charming stellate hairs, branched and simple, springing from the leaf epidermis on short, rather thick pedicels. Some of the rays are long, others short, and all are more or less sharp-pointed. In the Ivy (see Figure 4) each hair has from three to nine rays, branched or not, and distinctly broad and flat, each ray springing from the top of a long stem. Figure 2 showing illustrations from the leaf surface of garden white arabis, brings before us some of the quaintest stellate forms of which it is possible to conceive. A front view of such a hair has rather the appearance of a set of stag's antlers, whilst a side view looks rather like a tree with trunk and branches. If the leaf of Arabis be examined, its surface will be found to be very rough; this roughness is caused by the hairs upon it, and it is easy to realise why the leaf should be so scabrous when we find what remarkable hairs grow all over it. Apparently in different plant species the number of rays on each hair differs to some extent, though taken as a whole the number ranges between three and fifteen.



Side View. Front View.

Figure 2.

Stellate Hairs from the leaf of White Arabis.

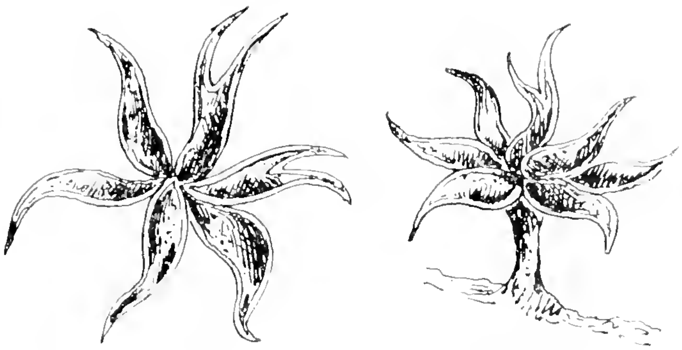
One large natural order of plants, the Compositae,

Side View. Front View.

Figure 3.

Stellate Hairs from the "felt" on the leaf surfaces of Lavender.

possesses a number of species specially noted for the "felt" on the under-surfaces of their leaves, stems, and so on. If only one be selected for examination, say the pretty little Mouse-ear Hawkweed, this one plant will afford much that will interest us, for the starfish-like hairs which form the "felt" are the most fascinating objects. Figure 1 represents some of them from the involucral bracts of the flower-head, but the leaves and stems of this plant are also covered with the same pretty silvery structures, very delicate and very chaste; and other lovely examples may be found on the leaves and stem of Hollyhock; amongst the Mallows; in the curious growths called "Oak spangles" or "galls," and in a great many other common garden and wild plants.



Front View. Side View.

FIGURE 4.

Stellate Hairs from the flower pedicels of Ivy.

It is difficult to say *why* hairs should become "stellate," yet one can see that their form is well adapted for the forming of "down" or felt-like growths, which no doubt play an important part in the protection of plant-surfaces.

Strange as are the stellate, the peltate or shield-like are, perhaps, the most curious of all the many different hairs with which we meet. Their appearance on a plant often causes the surface on which they spring to look, and feel, very scurfy and roughly scaly, for which reason the term "lepidote" has been given to such hairs, the word "lepis" being another name for "scurf."

FIGURE 5.

Peltate Hair from the leaf of Cornel.

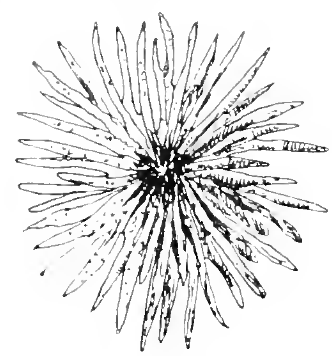


FIGURE 6.

Peltate Hair from the under surface of the leaf of *Eleagnus*.

Such a hair as this grow, from the epidermis of leaf, stem, and so on, in such a way that it is attached to it by its centre, and projects on either side in a horizontal way, thus forming a kind of shield or very flattened plate, which is membranous in texture, built up of many cells, and either more or less smooth and even round its margin, or cut up into numbers of sharp, delicate teeth of many varying lengths. It is owing to the presence of these "plates" that many plants present a scaly, scurfy surface. One need but look at Figure 6, a hair taken from the leaf surface of *Eleagnus*, to understand the reason for the leaf's lepidote appearance, nor can one well wish to see anything more rich in form than this flatly-expanded, toothed, radiating peltate hair, when seen under the microscope.

Other plants show different peltate forms, such as the Sea Buckthorn, the paleae of many young ferns, the Wallflower and many other cruciferous plants, Cornel, and so on. Figure 5 represents one taken from the leaf of Wild Cornel, and this is exactly the same in form as a similar hair from the Wallflower leaf. It is curious to note how masses of these low-growing, expanded flat hairs deck the leaf-surface, all more or less of the same size and height, the splayed tips almost poking into each other.

V.—(*a*) JOINTED (*b*) CLUBBED PLANT HAIRS.

Jointed hairs, compared with other forms on the whole, are by no means so common, yet they are met with in considerable numbers, and may be very well seen on the leaves of Hedge Woundwort and many of its allies in the large Natural Order, Labiatae; in Common Fleabane, Bugle, Mossy Saxifrage, Foxglove, Germander Speedwell, on the plants from whence the accompanying illustrations have been taken, and on the loose, hairy tissue on the surface of the stigma in many of the Orchidaceae.

If a hair of this kind be examined it will be found to show, at certain marked distances up its length, peculiar swollen joints that look very much like a series of knuckles, which seem to fit into sockets, the latter being much more clearly noticed in some instances than in others. The Purple Dead-nettle (see Figure 8) shows interesting examples of good jointed hair structures, which are extremely sharp-pointed. Those on the stem of one of the common garden species of *Harpalium* (see Figure 9) are really quaint-looking little things with their thickened joints, curved, sharp tips, and remarkably rough surfaces; indeed, imagination can almost liken them to the claws of a crab! Figure 10, representing a hair from the stem of the Mouse-ear Chickweed, is one the prettiest of all, perhaps, for there is a slenderness about it that is graceful, and the way in which joint fits joint is beautiful. In the Pineapple Sage (see Figure 7) are some glandular hairs, on the veins of the leaves, and the pedicels of these are distinctly pointed. When touched firmly, this plant emits a delicious odour of pineapple (which probably gives it its name), owing to the secretion formed within the hairs. Those people who have ever had the handling of Jerusalem Artichoke plants will know that their leaves are extremely rough, but few of them know that this fact is owing to the presence of countless myriads of sharp-tipped, jointed hairs that are, if anything, even more rough than those of the *Harpalium*, a plant of the same natural order. It needs but a microscope to show the bristling, scabrous upper coats of these simple, jointed structures, and we can then easily understand why the leaves

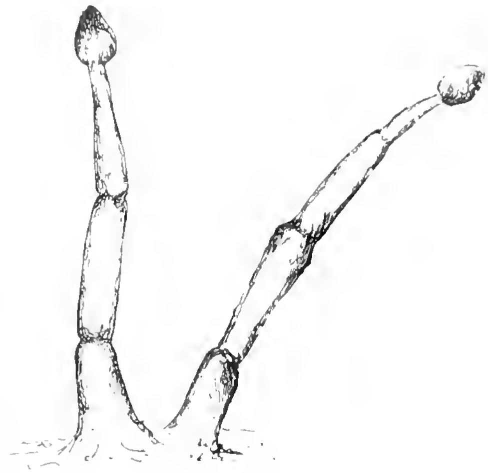


Figure 7.
Jointed Hair from the leaf veins of Pineapple Sage.

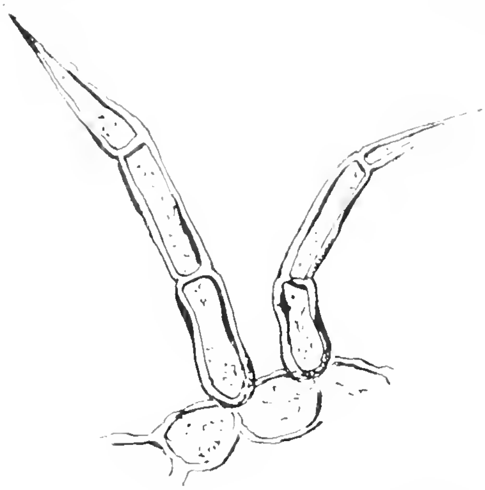


Figure 8. Jointed Hairs from the calyx of Purple Dead Nettle.

Figure 9. Jointed Hairs from the stem of Harpalium.

feel so rough and unpleasant to the touch.

Clubbed hairs are very often known as Clavate, or club-shaped, and are so marked in their features that it is difficult to overlook them even when they grow—as is often the case—in company with masses of ordinary long and simple, or other forms of hairy appendages. Some very nice examples may be seen in the White Campion and Pansy; in Avens and the interior of Willow-galls, and so on, but one of the best plants is the Scented Geranium. It is owing to the presence of these hairs on this plant that we get the delicious odour when the leaves and stems are pressed, for the hairs are glandular, but of so distinct a form that they are classed by themselves as the "clubbed." Figure 11 clearly shows some from the stem of the Geranium, and one can note the simple (*i.e.*, unbranched), thick-coated hairs, each of which is just like a club standing up on a curious swollen base. They are very pretty objects both individually and in the mass, and perhaps the fact that they are comparatively uncommon makes them all the more interesting when we come across them, as is often the case, unconsciously; for very often one kind of hair is met with exclusively on a plant, but at other times one may suddenly come across another kind interspersed just here and there, and no more. In this uncertainty lies the charm of real observation work, be it with the naked eye or microscope.

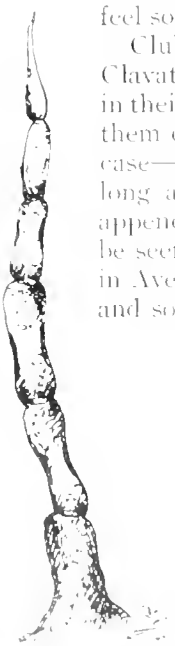


Figure 10.
Jointed Hair from the stem of Mouse-ear Chickweed.

Figure 11. Clubbed Hairs from the stem of Scented Geranium.

Figure 12.
Jointed Hair from the edge of Jerusalem Artichoke.

THE FACE OF THE SKY FOR NOVEMBER.

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

THE SUN.—On the 1st the Sun rises at 6.54 and sets at 4.34; on the 30th he rises at 7.43 and sets at 3.54. Sun-spots and faculae may occasionally be seen on the disc, but of late spots have been small, although faculae have been fairly conspicuous. The equation of time is a maximum on the 4th, the Sun being $16^m 21^s$ in advance of the clock, thus making the afternoons short and the mornings long. The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre of Disc N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Nov. 2	24° 33′ E.	4° 13′	227° 37′
„ 7	23° 35′ E.	3° 41′	161° 41′
„ 12	22° 26′ E.	3° 7′	95° 46′
„ 17	21° 5′ E.	2° 32′	29° 52′
„ 22	19° 34′ E.	1° 56′	323° 58′
„ 27	17° 51′ E.	1° 19′	258° 3′
Dec. 2	15° 59′ E.	0° 40′	192° 10′
„ 7	13° 57′ E.	0° 2′	126° 16′

THE MOON:—

Date.	Phases.	H. M.
Nov. 6	Full Moon ...	3 48 p.m.
„ 13	Last Quarter	7 26 a.m.
„ 20	● New Moon	8 40 p.m.
„ 29	First Quarter	1 42 a.m.
Dec. 6	Full Moon	2 52 a.m.
Nov. 8	Perigee ...	6 12 p.m.
„ 24	Apogee	4 24 p.m.
Dec. 7	Perigee ...	1 0 a.m.

There is an eclipse of the Moon on the 6th, but as the moon only passes through the penumbra of the earth's shadow very little darkening will be observable; moreover, one will only be able to observe the end of the eclipse and that under bad conditions, as the moon will be low down. The particulars of the eclipse are given below:—

	Nov. 6
First contact with the Penumbra ...	1.39 p.m.
Middle of Eclipse	3.37 p.m.
Last contact with the Penumbra ...	5.34 p.m.
Moon rises (at Greenwich)	4.17 p.m.

OCCULTATIONS.—The following are the principal occultations visible from Greenwich:—

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. point. E.	Reappearance. Mean Time.	Reappearance. Angle from N. point. E.
Nov. 7	32 Tauri	5·8	p.m. 7.23	14°	p.m. 7.57	299
„ 10	47 Geminorum...	5·6	—	—	7.36	306
„ 11	λ Cancri ...	5·9	9.7	153	9.35	210°
„ 20	ψ^2 Aquarii ...	4·6	9.15	89	10.10	212°
Dec. 7	130 Tauri ...	4·6	a.m. 1.40	19	a.m. 2.11	337°

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
Oct. 29	14 25	S 14°
Nov. 8 ...	15 27	S 19 5
„ 18	16 30	S 23 [illegible]
„ 28 ...	17 33	S 25 44
Dec. 8	18 27	S 25 20′

Mercury is in the neighbourhood of the Sun at the beginning of the month, but towards the end of the month the planet becomes an evening star in Scorpio, setting at 4.42 p.m. on the 27th November.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
Oct. 29 ...	11 28	N 2° 3′
Nov. 8 ...	11 59	N 0° 20′
„ 18 ...	12 53	S 2° 15′
„ 28 ...	13 11	S 5 25′
Dec. 8	13 51	S 8° 52′

Venus is a morning star in Virgo, and is at greatest westerly elongation of 46° 45′ from the Sun on the 26th, when she rises E. by S. at 3.5 a.m.

The planet appears as a very conspicuous object in the morning sky looking east. The apparent diameter of the planet is about 30″, whilst 0·5 of the disc appears illuminated; thus the telescopic appearance is that of "half moon."

MARS:—

Date	Right Ascension.	Declination.
	h. m.	
Oct. 29 ...	4 34	N 21° 49′
Nov. 8 ...	4 23	N 21° 58′
„ 18 ...	4 9	N 21° 53′
„ 28 ...	3 53	N 21° 37′
Dec 8	3 39	N 21° 16′

Mars is a very conspicuous object in the S.E. portion of the evening sky, where he appears as a very bright red star a few degrees to the South-east of the Pleiades. The planet is visible throughout the night, as he rises about sunset and sets about sunrise. The planet is in opposition to the Sun on the 25th, when he appears due South at midnight. This opposition is a very favourable one as regards the altitude of the planet, though not so favourable as regards nearness to the earth, compared with oppositions in 1907 and 1909. The planet's altitude on this occasion reaches 60° when on the meridian, whilst the apparent diameter of the disc is 18″, corresponding to a distance of about 48½ million miles. Below is given a table showing the altitude and comparative distance of several oppositions:—

Opposition.	Declination.	Altitude.	Relative Distance from Earth.
1905	S 19° 57′	21½	0·537
1907	S 27 1′	11½	0·408
1909	S 4 11′	34	0·390
1911	N 21 42′	61	0·517

… latitude of the planet's centre is −10°, hence the Southern hemisphere is inclined towards the earth, and is in the best position for observation; but little of the snow cap is visible as it has dwindled to small dimensions in the advancing summer of the Martian Southern Hemisphere. The dark markings, according to Lowell, should, during the summer of the hemisphere under observation, be increased in intensity. In telescopes of 3 or 4 inches aperture the dusky markings on the disc are observable when the seeing is good. The time of rotation is $24^h\ 37^m\ 23^s$, approximating to that of the earth, so that the same regions may be scrutinized on successive evenings. The well-known marking of the Syrtis Major is visible on the 12th about 10 p.m., and the Solis Lacus on the 28th at 9 p.m. The two small satellites, Phobos and Deimos, are only visible in the largest telescopes.

The moon appears near the planet on the morning of the 8th.

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
Oct. 29 ...	15 14	S 17° 11′
Nov. 8 ...	15 23	S 17° 45′
„ 18 ...	15 32	S 18° 16′
„ 28 ...	15 41	S 18° 50′
Dec. 8 ...	15 50	S 19° 20′

Jupiter is in conjunction with the Sun on the 18th, after which he becomes a morning star; during November, however, he is practically unobservable, being lost in the Sun's rays.

SATURN:—

Date.	Right Ascension.	Declination.
	h. m.	
Nov. 1 ...	3 3	N 14° 35′
„ 16 ...	2 58	14° 15′
Dec. 1 ...	2 53	N 13° 58′

Saturn is a very conspicuous object in the evening sky, rising E.N.E. immediately after sunset. The planet is about 15° to the West of Mars, and the two bright planets form a striking pair.

Saturn is in opposition to the Sun on the 10th, and thus is due South at midnight about this date.

The telescopic view is splendid, as the rings and belts are readily seen even when seeing is comparatively poor. In addition to the ring, the belts on the disc and also some of the numerous satellites may be observed. A telescope of three inches aperture is sufficient to show the four larger satellites, namely, Titan, Japetus, Rhea, and Tethys. Titan is generally to be looked for at a considerable distance from Saturn, not only to the sides, but also apparently above and below the planet.

The division in the ring may be seen in a good telescope of two inches aperture; whilst the dark ring requires an aperture of four inches, with good atmospheric conditions.

The apparent diameters of the outer major and minor axes of the ring system are respectively 47″ and 17″, and we are looking on the Southern surface at an angle of 21°, so that the ring appears open. The diameter of the ball is 18″. The ring is visible with a power of about 50, and the belts with a power of 80. The moon appears near the planet on the evening of the 6th.

URANUS:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Nov. 1	19 51 4	S 21° 33′ 4″
Dec. 1	19 55 23	S 21° 20′ 55″

Uranus is unfavourably placed for observation on account of his low altitude. He is situated low down in the S.W. portion of the sky at Sunset, and sets at 8.30 p.m. on the 15th. The planet appears in Sagittarius, in a part of the sky devoid of good reference stars, though the star σ Sagittarii is about 5° to the N.E.

NEPTUNE:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Nov. 1	7 42 16	N 20° 47′ 6″
Dec. 1 ...	7 40 55	N 20° 50′ 8″

Neptune rises about 8.30 p.m. near the middle of the month and crosses the meridian about 4 a.m. Thus he will be in a better position for observation a few months later. The planet is located in Gemini, nearly midway between 68 Geminorum and ψ^2 Cancri.

METEORS.—The principal meteor showers during the month are the Leonids and Andromedids:—

Date.	Radiant. R.A.	Radiant. Dec.	Characteristics.
	h. m.		
Nov. 14-16 ...	10 0	+ 22	Swift, streaks. (*Great Leonid* shower).
„ 17-23...	1 40	+ 43	Very slow, trains. (*Great Andromedid* shower).

Algol will be at minimum on Nov. 1st at 11 p.m., 4th at 8 p.m., 7th at 5 p.m., 24th at 9 p.m. and 27th at 6 p.m. The period is $2^d\ 20^h\ 49^m$ from which other minima may be deduced.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—η Cassiopeiae $0^h\ 43^m$, N. 57° 17′, mags. 3½, 7½; separation 6″·1. Binary star.

λ Arietis $1^h\ 52^m$, N. 23° 6′, mags. 4, 8; separation 37″. Components white and blue; easy with power 20.

η Persei $2^h\ 44^m$, N. 55° 28′, mags. 4, 8; separation 28″. The brighter component is orange, the other blue. There are also several other fainter stars very near.

QUERIES AND ANSWERS.

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

QUESTIONS.

54. I have a copy of the *Nautical Almanac* for 1911, and monthly compare the results given in "The Face of the Sky" supplied by Mr. Shackleton, F.R.A.S., and have often wished that I could so correct the tables as to make them applicable to any place other than Greenwich.

Will you kindly enlighten me through your columns on the following:—

(*a*) What is the formulae to obtain the inclination of the Sun's axis from the W. point?

(*b*) What is the formulae to obtain the heliographic latitude of the centre of the Sun's disc?

(c) What is the formulae to obtain the heliographic longitude of the centre of the Sun's disc?

Also:—Is there any way that I could apply the difference in time between Greenwich and Sydney to the tables of the *Nautical Almanac*, pages 513 and so on, showing position of Jupiter's satellites, so that they would be shown as they would appear at Sydney?

In what publication (or publications) could I find the formulae known as "Leuschner's Short Method" of computing comet orbits?

"CENTAURUS."

ANSWERS.

44. COLOURS OF THE SPECTRUM.—The green part of the spectrum cannot be divided into yellow and blue; otherwise, as the querist suggests, the prism would fail to produce a green band. The only effect of using a prism to split up the green part would be to magnify that part, as it were, by showing more gradations of green.

The term "Primary Colour" does not mean "A colour incapable of analysis into others"; the "Primary Colours" are those sensations out of which all other colour-sensations are built, according to Helmholtz' theory. For instance, though yellow light may have a definite wave-length, when it strikes the retina three distinct sets of nerves respond, in such a proportion as to give the sensation of yellow. Other colours excite them simply in different proportions, and the colours which excite only one set of nerves at a time are called the Primaries. They are a certain red, green and blue. But, although *the sensation* of yellow is made up of a mixture of three sensations, it does not follow that yellow *light* can be split up into three differently coloured lights.

C. N. F.

44. COLOURS OF THE SPECTRUM. The green region of the spectrum cannot be resolved into yellow and blue. Every part of a continuous spectrum has its own particular wave-length, and any very narrow portion of it may be considered as approximately monochromatic. The colours of the spectrum, when produced under proper conditions, (such as with a narrow slit, and so on), are pure; and it is important to distinguish clearly between such colours and the *subjective* tints which can be produced to imitate them by the proper blending of rays of other colours. On page ten of the new edition of Professor R. Wood's treatise "Physical Optics," there is the following reference to subjective colour: "The colour depends upon the wave-length, but colour cannot always be taken as an indication of wave-length, as certain colours can be imitated by the simultaneous action upon the retina of two trains of waves, *either of which acting alone would give rise to a totally different colour from that perceived when both act together.*" The italics are mine. "For example, a yellow scarcely distinguishable from the yellow of the sodium flame, can be produced by a mixture of red and green light in proper proportions."

CHARLES W. RAFFETY.

45. HEAT AND A VACU[illegible]—Heat can traverse a vacuum in the form of radiant h[illegible] [illegible]hich has the property of being reflected by polished surf[illegible] [illegible] thus the heat emitted from the inner vessel in a vacuu[illegible] [illegible] is sent back by the inner surface (polished) of the c[illegible] [illegible]; of course, some may be again reflected, back an[illegible] [illegible], and it is to be remembered that at each reflection [illegible] [illegible] slight loss; but at any rate, all the heat emitted is no[illegible] [illegible]ly that which is reflected an even number of times and t[illegible] [illegible]. If the space contained air, however, the conducti[illegible] [illegible] of the air layer would carry heat to the case, give it up to the case, and so cause a continual loss.

C. N. F.

50. (3) RADIO-ACTIVITY.—It is generally considered that the glow ("luminescence") of the glow-worm is due to a process of oxidation. The light-giving organs consist of two layers. The inner one is of an opaque whiteness, and is possibly protective and reflecting; the outer is semi-transparent and of a slight yellow colour.

Between the two layers is a network of very fine tracheae, which, it is presumed, supply the necessary air to the substances the oxidation of which results in the production of light.

The light of many Lampyeidae, especially those out here, is *regularly* intermittent, *i.e.*, the light appears for, say, two flashes, and then ceases for the time of four flashes of equal duration; others are three to one: but the causal mechanism is, I believe, unknown.

L. G. GILPIN-BROWN.

50. RADIO-ACTIVITY.—(1) It is now accepted that the α particles emitted by radio-active elements are atoms of the gas helium. In the case of niton (radium emanation) this is capable of spectroscopic verification.

Such processes may be regarded as spontaneous transformations of substances which we have every reason to consider as elements.

(2) The X-rays and the γ rays from radio-active substances may be considered as closely similar types of radiation the actual nature of which is very uncertain. Many eminent physicists favour a pulse theory,—*i.e.*, one which supposes the radiation to be composed of very thin pulse-shells in which the wave-front is not uniform but nucleated; and that such pulses are due to the negative accelerations (X-rays), and the positive accelerations (γ rays) of swiftly moving electrons. Other investigators favour the view that both types are corpuscular, being composed of neutral pairs, and hence not deviated by magnetic or electrostatic fields. We may reasonably hope for more definite knowledge in the near future.

(3) The light of the "glow-worm" is believed to be due to the active oxidation of a peculiar photogenic substance produced by the insect. Experiments support this theory.

CHARLES W. RAFFETY.

REVIEWS.

CHEMISTRY.

Chemistry in the New Edition of the Encyclopaedia Britannica.

The requirements of an article upon a particular science in a general encyclopaedia are, firstly, that it shall be easily understood by an intelligent reader who is practically unacquainted with the subject; and secondly, that it shall contain a full bibliography to which the expert can refer for directions where to find what he wants. The chemist, for example, will not want to use the Encyclopaedia as a text book, while the average general reader will be repelled by pages of mathematical formulae which are appropriate enough in the text book. Any attempt to satisfy both classes of reader will inevitably fail to satisfy either.

Judged by this criterion, the new edition of the "Encyclopaedia Britannica," marks a great advance upon the previous edition. As instances of the way in which the chemical articles meet these requirements, we may cite those upon "Elements," "Colour" and "Fluorescence," which any educated person can follow. The general article upon "Chemistry," admirably written as it is, errs somewhat in the direction of the text book.

In most instances, the subject matter has been brought well up to date. For example, the latest details on metallography are given, and excellent photomicrographs accompany the article on "Alloys."

It is, perhaps, in the biographical articles that the Encyclopædia will fill the greatest gap in the library of the chemist. This portion of the work has been fully dealt with, and in a manner that leaves little to be desired.

C. A. M.

GEOLOGY.

The Coast Scenery of North Devon.—By E. A. NEWELL ARBER, M.A. 261 pages. 63 plates. 11 figures. 2 maps. 9-in. × 6-in.

(J. M. Dent & Sons. Price 10/6 net.)

Mr. Arber is a distinguished palaeobotanist, but in the intervals of his researches has found time to write this fine monograph on an exceedingly interesting and beautiful portion of our coast. In an introduction the general geology of the area is described. The country is built of highly plicated slates, sandstones and shales of Devonian and Carboniferous age. Two types of cliff, the "flat-topped," and the "hog's back" are distinguished. Whilst the former represents the effect of sea-erosion on a flat tableland, the latter is far more complex, and its origin is left in doubt. One of the special features of the coast-line is the fine series of coastal waterfalls, which are naturally most conspicuous when falling over the "flat-topped" type of cliff. An excellent section on "beach-scrambling" gives one the impression that it is a sport quite as exciting, if not as dangerous, as mountaineering.

Part 1 describes in detail the six districts into which the coast-line is divided. For each district full directions are given as to suitable headquarters, ways of reaching the cliffs, and the necessary maps. Part 2 deals with the special features of geological interest along the coast. The somewhat neglected subjects of the marine erosion of folded rocks, the evolution of coastal waterfalls, and sea-dissected valleys, are dealt with, and the author claims, and claims justly, original value for his work. This part forms a valuable contribution to the study of scenery. Mr. Arber shows that the intersection of the plane of marine erosion with a maturely dissected country must result in headlands and bays—the former corresponding to the watersheds, and the latter to the valleys—which have no relation to the differential hardness of the rocks involved. Whilst the latter may sometimes control the larger features of a coast, as in Pembrokeshire, more usually it merely determines minor irregularities.

A good bibliography and index is given, and the book is illustrated by a series of fine plates. The reader may be perplexed by the absence in some of the plates of any means of estimating the scale of the view shown. The author is to be congratulated on this book, which will be useful to both geologist and geographer. The best compliment we can pay it is to hope that it may be the precursor and model of many similar works.

G. W. T.

METEOROLOGY.

British Rainfall, 1910.—Edited by HUGH ROBERT MILL, *Director of the British Rainfall Organization.* 440 pages. 65 maps and illustrations. $8\frac{3}{4}$-in. × $5\frac{1}{2}$-in.

(E. Stanford. Price 10/-.)

The British Rainfall Organization is an organization of voluntary and unpaid observers of Rainfall, nearly five thousand in number, resident in all parts of the British Isles. The work was established by the late G. J. Symons, F.R.S., and it is being ably carried on by his successor, Dr. Mill.

The volume for 1910 is the fiftieth of the series, and it is interesting to note that four of the observers who contributed to the first volume in 1861, also contribute to the volume for 1910. The volume for 1861 contained records from four hundred and seventy-one stations, that for 1910 contains records from four thousand eight hundred and seventy-four stations.

Although primarily a volume of statistics the book will prove of great interest to very many who care but little for figures. The excellent maps which illustrate the distribution of rainfall over the United Kingdom, both in time and in space; the observers' notes upon exceptional weather experienced by them, and the discussion of heavy falls of rain, hail and snow, should prove interesting to all. Dr. Mill contributes an article upon "The Rain Gauge in Theory and Practice," which is probably the final word upon the subject.

In addition to yearly results for nearly five thousand stations there are monthly tables for three hundred carefully selected representative stations, and daily values for ten stations.

The Rainfall for 1910 varied between 19·44 inches at Ropner Park, Durham, and 187·06 inches at Llyn Llydaw Copper Mill, Carnarvonshire.

J. A. C.

NATURE STUDY.

Garden and Playground Nature Study.—By J. EATON FEASEY. 184 pages. 65 illustrations. 5-in. × $7\frac{1}{2}$-in.

(Sir Isaac Pitman and Sons. Price 2/6 net.)

Mr. Feasey has already produced two volumes dealing with school work that should be done in the open air, but in his introduction he expresses the conviction that the work and methods advocated in the present volume will be more valuable even than the set lessons which were contained in the others, and will surpass them from the point of view of real education. He quite rightly emphasises the fact that Nature Study should not deal merely with animals and plants. His first lesson, entitled, "A Trap to Catch a Sunbeam," is a comparison between two thermometers, one of which is kept under a bell jar. The lessons on dew, shadows, and the laws of reflection, as well as those on the weathercock and on snow, follow out the same idea; but "bloom," "the sleeping and waking of plants," and on "being irritable" deal with the botanical side of Nature. Many of the illustrations are good and it is obvious that they have been made on purpose for the book. Mr. Feasey goes into considerable detail as to how the lessons are carried out, and we may say at once that every teacher of Nature Study will gain something by reading this book.

W. M. W.

PHYSICS.

The Radiation Theory of Light and Color.—By Mrs. A. ROGERS-MOORE. 78 pages. 21 illustrations. $9\frac{1}{2}$-in. × 6-in.

(U.S.A. The Stratton Press, Inc.)

A refutation of the Composite Light Theory of Newton. "To refute the Composite Theory, declared itself as the last necessity, not as incentive of color expression in nature. . . . The radiation theory has been evolved from the single desire to know the cause of the pink petal of a rose. . . . The work ended with a refutation of the Composite Theory as we have stated. . . . Let no condition of sunlight be lost therefore; if possible, let the observations be continued for years; as these have been to establish the Radiation Theory of Light and Color Formation."

Such is an extract from the Preface. It appeared promising! Later on: "Light and Color are the result of molecular motion of the air. . . . Light is the greatest air velocity which the eye recognizes. . . The spectrum is not any more spectral than any other colors and is just as natural." Finally: "It does not seem too much to assume that light rotates and pushes all ether and all the constituent parts of the air. In other words: the sun creates the world and everything on it. But not without a guiding hand."

I think after these quotations from the pamphlet a review is not of further necessity.

A. C. E.

ORNITHOLOGY.

The Young Ornithologist: A guide to the haunts, homes and habits of British Birds.—By W. PERCIVAL WESTELL, F.L.S., M.B.O.U., Author of "The Young Naturalist," "The

Young Botanist." 311 pages. With a frontispiece in colour, and sixty-five photographic illustrations. $7\frac{1}{4}$-in. × 5-in.

(Methuen and Co. Price 5/-.)

The title expresses the intention of this book, and the author writes with abundant vivacity and vigour. Young readers will find him to be a sympathetic and friendly adviser. For their edification he has "mapped out" the birds described according to their natural haunts, and this is put forward as the chief feature of the book. There are chapters on the birds of the garden, the country lane, the woodland, the waterside and so on. Such a division is fairly useful, and can be understood, but it is so far from being definite that it may be doubted if it is of any great value. No animals are less circumscribed in their bounds than birds and any arbitrary division is sure to require much explanation and qualification. Many species vary their habitats: this is illustrated, for instance, by Mr. Westell placing the Common Curlew and the Whimbrel both in the chapter on the birds of the moor and in that on the sea-shore. Correctly so: and this double-placing might have been extended to other birds also. The arrangement chosen makes queer neighbours, e.g., the Woodlark is immediately followed by the Partridge and the Quail by the Stone Curlew.

Plenty of information and vivid descriptions are given of the different species, and the style of writing is certainly likely to prove more attractive to young readers than to others. Occasionally the author allows himself to lapse into errors such as occur when he speaks of the Brambling (page 168) as nesting in the British Isles, and the Snow Bunting (page 224), as [illegible] England: and the statement that the Gannet bre[illegible] [illegible] groups of islands on our western shores" (page [illegible]) [illegible] that requires serious qualification. [illegible] the Fulmar Petrel (page 280) is not now [illegible] the Shetlands, having recently consid[illegible] breeding range, and the Little Bittern (pa[illegible]) [illegible] Common Bittern, nested in England at one [illegible] in the coloured frontispiece by Mr. G. E. L[illegible] Bittern at Home" is referred to in the text [illegible] Little Bittern: but it seems clearly to repr[illegible] Bittern. The remark that one hundred and [illegible] Heronries are still in existence (page 242) is not said t[illegible] only, but in Ireland more than three hundr[illegible] known, and in Scotland about two hundred [illegible] present. The photographs throughout the [illegible] excellent, more particularly when their necessarily [illegible] is considered.

The first part of the work (and it perhaps ought to have been mentioned first here) is by Mr. A. R. Horwood, of Leicester Museum, running to seventy-eight pages, entitled, "Hints for the Young Ornithologist," on observing birds, collecting, field work, and so on. This is an admirable and thorough production, and the bird-boy who can assimilate these hints and act upon them, will approach perfection. He will demonstrate that, while the interests of the British boy (even in bird-nesting) are of more importance than those of the British bird, yet the bird, too, has its rights, which should be fully respected.

H. B. W.

FLIGHT AND FLYING IN THE "ENCYCLOPAEDIA BRITANNICA."

The article under this heading is distinctly disappointing, and although the casual reader may find some pleasure in studying the investigations of Pettigrew, De Lucy, and others into the action of birds' wings, and so on, the modern student would rightly expect something more up-to-date in the latest edition of a work which claims to be abreast of the times.

Certainly there is some slight mention of the machines of the Wright Brothers and Santos Dumont, together with photographs of the Farman, Bleriot, and Roe machines, but there is no description of these later, nor is there one word about the modern theory of Flying Machines, which, even after making allowances for the exigencies of publication of a large work, must have been very well advanced at the time the article was written.

In short, there is nothing in the article of the least possible use.

F. W. K. C.

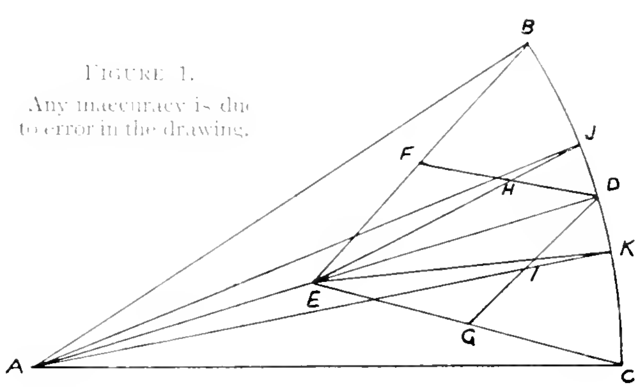
A METHOD (BELIEVED TO BE ORIGINAL) OF DIVIDING ANGLES OF 45° OR LESS INTO THREE EQUAL PARTS.

By C. S. BINGLEY, F.C.I.S.

Let B A C be the angle to be divided:
From the point A, mark or describe the arc B C
Bisect arc B C (D)
From D draw the line D A
Bisect line D A (E)
Draw lines E B: E C
Bisect lines E B: E C (F G)
Draw lines D F: D G
Bisect lines D F: D G (H I)

Draw lines E H: E I. Continuing to J and K: the distances B J: J K: K C, will all be equal and, therefore, the arc B C divided into three equal parts, so that lines drawn from the points J and K to A (J A: K A) will divide the angle B A C into three equal angles, B A J: J A K: K A C.

Figure 1.
Any inaccuracy is due to error in the drawing.



NOTES.

ASTRONOMY.

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

FIGURE OF THE SUN.—*Bulletin Astronomique* for September contains an interesting article on this subject by Father Chevalier, S.J., of the Zo Se Observatory.

The investigation has been carried on by photography: only plates on which the limb is sharp have been used. A great many possible sources of error, such as imperfection in the refraction correction, deformation due to the objective, tilt of plate, diffraction, and so on, produced by the exposing slit, have been examined, and it is claimed that the precautions taken have practically eliminated their effects from the measures. The surprising result emerges that for the five years 1905 to 1909 the polar diameter of the Sun is longer than the equatorial one, the figures being as follows:—

Year.	Excess of Polar Diameter.	Probable Error.	Number of Plates.
1905	0″·07	0″·05	160
1906	0″·17	0″·04	278
1907	0″·31	0″·03	421
1908	0″·29	0″·04	320
1909	0″·13	0″·02	536

General Mean 0″·20, with Probable Error 0″·015.

It will be noted that in every year the Polar Diameter exceeds the Equatorial by an amount greater than the probable error. It is also noteworthy that there is a sort of sequence in the figures. The excess moves steadily up to a maximum in 1907, which is the year of sunspot maximum, and then steadily falls off. The results for 1910 confirm the falling off; ninety-six photographs taken in April and August give + 0″·05; one hundred and two in September and October give −0″·05. There is certainly room for the suggestion that the sun's figure may change periodically in the sunspot period, which would be a result of great interest and significance. Dr. Chas. Lane Poor had already, in 1905, announced his suspicion of such a variation, from measures of photographs taken by Rutherford and Wilson. Father Chevalier is doubtful, however, whether the same precautions were taken in that series of photographs as in the present one, and is inclined to give it less weight. The fact of the Polar diameter exceeding the Equatorial one had been deduced by Dr. Auwers and MM. Schur and Ambronn. In fact, it appears that any long series of observations, however taken and however discussed, will yield this unexpected result.

MR. BARTRUM'S THIRD QUERY.—(August number, page 311).—The fallacy lies in considering the average value of r for equal time intervals. What we want to consider is the average value of disturbing force for equal time intervals. The Sun's whole action on the Moon varies inversely as the square of his distance, but his differential or perturbing action varies inversely as the cube of the distance. It can be shown that both the whole action and the differential action are greater for a more eccentric orbit of the Earth round the Sun. A simple geometrical proof for the whole action is given in Proctor's "Saturn and his System," First Edition, page 167. Consider two elliptical orbits with the same semi-major axis a, but with different semi-minor axes b, b[1], b being the greater. The periods (which depend on a) are equal. Let each planet be at the end of its minor axis, then each is distant a from the Sun. The areas of the orbits are as b to b[1], and this is also the ratio of the rate of description of areas, since the periods are equal. Now consider a very small interval of time from the moment when each planet is at the end of its minor axis. The small area swept out by each $= \frac{1}{2} a^2 \times$ angle swept out at Sun. Hence the angles swept out at Sun are as b to b[1]. Now considering either planet at any point of its orbit, the gravitational attraction is $\frac{\mu}{r^2}$, and the sum of the action in time $t = \int \frac{\mu}{r^2} dt$. Also from the equal description of areas $dt = k\,dA$, where dA denotes an element of area and k is a constant. And $dA = \frac{1}{2} r^2 d\theta$ where $d\theta$ is the small angle swept out at the Sun in the interval dt. Hence the whole gravitational action in time

$$t = \int \frac{\mu}{r^2} k \tfrac{1}{2} r^2 d\theta = \frac{\mu k}{2} \int d\theta = \frac{\mu k \theta}{2}.$$

Thus the action varies as the angle swept out. Now, returning to our two planets, the gravitational actions in the small interval of time considered are equal, since the distances from the Sun are equal. Thus action in whole revolution

$$= \text{action in small interval} \times \frac{2\pi}{\text{small angle swept out.}}$$

But we have seen that the small angles swept out in the interval are as b to b[1]; hence the gravitational actions in the whole revolution are as b[1] to b, or the action is greatest in the planet with smallest b or greatest eccentricity. Hence, as the earth's orbit becomes less eccentric, the total action of the Sun on the Moon diminishes. The differential action diminishes also. For this

$$= \int \frac{k'}{r^3} dt = \int \frac{k'}{r} \cdot \frac{dt}{r^2} = \int \frac{k''}{r} d\theta$$

(k′, k″ denote constants). Now in an ellipse $r = \frac{a\,(1-e^2)}{1+e\cos\theta}$

$$\text{hence} \int \frac{k''}{r} d\theta = \int \frac{k''(1+e\cos\theta)}{a\,(1-e^2)} d\theta = \frac{k''\theta}{a\,(1-e^2)} + \frac{k''e}{a\,(1-e^2)} \int \cos\theta\, d\theta.$$

Now, on integrating through four right angles the second term vanishes and the total differential action of the Sun in a year $= \frac{2k''\pi}{a\,(1-e^2)}$. As e diminishes this action also diminishes, and the Moon approaches the earth and moves faster.

COMET NOTES.—Brooks' Comet will be a morning star in November, but not very easy to see, owing to its approach to the sun.

The following is an ephemeris for 11 p.m.:—

	R.A. h. m. s.	S.Dec.		R.A. h. m. s.	S.Dec.
Nov. 4	12 37 43	4 57′	Nov. 16	13 0 17	18 3′
„ 8	12 43 56	9 40′	„ 20	13 9 45	21° 28′
„ 12	12 51 38	14 10′			

Two other comets were discovered at the end of September that of Quenisset was of magnitude 7, thus being an easy telescopic object; that of Beljawsky would have been a very fine object on a dark sky, but it could only be seen low down in the twilight. Neither comet will be well placed for observation in November, so we simply give elements without ephemerides.

	Quenisset.	Beljawsky.
T	1911, Nov. 12·67 (Berlin)	1911, Oct. 10·30 (Berlin)
ω	123 24′	71° 39′
Ω	35 37′	88 44′
i	108 23′	96° 38′
Log q.	9·8897	9·4823

The orbit of Quenisset is very like that of Comet 1790 III., discovered by Caroline Herschel.

THE NEW FRENCH TABLES OF THE MOON.—The appearance of new lunar tables is an important epoch in exact astronomy. It is about half a century since the appearance of Hansen's tables, which were an immense improvement on all that preceded them; they were considered, in the words of Sir John Herschel, "As a practical completion of the lunar theory, at least for the present age, and as establishing the entire dominion of the Newtonian theory and its analytical application over that refractory satellite." These high expectations were doomed to some disappointment; in a few years the errors of the new tables became serious; an examination of the cause was made by Professor Newcomb; he found that the main part of the error was due to Hansen's Venus terms; the one of two hundred and thirty-nine years period should be omitted altogether, and that of two hundred and seventy-three years seemed to need an alteration of phase. Newcomb further reduced the secular acceleration from 12"·18 to 8"·42. Hansen supposed he was using the theoretical value, and also that indicated by ancient eclipses, but Adams showed that the value really given by theory was only 6", and a more careful study of the eclipses showed that they were better represented by 8" or 9". Newcomb further showed that in consequence of his changes the motion of the moon in a century must be reduced by 29"·17. His correction to the two hundred and seventy-three year term was an empirical one (this expression denotes a term derived from observation alone, without any known basis in theory). It had a coefficient of 15½" and a period of two hundred and seventy-three years like the Venus term. All who have studied the moon's motion have found the need for such a term, though they differ about its exact size and period. Newcomb's corrections, which were introduced in the *Nautical Almanac* in 1883, were a great improvement on Hansen; the objection that some people made that they introduced empiricism into astronomy was not a fair one; Hansen's tables were themselves empirical as regards the erroneous Venus term, which has no basis in theory; three of Newcomb's four corrections brought Hansen nearer theory than before, only the fourth was empirical. In recent years the moon's place has begun to deviate considerably from Hansen corrected by Newcomb, so the need of new tables has been felt. The great French astronomer Delaunay was engaged on his lunar researches at the same time as Hansen, but in a different manner. His idea was to find algebraical expressions for all the terms as functions of the elements of the solar and lunar orbits. The advantage is that the effect of a change in the adopted value of any element can at once be deduced, also that the investigation serves for other satellites, provided their eccentricities and inclinations are not too great (they break down for the new satellites of Jupiter and Saturn). The drawback is that the expressions do not converge rapidly, and that even after computing a very large number of terms, he had reason to fear that those of higher orders were still sensible. Delaunay was unhappily drowned at Cherbourg in 1872, when the theoretical work was nearly completed, but the preparation of tables scarcely begun. These long remained in abeyance, till the Bureau des Longitudes took up the matter, and it has now been concluded with the help of the late Professor Tisserand, MM. Schulhof, Andoyer and others. It is not a blind following of Delaunay, whether right or wrong, but advantage has been taken of the work of Radau, Brown, Cowell, and others, to correct and supplement those terms that seemed to be defective, if necessary carrying Delaunay's developments to a further approximation; this has been done chiefly by M. Andoyer. The new tables diminish Hansen's mean motion by 27" per century, and his acceleration by 4"·48, making it 7"·7. Instead of Newcomb's empirical term of two hundred and seventy-three years, they introduce the following two empirical terms:

$+11''\cdot5 \cos\ 1°\cdot37\ (t-1790\cdot5)$. Period 263 years.
$+\ 3''\cdot3 \cos\ 5°\cdot6\ \ (t-1856\cdot5)$. Period 64·3 years.

They make an interesting suggestion as to the possible origin of these terms: "Consider a swarm of tiny planets circulating rou[nd] the sun at a distance about 0·178, period 27·3 d[ays], almost the same as that of the moon. If the tot[al mass] of the swarm was one-fifteenth of that of Merc[ury, tha]t is one-third of that of the moon, there wo[uld be] a term in the moon's longitude with coeffici[ent] 12" [and per]iod two hundred and seventy years." Other posit[ions] [illegible] are also given which might produce such a result. It i[s a stri]king instance of the possible importance of small masses [when their] periods are almost commensurable with other periods. [It wi]ll probably be of general interest to note the arithmetical va[lues of] the more important terms in the new tables and the corresponding values found by Cowell from an analysis of the Greenwich observations; the latter is denoted by C. For the Evection they use 4586"·32, C. 4586"·4; variation 2369"·95, C. 2370"·2; Principal Elliptic Term 22639"·75, C. 22639"·5; Annual Equation −668"·92, C. −668"·2; Parallactic inequality −125"·10, C. −124"·9. For a geometrical explanation of these terms the reader is referred to Proctor's "Moon," or to "KNOWLEDGE" for March, 1903. For the mean parallax they use 3422"·70, agreeing well with Newcomb's gravitational value 3422"·68; Hansen's value was 3422"·24; for the mean semi-diameter they use 933"·60, which is half a second less than Hansen, and exactly agrees with Cowell's value deduced from fifty years of Greenwich observations; Hansen's value is evidently too great; even the new one is one second greater than the value obtained from occultations, the difference being due to irradiation, which causes all bright bodies to be measured a little too large. On the whole the new tables are a great improvement on Hansen's, and the only doubt about their utility is due to the fact that Brown's tables are nearly ready, and will probably be still more exact than these. However, there are some advantages in having two reliable tables; sometimes small errors are picked up by comparing them; thus a small error in Newcomb's Mars tables was found by comparison with Leverrier's tables, which are still used by the Connaissance des Temps; I presume that it will use the new lunar tables, starting with the year 1914.

ERRATA IN LAST MONTH'S NOTES. Two points in last month's notes need correction. The diagram showing the change of period of Encke's comet was printed upside down. It is now repeated correctly. Secondly, in the list of dates of observations of the satellites of Mars, one accidentally dropped out. The list is therefore repeated; the dates for

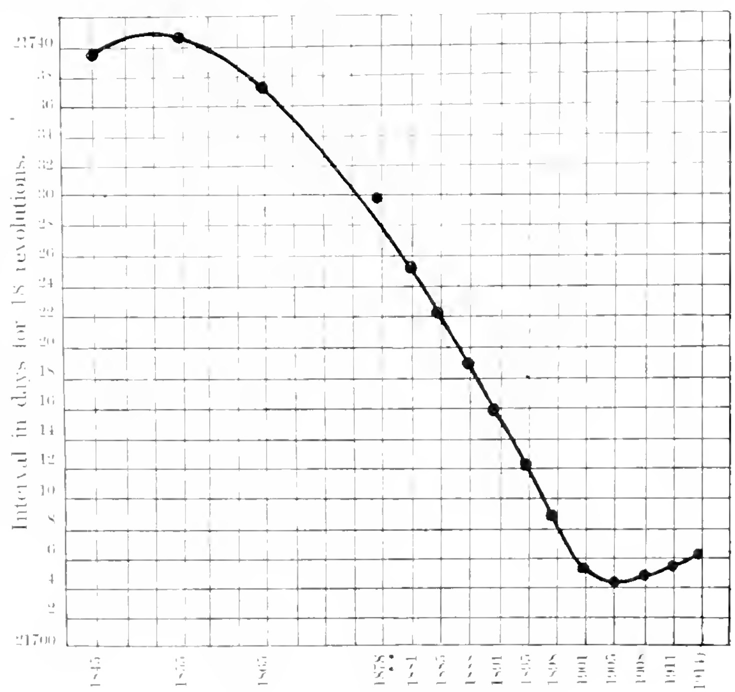


FIGURE 1. Encke's Comet.

Deimos are 1877·7, 1879·9, 1880·2, 1892·6, 1894·8, 1896·9, 1907·5. For Phobos 1877·7, 1879·9, 1892·6, 1894·7, 1894·8, 1896·9, 1907·5.

BOTANY.

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

PAPERS ON ECOLOGY.—Two of the Continental botanists contributed papers, both on Ecology. Prof. Schröter described in an interesting fashion "The Swiss National Park and its Flora," giving an account of the admirable and extensive operations of local Committees, assisted by the Federal Government, in the useful work of conserving the natural features of various parts of Switzerland and protecting the native flora from extinction. Prof. Massart described, under the title "Phytogeography as an Experimental Science," various methods and results of experiments in which plants were grown under conditions strikingly different from their natural habitats.

Professor Cowles described his observations on advancing sand-dunes in Michigan, which he has studied for about fifteen years. The dunes are of gigantic size, the advancing front having an altitude of twenty-five to sixty-five metres above the country in the path of advance. So high are the dunes and so great their rapidity of movement, that very few of the overtaken plants are able to survive. Curiously, the plants able to endure partial burial by these dunes are not xerophytes, like the pines and oaks, but swamp plants and mesophytes, such as species of *Salix* (Willow), *Populus* (Poplar), and *Cornus*; the shrubby plants are stimulated by the advance of the sand to extraordinary elongation of their stems. Survival depends upon the capacity of a plant to put forth new roots and to elongate as rapidly as the dune advances. In some places there are Elms thirty metres in height, above the original country level, with the tree tops projecting only one or two metres above the sand, yet their foliage is healthy and they flower and fruit vigorously.

Miss Sarah Baker, dealing with "The Brown Seaweeds of a Salt Marsh," stated that the capability of giving rise to marsh forms seems to be shared by all the brown seaweeds inhabiting the upper parts of rocky shores. *Pelvetia canaliculata*, *Fucus spiralis*, *Ascophyllum nodosum*, and *Fucus vesiculosus*, all show marsh varieties or species. The reason that *Fucus serratus* and *F. ceranoides* have no representatives in the marsh habitat is probably their intolerance of desiccation. The physical and chemical environment factors on the marsh being much more complex and varied than on a rocky shore, one would expect a corresponding variation in the structure of its plants. The most marked characteristics of the common marsh species are a great tendency to spiral twisting or curling of the thallus—and vegetative reproduction. That this latter feature is not directly caused by the marsh habitat is shown by exceptional species where reproduction is normal. The zoning between the brown seaweeds of a marsh is often very striking; but the factors governing it must be far more complicated than those operating on the seashore. The extensive mattings of brown seaweeds often found on English marshes have a decidedly beneficial effect on the Phanerogams. It seems possible that *F. volubilis* may act as a pioneer in the establishment of salt marshes in certain cases.

Mr. W. B. Crump contributed two interesting and detailed papers on "The Water Content of Acidic Peats" and "The Wilting of Moorland Plants." These two papers, somewhat too lengthy to be reproduced here, and too condensed to be readily summarised, represent an earnest attempt to fill a decided gap in ecological literature and to supply exact data, based on quantitative experimental work, regarding the water-content, humus content, and mineral content of the soil on moorlands, and the percentages of available soil-water for different plants. Much work of a similar kind has been done with arable soils, but it is important to have as much knowledge as possible concerning the physical and chemical characters of economically barren soils, in order to be able to deal better with the problems of plant distribution.

Miss Lilian Baker and Mr. B. W. Baker, contributed a paper entitled "Types of Vegetation in the District around Macclesfield." The area under study comprises parts of Cheshire and Staffordshire, the four corners being roughly represented by the towns of Northwich, Crewe, Leek, and Macclesfield. It includes part of (1) the Cheshire Plain, largely cultivated, with numerous parks and wooded estates, and a few sandy heaths and "mosses"; and (2) the Pennine Foothills consisting of approximately parallel ridges intersected by the Dane valley and other wooded ravines and covered by moors. The rainfall increases from the level western parts towards the hilly east. The two regions show marked geological differences; the plain consists of triassic rocks buried in Pleistocene times under a thick covering of glacial deposits, while the hill region consists of carboniferous rocks. Peat-mosses occur on the plain in the position of former glacial lakes, but have been largely reclaimed. The chief Associations described are (1) Moorland and Heath; (2) Grassland, represented by heath pastures; (3) Woodland; (4) Aquatic, and (5) Pasturage.

Prof. Oliver gave an account of "The Life History of a Pebble Beach," and Prof. Yapp discussed "The Causes of the Formation of Hairs and Palisade Cells in certain Plants," but no printed resumé is available in either case; probably the results will be published in botanical periodicals sooner or later, when they will be noted here. The same remark applies to a paper read by Dr. F. J. Lewis on "The Forest Stages represented in the Peat underlying the Moorlands of Great Britain."

Some interesting points were raised by Mr. C. Reid, in his paper on "The Relation of the Present Plant Population of the British Isles to the Glacial Period." A century ago it was generally supposed that species had originated mainly in the districts in which they were then found; but this presented the obvious difficulty that the same species was not likely to have originated at several different points, hence the anomalies of discontinuous distribution were left unexplained, and with the growth of the idea of evolution it was realised that faunas and floras had a past history, even if the included species had remained unchanged, and botanists realised that there were many further points requiring explanation. For instance, it was early noticed that each of our mountain tops possessed a small outlying fragment of the arctic flora; how, then, came it that the same species occupied so many different mountains? About sixty years ago, Edward Forbes seized the clue afforded by the discovery of the Glacial Period, and explained the arctic plants stranded on our mountain tops as relics of this Period—they were left behind when the climate became too warm for them to survive longer on the plains, and the subsequent discovery of fossil remains of these plants scattered over the plains, often associated with relics of arctic animals now extinct in Britain, seemed a brilliant proof of Forbes' view, which has been generally adopted.

But Forbes' hypothesis, granting that it explains our alpine flora, makes more difficult, rather than easier, the explanation of our southern flora, which occurs in a similar way, stranded in some of the warmest low-lying parts of Britain. This difficulty appears to have been generally overlooked. We must start with the assumption that we have merely to account for the incoming of our existing flora, after an earlier (Preglacial) assemblage had been swept away as completely and effectually as the celebrated volcanic eruption wiped out the plants of Krakatoa. None of our flowering plants, excepting a few arctic and alpine species could possibly have survived and lived through the cold of the Glacial Period. We know that the same temperate species that live in Britain now were here in pre-Glacial times, hence they must have found a refuge somewhere, but this refuge cannot have been in Britain. During the greatest intensity of the cold all Scotland, Ireland, and the greater part of England were buried under ice and snow, except possibly for some high peaks on which a few arctic species survived; ice filled the North Sea and covered the lowlands of England down to the mouth of the Thames, its southern limit extending to South Wales, where tongues of ice reached the Bristol Channel, in big glaciers like those of the Antarctic or Greenland. The glaciation in Ireland was even more extreme, for no part escaped—even the warmest parts of the south-west are striated and covered by moraine material, the ice forming bergs so large that they floated to the Scilly Isles before melting. Obviously, no temperate plant could survive such conditions, and even if we consider the non-glaciated area south of the Severn and Thames, we find evidence of such cold as precludes the possibility of warm nooks in which the temperate flora may have survived.

If the southern plants were completely swept away by the cold, how did they come back again, especially to islands like Ireland and the Scilly Isles, and how did they obtain their present singular distribution? Before we adopt the view that for plants to spread to islands one must have land connection—Britain has often been connected with the Continent—one must remember the rapidity with which the exterminated flora of Krakatoa came back. Moreover, some peculiarities in our flora cannot be explained by land connection; for instance, the Pyrenean element in our flora is practically confined to Cornwall and the West of Ireland, but geologists nowadays will not agree to the reconstruction of a lost Atlantis to account for this peculiar distribution, since no likely elevation of the land would suffice to connect the areas mentioned.

Chance introductions of seeds during thousands of years explain the existing peculiarities of geographical distribution in a way that no changes of sea or land or climate will do. Our alpine flora consists largely of survivors from a colder period; but the rest of our flora is constantly being added to by chance introductions from the nearest continental shore—hence the Atlantic element and the Eastern element, though not consisting to any great extent of maritime plants, are confined mainly in Britain to areas within a few miles of the coast. Seeds are evidently brought from the Continent and scattered broadcast over certain coastal districts, and they grow and spread where soil and climate are suitable; but the post-Glacial period has been so short that the process is still incomplete, and the slow spreading inland has only as yet extended a few miles.

Mr. Reid concluded by stating his view that there is no such thing as a native plant in Britain. Our flora has been swept away like that of Krakatoa, but we have arrived at a much later stage in the re-peopling of our islands. "It seems to me far more interesting to watch this process of introduction, change and spreading, than to enter into speculations as to what species shall be listed as 'natives,' 'denizens,' or 'colonists.' No such differences exist; it is all a question of degree. Britain for several thousand years has been receiving colonists from all sources, and the process still goes on. The oldest element in our flora—the alpine—occurs on nearly all our mountains; for it once occupied the intervening areas, and it does not greatly depend on conditions of soil. The limestone, aquatic, and Lusitanian flora, on the other hand, are more recent introductions; they can never have occupied continuous areas, and their present distribution is full of singular anomalies. These three elements of our flora are steadily growing in importance, while the alpine element is stationary or tends to die out."

PAPERS ON PALAEOBOTANY.—Palaeobotany was well to the fore, figuring largely not only in the Presidential Address to the Section but also in the papers read.

In a paper entitled "A Palaeozoic Fern and its Relationships" (not actually read, owing to lack of time), Dr. D. H. Scott described a specimen of one of the simpler Palaeozoic Ferns (Primofilices of Arber, Coenopterideae of Seward), probably a new species of *Zygopteris* (*Z. Sutcliffii*). The stem of this new specimen has a five-rayed star-shaped stele, leaf-trace bundles with axillary shoots, scale-leaves (aphlebiae), and adventitious roots; the characteristic internal xylem, consisting of narrow tracheids embedded in parenchyma, is especially well shown both in the main stem and in the axillary stele. The leaf-trace is crescentic in section; the evidence of the new specimen favours the view that the large strand given off from the stele is really a leaf-trace and not itself a branch—the branch which the leaf-trace gives off higher up may therefore retain the name "axillary shoot" originally given it by Stenzel. The course of the aphlebia-strands, given off by the leaf-trace both before and after their separation from the stele, could be clearly followed.

Dr. Benson described "The Structure of a New Type of Synangium from the Calciferous Sandstone Beds of Pettycur, Fife, and its Bearing on the Origin of the Seed." This synangium, or chambered spore-case, is attributed to the Pteridosperm *Heterangium grievii*, and probably represents the pollen synangium of that plant. It differs from all hitherto described synangia in the variety and large proportion of its sterile tissue, which shows the sclerotic plates characteristic of the inner cortex of *Heterangium grievii*.

Numerous vascular bundles with hydathodal (water-gland-like) ends occur, and irregular longitudinal dehiscence was brought about by the swelling of hygroscopic fibres. Another wholly new feature is the occurrence of both central and peripheral loculi (four central and twelve peripheral). The loculi agree in size and form with those of the incrustation fossil, *Diplotheca stellata* (Kidston), which is identified as the same synangium in a dehisced phase. The discovery of the structure of this early synangium adds fresh confirmation to the synangial theory of the seed, which may be restated as follows: The Palaeozoic ovule of the Lagenostoma type may be regarded as the product of the elaboration of a synangium comparable to the above—the megaspore or embryo sac being derived from the central group of loculi, and the canopy and peripheral part of the ovule from the peripheral part of the synangium with its envelope, twelve loculi, cortical tissue, and vascular bundles.

Professor Seward read a preliminary account of his observations on a petrified Jurassic plant from Scotland, resembling *Bennettites* in some respects, but showing peculiar characters of its own, such as the presence of large quantities of filamentous hairs forming a packing between the bracts of the cone.

Mr. H. H. Thomas described some "Recent Researches of the Jurassic Plants of Yorkshire," from which it appears probable that some extremely interesting results may be expected. The paper gives a summary of some results already obtained by Nathorst, Halle and the writer. For instance, from material collected on the Yorkshire coast, Nathorst has recently discovered the male sporophylls of *Williamsonia*, which are joined into a cup-like structure somewhat comparable to a flower, and are covered with large sessile synangia from which the remains of the microspores (pollen-grains) can be extracted by treatment with acid; the female cone of *Williamsonia* closely resembles that in *Bennettites*, but the flowers were unisexual. Thomas recently found a new Bennettitalian flower which appears to be bisexual, like the American specimens of *Bennettites* (*Cycadeoidea*); the central axis bore the usual ovules and intraseminal scales, and below this there was a whorl of five or six large free sporophylls arranged like the petals of a hypogynous flower, each bearing five or six large kidney-shaped sporangia. Reference was also made to the discovery of small fruit-like bodies named by Mr. Thomas as *Caytonia*; they appear to contain the remains of about ten seeds, and similar isolated seeds have been found, some of the structure being preserved—e.g., integuments, micropylar tubes, and nucellus. Among various interesting Ferns there are forms allied to such modern genera as *Todea*, *Cyathea*, and *Marsilia*.

In a short paper, Miss Lockhart made a "Contribution to the Theory of the Formation of Calcareous Nodules containing Plant Remains." Three boulders from the Calciferous Sandstone of Pettycur were entirely cut into thin serial sections in the search for a minute object, and it was thus possible to trace the position, in a block, of any particular plant. *Metaclepsydropsis duplex* and *Botryopteris antiqua* were chosen, as they presented a contrast between a large and a small plant. The clear delimitation of even the smallest fragments points to mechanical fracture subsequent to immersion, and the parallel position of plant remains in the boulder further indicates the agency of water currents. The results confirm

Dr. Gordon's views of thermal pools as the actual site of petrifaction.

PAPERS ON FUNGI AND BACTERIA.—Mr. A. S. Horne described the nuclear divisions which occur in a Fungus parasitic on the Potato, *Spongospora solani*, a member of the lowly group Plasmodiophoraceae. Several other genera of this group were also dealt with by Mr. T. G. B. Osborn in a paper entitled, "The Life Cycle and Affinities of the Plasmodiophoraceae." Without entering into the technical details of nuclear division described in these papers, it may be stated that the observations made tend to strengthen the suggested relationship of this group to the Slime-Fungi (Myxomycetes) and possibly also with the Chytridiaceae. In *Spongospora solani*, Horne describes a very curious form of nuclear division, in which four loop-like chromosomes appears and later join end to end to form an equatorial ring around the nucleolus; this ring divides into two daughter rings, each of which finally breaks up again into four chromosomes, while the nucleolus constricts to form two daughter nucleoli.

Professor Bottomley described the structure and function of the root-nodules of the bog myrtle (*Myrica gale*) which are formed as modifications of normal lateral roots, these branching and forming clusters covered with rootlets growing out through the end of each nodule or branch—the branching is due to the outgrowth of lateral roots, and not to forking of the apex of the primary nodule, as in the nodules of *Cycas*, Alder and *Elaeagnus*. The cortex of a young nodule contains (*a*) numerous cells with bacteria, and (*b*) cells filled with oil drops; towards the apex of the nodule the infection threads can be seen passing from cell to cell, and the whole nodule is covered by two or three layers of cork cells. Pure cultures of the bacteria show small rod-like bodies resembling *Pseudomonas radicicola*, the organism found in all Leguminous nodules, and giving a definite fixation of nitrogen when grown in flasks. Young *Myrica* plants grown in pots in soil deficient in nitrogen flourished well if possessing nodules; if without nodules on their roots they soon died. Evidently the nodules of Myrica are concerned with the assimilation of atmospheric nitrogen, as are the root-nodules of *Cycas*, Alder, *Elaeagnus* and *Podocarpus*, the other known genera of plants outside of the Leguminosae which have root-nodules.

PAPERS ON PHYSIOLOGY. — Professor Bottomley described "Some Effects of Bacteriotoxins on the Germination and Growth of Plants," illustrated by some remarkable photographs of comparative cultures. An aqueous extract of well rotted manure or fertile soil, obtained by treating one hundred grammes of manure or soil with five hundred cubic centimetres of isotonic salt solution and filtering through a Pukall filter, has an injurious effect on the germination of seeds and their further growth in sand, even when supplied with normal food solution. This inhibitory effect of the extract can be destroyed by boiling. The harmful effect is due to the presence of certain bacteriotoxins, probably of the nature of toxalbumoses, formed by the activities of the decomposition and denitrifying bacteria in the manure or the soil, and by heating the toxic influence is destroyed and the substance rendered available as a nutrient.

Experiments with germinating seeds of mustard, turnip, tares, and barley give support to this theory. Seeds germinated in pots containing sand moistened with (*a*) distilled water, (*b*) saline solution, (*c*) raw extract, (*d*) boiled extract, showed that the raw extract almost prevented germination and the subsequent growth was very feeble, whilst the boiled extract, although slightly retarding germination at first, soon appeared to benefit the seedlings which became stronger and healthier than those grown without extract. The extract was also found to have a marked influence on the growth of certain soil organisms. It stimulated the growth of denitrifying bacteria, and inhibited the growth of the nitrogen-fixing bacteria. Both these effects were destroyed by boiling the extract.

Mr. S. Mangham, who has already done useful and interesting work on the translocation of carbohydrates in plants, described some of his observations on the presence of sugar in the tissues of the Sea Tangle, *Laminaria*. The two species *L. digitata* and *L. saccharina* were examined for sugars at various times of year by means of Senft's method of forming osazones. Observations were made upon sections cut from the stipe, the region of new growth, and from the lamina. Crystalline osazones have been found in the cortical cells, the sieve-tubes, and the hyphae in both species, and particularly at the time of formation of the new lamina in *L. digitata*. Some of the crystals in the latter plant very closely resemble those yielded by maltose, but their exact identity is at present unknown. This production of osazones in the hyphae and in the sieve-tubes after treatment with Senft's reägent affords experimental evidence in support of the conducting and storing function hitherto assigned to these elements mainly on account of their structure.

Miss Fraser described in detail "The Longitudinal Fission of the Meiotic Chromosomes in *Vicia Faba*."

Dr. A. A. Lawson, in a paper on "Nuclear Osmosis as a Factor in Mitosis," put forward views which run counter to some generally accepted interpretations of the phenomena of nuclear division, and which are likely to lead to further discussion. Dr. Lawson claims to have discovered that the nuclear membrane does not break down or collapse at any period, but behaves as one would expect a permeable plasmatic membrane to behave under varying osmotic conditions; and that the achromatic spindle can no longer be regarded as an active factor in mitosis, but is simply the passive effect or expression of a state of tension set up in the cytoplasm and caused in the first place by nuclear osmotic changes.

Miss L. Digby gave a preliminary account of the cytology of the hybrid *Primula kewensis*, its parents, and the ensuing generation. The original *P. kewensis* appeared in a pure batch of *P. floribunda* seedlings at Kew in 1899, and proved to be a cross between *P. floribunda* and *P. verticillata*. The hybrid was sterile, with only thrum-eyed flowers, but some years later a single pin-eyed flower was noticed in Veitch's nurseries. This was promptly fertilised, good seed was set, and the resulting plants had both pin-eyed and thrum-eyed flowers and were fertile. Thus the whole fertile or seedling stock of *P. kewensis* owes its origin to the one pin-eyed flower on the sterile or type stock of *P. kewensis*.

The parents of *P. kewensis* (sterile) have identically the same number of chromosomes, and (as might be expected) this number is repeated in the hybrid: *P. floribunda*, *P. verticillata*, and *P. kewensis* (sterile) all have eighteen (2x) and nine (x) chromosomes. The surprising phenomenon occurs in the seedling *P. kewensis*, in which there are thirty-six (2x) and eighteen (x) chromosomes. By some means either at, or subsequent to, the fertilisation of the pin-eyed flower on the sterile stock the number of chromosomes has been duplicated; this doubled number is continued throughout the generations of the fertile *P. kewensis*, and is also characteristic of the variety *P. kewensis farinosa*. This increase cannot be accounted for by apogamy; the divisions in the embryo sac mother nuclei of both sterile and fertile forms are normal, and in the one case nine (x) and in the other eighteen (x) chromosomes are seen at meiosis, while in the surrounding tissue there are correspondingly eighteen (2x) and thirty-six (2x) chromosomes. The doubled number of chromosomes has since re-appeared in a cross made in 1910, at Kew between *P. floribunda* var. *isabellina* and *P. verticillata*; the resulting hybrids not only resemble *P. kewensis farinosa* in external features, but also possess thirty-six (2x) chromosomes.

This remarkable sudden duplication of chromosomes has its counterpart in the Oenotheras. *Oe. Lamarckiana* has fourteen (2x) and seven (x), while *Oe. gigas* which mutated from *Oe. Lamarckiana* has twenty-eight and fourteen. Like the fertile *P. kewensis*, *Oe. gigas* has again arisen from two sources—once as a hybrid and once from a pure strain of *Oe. sublinervis*. In the Oenotheras, as there is no evidence of the addition of new unit characters, the doubling of the chromosomes is believed to be brought about by longitudinal fission. In the Primulas the phenomenon is apparently associated with the change from the sterile to the fertile condition.

When *P. floribunda* var. *isabellina*, with its eighteen and nine chromosomes, is crossed with *P. kewensis* seedling form, with its thirty-six and eighteen, the offspring resemble the seed-parent (*P. floribunda* var. *isabellina*) both in external characters and in number of chromosomes. By some regulating process the sum of 9 (x) + 18 (x) = 18 (2x). Again an analogy is found in the Oenotheras, for *Oe. lata* (fourteen and seven chromosomes), crossed with *Oe. gigas* (twenty-eight and fourteen chromosomes), results in a hybrid with twenty-one (2x) chromosomes; according to Geerts, at meiosis the seven homologous chromosomes derived from either parent become paired, while the seven supernumerary unpaired chromosomes disintegrate, and in this way the x number of chromosomes in the hybrid is reduced to that of the parent which possesses the lowest number.

MISCELLANEOUS PAPERS.—Miss Kershaw described the ovule of *Bowenia spectabilis*, which agrees on the whole with other genera of Cycads. The pollen chamber of *Bowenia* forms by the breaking down of a strand of elongated cells, extending from the tip of the nucellus almost to the megaspore. First a small cavity (upper chamber) forms in the narrow apex of the nucellus, and this probably accommodates the pollen when it enters the ovule. The nucellar tissue below gradually breaks down, forming a larger cavity (lower chamber), into which the pollen grains pass from the upper chamber. The upper and lower chambers correspond in function with the lagenostome and plinth of such fossil seeds as *Conostoma*, but are much less specialised than the corresponding structures in the Lagenostomales.

Mr. Horne discussed "The Polyphyletic Origin of Cornaceae," giving the results of detailed study of the flower of several genera of this order, together with comparative study of the effects brought about by progressive sterilisation and reduction in the ovary of the Caprifoliaceae, Hamamelidaceae, and Araliaceae. In the Caprifoliaceae every intermediate stage may be found between ovaries of the *Leycesteria* type (double rows of ovules in each chamber) and uniovular ovaries (*Viburnum*); progressive reduction trends to the uniovular condition, but each genus pursues an independent course of development towards this condition. In the Cornaceae, the flowers possess certain resemblances, e.g., polypetaly and epigyny, while the ovaries or loculi in some genera are uniovular with terminal ovules, but they possess peculiarities in (*a*) structure of ovary (*Cornus*); (*b*) vascular supply of ovary (*Garrya*); (*c*) vascular supply to ovule (*Griselinia*); (*d*) form of ovule (*Davidia*); (*e*) structure of nucellus (*Aucuba*); and so on. It is suggested that these peculiarities indicate different origins; the general resemblances in structure do not appear to be of any considerable value in establishing close relationships in the order, but are to be regarded as striking parallelisms brought about by the operation of similar evolutionary processes upon distantly related forms.

During the Portsmouth meeting, a semi-popular lecture was delivered by Dr. F. Darwin on "The Balance Sheet of a Plant"; while one of the evening discourses was given by Professor Seward, his subject being "Links with the Past in the Plant World."

Two interesting Excursions were made by the Botany Section, one to the New Forest to study especially the heath vegetation, the other in a steam launch up Southampton Water for the estuarine vegetation, and especially the *Spartina* grasses.

CHEMISTRY.

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

NATURAL GAS IN GALICIA.—Dr. K. Feldmann, writing in *Petroleum* (1911, VI, 2232), gives an interesting account of the steps recently taken to utilise the natural gas emitted from the borings for petroleum oil in the Boryslaw-Tustanowice oil-fields. Until about two years ago this gas was, for the most part, allowed to escape into the air, only a small proportion being used for heating and power purposes upon the spot. Recently, however, a pipe-line has been constructed for conveying the [illegible] gas to Drohobycz, a distance of over eight kilom[illegible], where it is intended to utilise it in the oil-refineries an[illegible] [illegible] in the town.

The gas issuing from the b[illegible] [illegible] [illegible]ourless, and has a specific gravity of about 0·75 an[illegible] [illegible] heating capacity of about 10,835 calories per [illegible]. Two typical samples from different borings [illegible] [illegible] and 8·8 per cent. of heavy hydrocarbons; 8[illegible]5 an[illegible] [illegible] cent. of light hydrocarbons; 1·0 and 1·7 per cent. [illegible] [illegible] and 3·8 and 0·4 per cent. of nitrogen (corresponding [illegible] [illegible] per cent. of air) respectively.

The various pipes conducting the gas [illegible] [illegible] different borings come together at Kamilla, and it is inten[illegible] [illegible] establish a central power station at that point. Here the [illegible] [illegible] from moisture, and passes through an apparatus which [illegible] the percentage of air, this precaution being taken to p[illegible] an explosive mixture (one containing over 10 per cent. of air) being distributed. As the gas is poisonous a small addition of mercaptan is also made at this stage, in order to render any escape perceptible by its odour.

The main pipe is constructed of steel tubes which have been tested in the works up to a pressure of ten atmospheres, and these are coated with a layer of jute surrounded within the trench with tar and lead. The finished pipe line is tested up to a pressure of four atmospheres, although the maximum pressure at which the gas is driven through it does not exceed 1·8 atmospheres.

BOLOGNA LUMINOUS STONES.—Lémery in his "Treatise of Chymistry," published in 1720, in a section upon the Bolonian Stone, describes it as "a small gray stone, weighty but soft, sulphureous, sparkling in many Places, of the Largeness of a Walnut, whose Surface is not equal but bunchy and protuberant and the opposite side is hollow. Large Stones are only valuable for their Rariety; for they are not so good to make the *Phosphorus*, because commonly they are opaceous; the small ones are much better, they shine more and have fewer Blemishes." According to Lémery the nature of the phosphorescence was investigated by an Italian who "did particularly apply himself to this Discovery, and he made great Progress in it. But it does not appear that he did communicate the same to any Body, so that the secret has been buried with himself many years ago."

Since the days of Lémery the phosphorescent stones of Bologna have frequently been examined and it has been shown that the luminous property depends upon the presence of sulphides.

In a recent issue of the *Journ. prakt. Chem.* (1911, LXXXIV, 305) an account is given of experiments made by Messrs. Vanino and Zumbusch to ascertain the factors upon which the luminosity depended. They found that good specimens of the stones contained from twelve to thirty-three per cent. of sulphur, and that the condition in which that element was present had a pronounced effect upon the results.

Thus stones containing only monosulphides were very deficient in luminosity, whereas in highly phosphorescent specimens there was a considerable amount of polysulphides (up to 2·5 per cent.) A small addition of starch increased the luminosity, but a larger proportion than about four per cent. had the opposite effect. The length of exposure to daylight required to induce the maximum phosphorescence varied with the composition of the stone, those of more complex character requiring a longer exposure, though they also showed a correspondingly longer period of decay.

The luminosity was not increased by confining the stone in an atmosphere of chlorine or ammonia. It was reduced to a marked extent by grinding the stone in a mortar, the colour being simultaneously altered. Exposure to sunlight also changed the colour, but it was not possible to trace any connection between the luminosity of the stone and the speed with which its colour altered.

CHEMISTRY AT THE BRITISH ASSOCIATION.—The address of the President of the section, Dr. Walker, deals with the "Theories of Solutions," which have arisen upon the foundations laid by van t'Hoff. A masterly outline in

... the present ideas upon the subject, and it is shown ... certain conflicting notions may be reconciled.

Other important contributions are devoted to the "Absorption Spectra of Metallic Vapours," by Dr. Bevan, "The Compressibility of Mercury," by Dr. McLewis; and "The Use of Indicators for determining Affinity Values," by Dr. V. H. Veley. There is also an interesting paper on "The Theory of Colloids," by Professor Freundler, in which he classifies colloidal (or glue-like) solutions into two groups, viz., those in which the solid body, e.g., a colloidal metal, is in a state of extremely fine suspension, termed "Suspension Colloids" or "Lyophobic Sols"; and "Emulsion Colloids" or "Lyophilic Sols" (including gelatin solutions and the like) which approximate more closely to true solutions.

In a paper upon "The Treatment of Wheaten Flour," Mr. A. Humphries describes the results of his investigation of the changes produced in flour on baking. From these it appears that a large proportion of the organic phosphorus present is converted into an inorganic form.

ALUMINIUM NITRIDE AND ITS USES.—On heating aluminium powder in the air it absorbs oxygen and nitrogen in proportions depending upon the temperature reached. Thus, at 600 C. oxygen is absorbed up to 8·8 per cent. of the weight of aluminium, but there is little or no absorption of nitrogen; while at 800 C. the amount of nitrogen absorbed is trifling. On raising the temperature to 1100 C., rapid absorption of both oxygen and nitrogen takes place, until, after about six hours, the metallic aluminium has been converted into oxides and nitride, the absorbed nitrogen being subsequently displaced by oxygen, with the final production of a hard aluminium oxide resembling alumina in properties but containing a different proportion of oxygen.

When the aluminium is heated in an atmosphere of nitrogen at 900°C., it absorbs 12·21 of that element, to form a nitride, which is decomposed into an aluminium oxide when heated in the air at temperatures above 800°C.

In the current issue of the *Bull. Assoc. Chim. Sucr. et Dist.* (1911, XXVIII, 1010), M. Kohn-Abrest recapitulates his work on this subject, outlined above, and suggests that it may be possible to prepare aluminium nitride on a large scale from bauxite, or alumina, in the electric furnace. The products would contain from 33 to 34 per cent. of nitrogen, and in the case of bauxite would cost less to make than sodium nitrate, containing 15·5 per cent. of nitrogen. Further experiments are needed, however, to ascertain whether ammonia could be produced economically on a large scale from this source: or whether, if applied to the soil as a fertilising agent, aluminium nitride, as thus prepared, would part with its nitrogen in the form of ammonia.

GEOLOGY.

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

QUARTZ VEINS.—Whilst in many cases undoubtedly due to deposition from water containing silica in solution, it is now thought that some quartz veins may have an igneous origin. The "aqueous" veins generally have a "comb" or other regular structure growing out from the sides of the fissure in which they have been deposited. Quartz veins of igneous origin have a coarse pegmatoid structure, and may show gradations in mineralogical composition uniting them with typical pegmatites. The latter are admittedly igneous, and represent the final product of the slow crystallization of the more volatile residual portions of a granitic or syenitic magma. These mother-liquors, rich in magmatic water, were forced into fissures of the already-solid magma, or into the adjacent country-rock, where their extreme liquidity permitted the formation of very large and perfect crystals of the later-crystallized constituents of the magma, such as quartz and orthoclase. Quartz veins associated with granite masses may be regarded as pegmatites composed entirely of quartz, and there is no reason why they should not have the same origin as the more normal pegmatites.

It is to be remarked that the distinction between "aqueous" and "igneous" becomes very shadowy in the case of quartz veins. In discussing pegmatite Mr. Harker remarks: "The magma or solution, from which the pegmatites crystallised was igneous, in that it was the residual part of a granitic or syenitic or other igneous magma, of which the greater part had already crystallised under plutonic conditions. It was aqueous, inasmuch as it contained, perhaps very richly, magmatic water, concentrated (with other volatile constituents) in the residual magma by continued crystallization of anhydrous minerals. The pegmatites themselves represent this watery residual magma, except that the greater part of the water and other volatile substances was expelled in the final crystallization . . . . Logically, indeed, we might include under the same head simple quartz veins crystallised from solution in water (at perhaps 200°C), if both quartz and water were of direct intratelluric origin, the final residuum of an igneous rock-magma."

Some observations bearing on the origin of quartz veins in association with a granite mass have been made by W. C. Simmons, in a paper on the Foxdale Granite of the Isle of Man (*Geol. Mag.*, August, 1911). In both the larger granite mass at Foxdale, and the smaller one of Eairy, thick veins of quartz and coarse pegmatite occur. Sometimes these quartz veins, then resembling dykes, are found, outside the granite, intruded into the country rock. Associated with them and with the granite are characteristic dykes of micro-granite intruded into the slates with a N.W.—S.E. trend. The veins occur in greatest number on the south-side of the intrusion, and attain a maximum thickness of eighteen feet. In the large Foxdale Silica Quarry several veins are to be seen, which pass locally into a quartz-mica pegmatite. In one case a vein has a selvage, half-an-inch thick, consisting of a felted mass of bronzy mica; in another the selvages, again half-an-inch thick, are composed of a mixture of quartz and orthoclase. The evidence seems to support the theory that the quartz veins represent the final consolidation product of the granite magma. The selvages are believed to be due to the segregation of impurities from the molten silica solution. There is no sign of "comb" or any other structure to indicate that the veins are due to vapour or water deposition.

PETROGRAPHICAL PROVINCES.—In his Presidential Address to the Geological Section of the British Association at Portsmouth, Mr. Harker took as his subject "Some Aspects of Modern Petrology." Most of the address was concerned with what one may call "regional petrology"—the space and time distribution of igneous rocks. This is a fascinating subject, and its study is opening up some wide problems, and giving not a few hints as to that natural classification of igneous rocks which belongs to the future, but which at present is merely hoped for. Petrographical provinces are, in Mr. Harker's words, "more or less clearly defined tracts, within which the igneous rocks, belonging to a given period of igneous activity, present a certain community of petrographical characters, traceable through all their diversity, or at least obscured only in some of the more extreme members of the assemblage." It is natural to attribute such a family likeness amongst a given group of igneous rocks to a community of origin. The simplest hypothesis is that which holds all the varied types of a petrographical province to have been evolved by the progressive differentiation of an originally homogeneous parent-magma. Becker holds the view that petrographical provinces are the expression of a primaeval heterogeneity of the earth's crust, which has persisted throughout geological time. This is difficult to reconcile with the small extent and sharp definition of provinces like that of Assynt or the Bohemian Mittelgebirge. An even stronger objection is that petrographical provinces are not permanent. In the Midland Valley of Scotland, for instance, a calcic petrographical province (Old Red Sandstone) is followed by one distinctly alkaline (Carboniferous), extending over almost exactly the same area. Daly's theory of the origin of alkaline rocks as due to the assimilation of limestone by calcic magmas, is open to the same serious objections.

In the land areas of the globe, calcic magmas have a decided predominance over the alkalic. Mr. Harker makes the interesting suggestion that this is due to the association of alkaline rocks with areas of subsidence. In connection with this it is remarked that the volcanic islands in the Atlantic, from the Azores to Tristan d'Acunha (and, it might be added, many in the Pacific) have igneous rocks of alkaline facies, and conceivably belong to very extensive tracts of alkaline material now submerged under the ocean.

Mr. Harker is inclined to drop those unhappy terms "Atlantic" and "Pacific," as applied to, and synonymous with, the alkaline and calcic branches respectively of igneous rocks. Nevertheless the distribution of types upon which that nomenclature rests is regarded as none the less significant. The distribution coincides not with the Atlantic and Pacific *oceans*, but with the contrasted tectonic structures which border those oceans. Consequently it is not to be expected that the oceanic islands of the Pacific should necessarily have igneous rocks of calcic facies; on the contrary, the dominant element in their tectonics, according to Suess, being of Atlantic type, the igneous rocks should be generally alkaline, as in fact they are. The observed alkalinity of the igneous rocks of Hawaii and Tahiti, therefore, instead of constituting an objection, as urged by some American petrologists, confirms the simple generalization of distribution made by Harker, Beeke and Prior.

METEOROLOGY.

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

THE weather of the week ended September 23rd, as set out in the Weekly Weather Reports issued by the Meteorological Office, was at first very fine and dry, though cool, but about the middle of the week there was a change, rain fell generally and thunderstorms occurred. The temperature was below the average in all districts, for the first time since the end of June. In the North the deficit was but slight, but in the Midlands and the South it was greater, reaching 3°·0 in England S.E. The highest maximum was 73° at Tottenham on the 18th, the next highest being 70°, reported at both Aberdeen and Guernsey, on the same day. The lowest of the minima were 24° at West Linton, 25° at Balmoral and 29° at Marlborough. It was only at a few stations, however, that the temperature fell below the freezing point. In Westminster the minimum was 41°. On the grass the temperature fell to 18° at Llangammarch and to 22° at Balmoral, Hereford and Marlborough. Rainfall was in excess in all districts excepting Scotland, E. and W. The excess was greatest in the South-West, where at Falmouth and other stations the total fall was more than twice as much as usual. Sunshine was in excess in the Central and Eastern parts of the kingdom, but was in defect in the western districts. The sunniest stations were Felixstowe and Clacton with 61 hours (71%). At Westminster the aggregate was 47·2 hours (55%). At Aberdovey the total was only 13·9 hours (16%). The mean temperature of the sea water ranged from 51°·4 at Wick to 62°·0 at the Shipwash Lightship.

During the week ended September 30th the weather was changeable and unsettled, with frequent heavy rain. Temperature was below the normal in Scotland, England, N.W., and in Ireland, but above it elsewhere. The differences, however, were nowhere very large. The highest of the maxima ranged from 62° at Strathpeffer, in Scotland, E., to 72° at Geldeston, in England, E., and at Greenwich. The lowest of the minima was 28° at Balmoral, on the 25th, and only at this station did the shade temperature fall below the freezing point. On the grass, however, readings were in places much lower, down to 21° at Llangammarch, 23° at Crathes, and 24° at Balmoral. Rainfall was variable. There were some very heavy falls in Ireland and Wales on the 25th: 3·00-ins. at Roches Point, 2·23-ins. at Waterford, and 1·40-ins. at Bettws-y-coed; but in the South there were stations where the amount for the week was only 0·3-in. or even less. Bright sunshine was above the average in all districts, most so in England, S.E., where the sun[illegible] Worthing, reported 57·6 hours (69%). The temp[illegible] the sea water varied from 45° at Ballantrae to 6[illegible] Shipwash Lightship.

The week ended October 7t[illegible] with strong winds and gales in the early [illegible] was low everywhere, especially so in Engla[illegible] the mean was only 48°·0, compared with t[illegible] The highest reading reported was 62° a[illegible] at the majority of stations the maximum di[illegible] The lowest readings were 23° at Balmoral, [illegible] and 29° at Marlborough. The lowest on [illegible] at Llangammarch, 19° at Hampstead, and [illegible] Rainfall was slightly above the average in En[illegible] and much above in the English Channel, where [illegible] amount collected was just double the average. [illegible] district was Scotland, W., where Glasgow and Dunt[illegible] rainless. At Tunbridge Wells and at Canterbury there [illegible] falls of over an inch on the 4th.

Sunshine was about the average, except in Scotland, W., and in England, N.W., where it was in excess, and in the English Channel where it was in defect. Douglas reported the largest aggregate 41·0 hours (51%), while Markree Castle reported the least, namely 14·0 hours (18%). The temperature of the sea water ranged from 46° at Kirkwall and Scarborough to 60° at the Shipwash and at Salcombe. A pilot balloon sent up at Manchester on the 3rd August was traced to a height of 25 kilometres, or more than 15½ English miles.

The week ended October 14th was fine generally, but with a good deal of mist and fog. Thunderstorms occurred in several places on the 13th. Temperature did not vary greatly from the average. There was an excess in England, E., S.E., and S.W., the English Channel, and Ireland, N., but a deficit elsewhere. The highest readings were 68° at Greenwich, Prestwich, Bettws-y-coed, and Cullompton; the lowest were 24° at Balmoral and 26° at Kilmarnock. Except in England, E., and the English Channel, temperatures at or below the freezing point were experienced in all districts. In the English Channel the minimum was 40°. On the grass the temperature fell to 17° at Llangammarch and to 20° at Balmoral.

Rainfall was extraordinarily low, and in seven of the twelve districts into which the country is divided for the compilation of meteorological statistics, the mean amount of rainfall was less than 0·1 inch, and in Scotland, W., the week was rainless. At many individual stations also, in other districts, the week was rainless. On the other hand, at Jersey, on the 13th, 2·42 inches of rain fell in one day. Bright sunshine was above the average except in Scotland, N., and in Ireland. The sunniest district was England, N.W., with a mean of 40 hours (53%); the sunniest station was Llandudno, with 51 hours (67%). The lowest record for the week was 0·6 hours at Baltasound, Shetlands. The temperature of the seawater ranged from 44° at Ballantrae to 59° at Salcombe.

THE SUMMER OF 1911.—In the thirteen weeks of summer ended September 2nd, the weather in England, S.E., had been unusually warm in ten weeks, unusually dry in eight weeks and unusually bright in nine weeks. The corresponding numbers for the summer of 1910 were respectively three, four and one.

INTERNATIONAL INVESTIGATION OF THE UPPER AIR.—During the period, September 11th to 16th, simultaneous ascents of unmanned balloons were made at a large number of stations in Europe and elsewhere. The co-operating stations in the British Isles were Pyrton Hill, Oxon; Ditcham Park, Petersfield; and Manchester, in England; Crinan Harbour, in Scotland; and Mungret College, Limerick, in Ireland.

Small balloons carrying recording instruments were dispatched simultaneously, and the return of the records and the tabulation of the results is anticipated with much interest. One balloon sent up at Limerick was found at Ballater, in Scotland.

MICROSCOPY.

By A. W. Sheppard, F.R.M.S.,

with the assistance of the following microscopists:—

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

A CASE OF DIATOM-WELDING. The photomicrograph illustrates the probable fusion of two diatoms that has taken place during mounting. The slide is an old one by Wheeler, labelled "Test Slide, Dry, *Amphipleura pellucida*, 1/8 in. obj." and it is a mixed one. Mr. West, to whom this photograph and others taken at a magnification of × 1000 were submitted, is of the opinion that the smaller valve lying alongside the *A. pellucida* is a *Navicula laevissima*, and that the junction is an accidental one. I understand that in mounting test diatoms dry, it is the custom, after cleaning the cover glass, to place upon it a drop of the material with a drop of added water, and allow evaporation to take place slowly. The cover is then placed on a piece of platinum foil or ferrotype plate which is heated to redness, and it is doubtless at this stage of the process that the unnatural union has taken place.

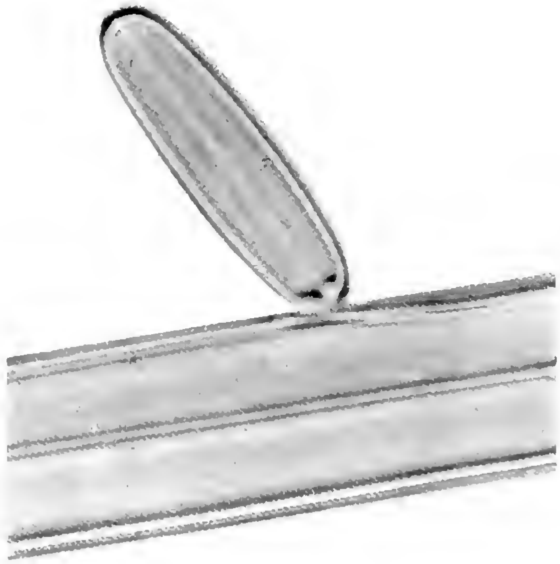


Figure 1.

Obj. 2 mm. H.O.I. Apochromat N.A. 1·40 (Leitz), Oc. Compens. × 18, Achromatic Substage Condenser. Auxiliary *Lens with Iris. Screen* (D+H.) Wratten and Wainwright, "M" Series. Liliput Arc lamp, 8 Amps.

F. W. Butcher, M.B., C.M.

TETRASPORA (LINK).—At a recent excursion of the Quekett Club I came across *Tetraspora*, an alga perhaps not very frequently met with, and most likely often overlooked when it does occur. It was clinging to some weeds in water about a foot deep near the edge, and appeared as a pale green filmy looking body without any definite outline. There was some difficulty in collecting it—so fragile was it, that an incautious movement with the net at once caused a part to disperse in the water. The plant consists in its young condition of a colourless gelatinous sac, which later extends in various directions, becoming lobed, torn and membranous finally, it may reach a considerable size, up to several inches in length. In this are embedded in a single layer the cells which are the living units of the organism. Typically they are globose, of various sizes, according to age, and when mature divide first into two hemispheres, which soon divide again at right angles in the same plane. The four portions, at first somewhat angular, subsequently become rounded off, but not usually separating far from each other, cause the grouping into four, which is the noticeable characteristic of the plant. The mother cell-wall swells and becomes gelatinous thus increasing the extent of the colony (Figure 2 a). During some period at least of their life these cells are provided with two long "pseudocilia" (Figure 2 b), but the organism as a whole has no spontaneous motion. In reproduction zoogonidia are formed with two cilia (Figure 2 c), which swim away, but their actual development into a fresh colony has not been observed. Sometimes when a specimen has been kept in a collecting bottle for a few days, it will be found that all the cells have taken this form and settled on the side of the bottle towards the light, leaving the structureless jelly useless for examination. It is very doubtful if there is more than one well-established species, to which, however, a considerable amount of variation, owing to environment and age, must be allowed. My example, in which the cells, from eight to ten μ diameter—are arranged in groups of two or four, corresponds best with *Tetraspora lubrica* (Roth). Dr. Cooke gives four species, but is very doubtful about the last of them, and certainly the first, *T. bullosa*, from the figure—"British Freshwater Algae" Plate 6, Figure 1, appears to resemble *Monostroma* rather than *Tetraspora*; in the latter genus the cells should be at least sub-spherical except when undergoing division. Neither does he refer to the "pseudocilia," which, though they are easily overlooked and cannot be distinguished in all cases, West makes of diagnostic importance. Who also mentions the occurrence of hypnospores—*i.e.* resting spores—with thick brown cell-walls, but I have not seen them. Considerable importance is attached to the plant from an evolutionary point of view—West's "British Freshwater Algae," page 24. Figure 2 a is from my own specimen, b and c are from figures in the above book.

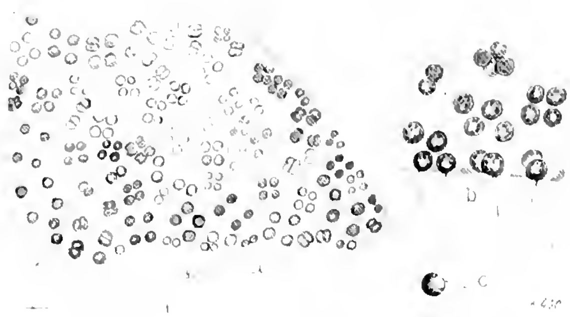


Figure 2.

J. Burton.

TABANIDAE.—The exceptionally fine and hot weather of the past summer has resulted in an unusual profusion of insect life, and in no respect has this been so apparent as in the case of the Tabanidae, which, especially abroad, have been so numerous as to constitute a veritable plague. Not only have the grey Breeze flies been remarkably abundant, but the larger species of Tabanus varying in size from one-half inch to one inch in length, beset the traveller wherever he went, even on the higher slopes of the Alpine pastures, above the tree level to a height of over nine thousand feet. For the protection of the face and neck a light veil was effective, but the hands and legs were especially exposed to attack, since these flies could alight upon a glove or stocking without being noticed, and could easily pierce the skin through any tight-fitting garment. As regards the Tabanidae, the males appear to subsist on the juices or secretions of plants, but the females are extremely bloodthirsty, and lose no opportunity of attacking both animals and human beings. The mouth organs of the various species are similar, and are of considerable interest not only to the microscopist, but also to many others who, whilst suffering from the bites, at least like to know by what means they are bitten. The large fleshy proboscis—or *labium*—common to both male and female, does not greatly differ in shape or structure from that of the well-known Blow fly, and as this organ does not take any active part in the process of bloodsucking, it need not claim our attention here. The central blade of the set of five lancets is the *labrum*, which in a specimen before us measures ·06-inch × ·01-inch but tapers toward the extremity, ending in two oval chitinous plates set obliquely on each side, each bearing about sixteen rasp-like teeth, the central portion between them being also finely toothed. The edges of the labrum are thin and sharp and furnished with delicate hairs, whilst down the centre there is a groove, the upper end of which is in communication with the alimentary canal. Immediately below this is the true tongue, or *hypopharynx*, somewhat shorter and narrower than the labrum, slightly grooved on its outer face, and tapered towards its rounded extremity. When in operation this is pressed upon the inner surface of the labrum and the grooves being then in apposition, form a tube up which the blood is drawn. On either side of these are the *mandibles*, rather longer than the labrum and about the same width, formed of two extremely thin laminae and tapering to a lancet-shaped point, the outer edges being smooth and sharp, whilst the inner edges are bordered with minute teeth the forty-thousandth of an inch in size. Outside these again are two delicate blades which are generally regarded as the *maxillae*. These are somewhat shorter than the mandibles, but are only ·004-inch wide, slightly tapering and rounded at the ends. If these are examined with a magnifying power of, say, × 150 or × 200, it will be seen that the ends are furnished with ten to twelve rows of strong teeth pointing upwards, each tooth consisting of a sharp point set in a socket of more flexible material. A short distance from the end, where the maxilla has widened to almost its full breadth, these large teeth give place to a band of teeth of a smaller size, running down either side, beginning in close rows of seven, but gradually diminishing in number until they narrow to a single tooth, leaving the central portion of each maxilla bare; the inner margin of each maxilla is smooth, but the outer edge is closely fringed with long soft hairs almost throughout its entire length. All the teeth point in the same direction, their use being, no doubt—as in the case of the reflexed teeth on the hypostome of a Tick—to enable the insect to maintain a firm hold whilst sucking up the blood. The effects of the bites of these flies vary considerably according to the state of health of the person bitten, but the after irritation is often much increased by portions of the mouth organs being broken off in the puncture by a sudden attempt to crush the creature when caught in the act. In many specimens which I have examined, the partly damaged mandibles and maxillae seem to confirm this suggestion. In some of the smaller species of Tabanidae the diameter of the suctorial tube is obviously less than that of a human blood corpuscle, and it is therefore thought by many that the saliva of the insect—probably containing some form of formic acid—is injected into the wound for the purpose of breaking down the red corpuscles to enable their contents to be more easily absorbed; but in answer to the question why are visitors so much more persecuted than natives, it is asserted that the latter become in a short time so inoculated with the poison as to be immune to the usual after-effects, as indeed is said to be the case with bee-masters, to whom, after becoming similarly inoculated, the sting of a bee merely means a momentary prick.

R. T. L.

CLARE ISLAND SURVEY.—The results of this survey are being published by the Royal Irish Academy, and will form Vol. XXXI of the Proceedings. When completed there will be sixty-seven separate reports dealing with the flora, fauna, geology, archaeology, and so on, of the Island and the adjacent Mainland. We have before us Nos. 37, 51 and 52, of these reports, dealing with the Arctiscoida—James Murray; Rotifera (excluding Bdelloida)—C. F. Rousselet; Rotifera Bdelloida—James Murray. Until the commencement of the Clare Island Survey, there appears to have been no previous record of the occurrence of Water-bears in Ireland. Thirty-three species were collected in the small area under examination, and it cannot be supposed that this list is fairly representative of the whole of Ireland. When other parts of the country are examined the list [illegible]dly be considerably increased. There are ele[illegible] which are new records for the British [illegible] the Britannic list up to sixty-one speci[illegible]sting feature of the Irish list of water-bear[illegible]rrence of three species which were recently discove[illegible]ada and which were hitherto unknown in Europe :—*Ec*[illegible]*intermedius*, *Macrobiotus occidentalis* and *M.* [illegible] With the Canadian Water-bears is associated [illegible] Canadian Bdelloid Rotifer—*Callidina asperula*. [illegible] open up some interesting questions in the geogra[illegible] distribution of fresh-water organisms. Are they cosmo[illegible] given the suitable conditions postulated by Mr. Rousse[illegible] recent paper on the Geographical Distribution of the Ro[illegible]

The Survey collected fifty-seven species of Bdello[illegible]ides a number of very distinct varieties. As there were [illegible] records from Ireland of nine species, forty-eight are additions to the Irish fauna. The study of the list in relation to the world distribution of the species is instructive. There is not a single species which is confined to Ireland. Nevertheless, the Irish Bdelloid fauna exhibits much more peculiarity than that one fact would seem to indicate. Much importance attaches to the varieties of common species which are found, these occuring chiefly among the spiny Bdelloids, in the genera Dissotrocha, Pleuretra and Callidina. Mr. Murray's reports are illustrated with his well-known skill.

A Course of eight lectures on "The Manipulation and Theory of the Microscope" is being delivered by Mr. J. Edwin Barnard, F.R.M.S., at King's College, Strand. The lectures are addressed to advanced students of the University and to others interested in the subject. Admission free, without ticket. The syllabus shows that a very complete treatment is aimed at, and the lectures cannot fail to be of very considerable interest to students and others.

We have received Catalogue No. 2 from Messrs. H. F. Angus & Co., Wigmore Street, W., containing a list of second-hand scientific apparatus and accessories. That part of the catalogue devoted to the Microscope is divided under separate headings, such as: Stands only, stands with objectives, objectives and eyepieces, substage illuminators, and so on. All the instruments listed have been tested and adjusted where necessary. It is proposed in course of time to issue a larger list at periodical intervals.

A catalogue has also reached us from Messrs. Clarke and Page, Thavies Inn, E.C., of microscopical preparations, microscopes and accessories which they supply. Their catalogue is now issued in a much improved form to previous editions. We would draw attention to Section A of their list of mounted microscopical objects, a series of preparations mounted without pressure in cells, in which a new fluid medium is used. All these slides are particularly fine for dark ground illumination. We have before us five of these preparations, of which we would specially mention: *Corallinum rubrum*, with extended polype, Ambulacral disc and tube of *Echinus esculentus*, and the head of a Sand-wasp (*Miscus sylvestris*), showing the mouth parts. These fluid mounts are finer than any which have hitherto come under our notice.

ORNITHOLOGY.

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

NEW NAMES FOR THE GREEN WOODPECKER.—Amongst the vicissitudes of birds at the present time is the peril of losing their old and honoured scientific names and of having a fresh and unknown style conferred upon them. We suppose that it is not within the scope of the operations of the Society for the Protection of Birds to attempt to save the good name of a bird, but, if it were so, they might well intervene. A new name is now proposed by Dr. Ernst Hartert for the English form of the Green Woodpecker viz.:—*Picus viridis pluvius*, subsp. nov. With an unexpected regard for tradition the justification is added, "because of the well-known ancient superstition that its call is a sign of approaching rain." This proposal is made in the course of a short article "On the English and other Green Woodpeckers" in the current number of *British Birds* (V, page 125), where the authority above named distinguishes briefly five forms within Europe alone. These are:—

1. *Picus viridis viridis* L. Birds from Scandinavia, the greater part of Russia, and north-eastern Germany (east Prussia).
2. *Picus viridis pinetorum* (Brehm.) Central European birds.
3. The new name given above for English birds.
4. *Picus viridis pronus* subsp. nov., another new name given to Italian birds.
5. *Picus viridis sharpei*. Spanish birds.

Such is the transformation proposed in the present names of *Gecinus viridis* (Linn.), and *G. sharpii*, Saunders, for the Green Woodpecker.

THE GREAT BUSTARD IN NORFOLK IN 1900-1.—The recent death of Mr. Alexander Williams, of Jerez de la Frontera, Spain, has given occasion to *The Field* (16th September, 1911) to recall his connection with the attempt to re-introduce this species (*Otis tarda*) into one of its old haunts in England. Mr. Williams collected in Spain sixteen Great Bustards, and sent them to England, in the year 1900, when they were turned out at Elveden, Suffolk, Lord Walsingham and Lord Iveagh assisting in the project to re-establish the birds as breeders. Some of the birds did manage to nest, and *The Field* publishes a unique photograph of a nest in Norfolk. The experiment was not in the end successful, the birds surviving only for a limited period, some being killed in a wanton manner and others straying and being lost.

The native British race became extinct probably in 1838, when two birds were killed near Swaffham in Norfolk. In earlier times the species occurred in the champaign parts of Britain from East Lothian to Dorset, and being the largest in size of our land-birds must have been a conspicuous figure.

A photograph of a recent Spanish nest can be seen in Col. Verner's book "My Life amongst the Wild Birds in Spain."

ANOTHER NEW BRITISH BIRD—THE SLENDER-BILLED CURLEW.—The list of occasional bird-visitors to the British Isles continues steadily to receive additions, the last reported being the Slender-billed Curlew, *Numenius tenuirostris* Vieill., obtained towards the end of September, 1910, on Romney Marsh, near Brookland, Kent. Out of a small flock occurring there, three were shot, one of which is figured in *British Birds* for October, 1911, (V., page 124), with a brief account of the species by Mr. M. J. Nicoll. It winters in the countries bordering the Mediterranean Sea and breeds in Western Siberia. It has been met with rarely in Heligoland, Germany, Holland, Belgium and northern France, but not hitherto in Britain.

THE FULMAR'S BREEDING RANGE.—The Fulmar Petrel (*Fulmarus glacialis*) is one of our native birds which, happily, is spreading as a nesting species within the United Kingdom. The latest new breeding localities reported are in Ireland, on the northern coast of Mayo and on a cliff in Ulster. (*The Irish Naturalist, 1911*, pages 148, 149-152, 152-154). The original breeding station in the British Isles is St. Kilda, and this was for long the only one place so known. Since 1878, birds have been nesting in Foula, Shetland, and they are now known in several localities in Shetland and also in the Orkneys, where they first occurred as breeders in 1891. The first nests on the Scottish mainland were probably in 1897, and some three different places there are reported to be now frequented. Scottish islands on which the species has within recent years commenced to nest are Handa, Barra, the Flannan Isles, Fair Isle, and North Rona. It seems justifiable to assume that this expansion means an actual increase in the total numbers of the bird.

TWEED BIRDS.—The latest volume published in the fine series of the "Vertebrate Fauna of Scotland" is from the pen of Mr. A. H. Evans, and entitled "A Fauna of Tweed" (Edinburgh, 1911). It surveys the romantic region of the Eastern Borders, including part of Northern Northumberland, and the Farne Islands. The varied natural features of this extensive district—islands, sea-shore, coast-lands, lowlands, valleys, glens, moors and hills up to the altitude of The Cheviot (2676 feet)—secure an *ornis* fairly representative of our native birds, although perhaps not so numerous in species, as might be anticipated. Some two hundred and sixty-five different kinds (including eleven whose occurrence in the area requires verification) are dealt with in the Aves section of the work (pages 52-240). The accounts given of the Grasshopper-Warbler, Pied Flycatcher, Great Spotted Woodpecker, Barn and Short-Eared Owls, Shoveler, Stock-Dove and Pallas's Sand-Grouse may be singled out as particularly full of information and interest.

BIRD-OF-PARADISE SINGING.—Mr. Walter Goodfellow made the observation, when in Dutch New Guinea last year with the British Ornithologists' Union Expedition, that the King Bird-of-Paradise possesses a song which is sufficiently melodious to command attention even were it to be heard along with that of other birds recognized or classed as song-birds. The songs of the natives of the country on the Mimika River have a remarkable resemblance to this bird's notes, and invariably end with the loud calls which it gives. These may sometimes be heard from the birds kept in the Zoological Gardens, London.

TERRESTRIAL MAGNETISM AND CARRIER-PIGEONS.—In finding their way birds of passage are said to be influenced by the magnetic meridian, and M. A. Thauziès, a French specialist in carrier-pigeons, has given some interesting information respecting their perception of terrestrial-magnetic currents. At last year's Geneva International Congress of Psychologists he gave an account of his twenty-three years experience and observation, which have brought him to the conclusion that the sense of direction in these birds is influenced by such currents.

As instances, on 22nd July, 1906, and 18th August, 1907, the results of numerous flights by carrier-pigeons were very bad. Pigeon-fanciers, meteorologists and astronomers who were consulted, could give no explanation. Marchand, a specialist in electro-magneto research, found a solution by ascertaining that on these two days an exceptional electric tension of the atmosphere manifested itself in magnetic storms. Such observations accord with the fact discovered by pigeon-fanciers, that, with the great increase of wireless telegraphy, much less reliance can be placed on carrier-pigeons. (See "Sense of Direction in Animals and the Magnetic Meridian," by Dr. K. Endriss, translated by L. R. S. Tomalin, from Dr. Jaeger's "Monatsblatt").

PHOTOGRAPHY.

LOW POWER PHOTOMICROGRAPHY FOR NATURALISTS.—The ordinary photographer for the most part is concerned with images which are very considerably less than the objects, though at times he may do copying work up to "same size," or life size. The photomicrographist, in turn, is chiefly occupied with such magnifications as 50, 100, 500, or 1,000, or even 10,000 diameters in rare cases. But between these two useful fields of work is a large region where magnifications of 2, 3, 4, and so on, up to, say, 10 diameters is of peculiar interest to the naturalist. In a word, what the naturalist in the field can see with an ordinary pocket magnifier or Coddington he would like to be able to record permanently by means of photography with the minimum expenditure of labour and outlay for special apparatus.

Having made a considerable number of experiments in this low magnification region I propose to set forth in detail some of those aids which are easily home-made and have proved useful and practical. It is here assumed that the worker possesses an ordinary field, or bellows camera, lens, and tripod, and is familiar with the usual procedure of negative-making.

Figure 1 shows a quite simple and effective expedient for holding a camera vertically over such a small object as a flower. This is laid on a sheet of gray non-shiny, but not very rough, paper, and supported at a convenient height above the floor by a box, pile of books, and so on. The camera is held in the position shown by tying the tripod legs to the top rails of two chairs. The sheet of white cardboard on edge between the box and chair is used as a reflector to prevent the object casting too dark and detail-less shadows. This method also serves conveniently for copying maps, plans, diagrams, and so on, in books. The photographic reader will scarcely need to be told that to copy "same size" the lens will have to be at double its focal length from the ground glass, and also this same distance from the object.

To find the lens-to-image distance for any magnification, e.g., 4 times, we add 1 to 4 getting 5 and multiply this by the focal length. Thus with a 6-inch lens and 3 diameters magnification the *lens to image* distance is 3 plus 1 times 6, or 24 inches. While the *lens to object* distance is one third of 24 or 8 inches. It will thus be seen that in this field of work our limit of magnification depends on the relationship of focal length of lens to camera bellows length. Thus to find the greatest magnification with a 12-inch bellows and 4-inch

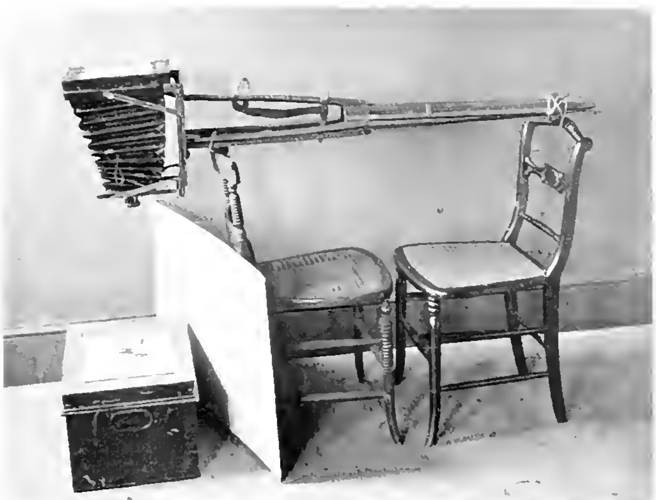


FIGURE 1.

lens we divide 12 by 4 and get 3. Then subtracting 1 we get 2, or the maximum magnification with a 4-inch lens and 12-inch camera bellows is 2 times *i.e.* double life size. Finally, requiring to know what lens will give us 10 diameters magnification with a 24-inch camera bellows we add 1 to 10 getting 11, and then divide 24 by 11 getting $2\frac{2}{11}$, as the maximum focal length, so that to be on the working side we should limit our focal length to 2 inches. The above scraps of simple arithmetic must be kept in mind whenever we are fitting up home-made contrivances of the sort to be herein below mentioned.

I now turn to an easily-made apparatus (Figure 2) that I have had in use for many years with complete satisfaction. It is especially well adapted for small objects, e.g., shells, fossils, seeds, and so on, which can be stuck to a card, or small enough to rest on a quite narrow (half-inch) shelf.

Figure 2.—A, the top of an ordinary tripod stand. The camera screw is attached to the under-side of the triangular top by means of a cheap steel watch chain with swivel end, which engages with a ring passing through the pierced head of the camera screw. This prevents the camera screw from being lost. BB a straight grain piece of (teak) wood, say three feet long by four inches wide by half-an-inch thick, which acts as an extension and base board. The camera screw passes through its usual hole in the tripod top, then through a hole in BB, and finally enters the "bush" let into the base of the camera. These three parts now become as one solid piece on tightening the screw. CE is a loose piece (see Figures 3 and 4) which slides along BB.

D is a loose piece which sli[illegible] the top of the upright part E, and it forms a shelf ([illegible] 3). These two moving pieces are made out of the w[illegible] a cigar box, and cigar box nails.

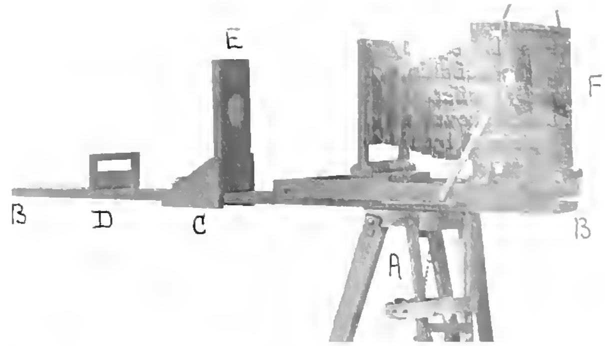


FIGURE 2.

At F we see the plate end of the camera, but the reversing back and focussing screen have been removed, so that we may see a contrivance which enables us to use the right and left-hand halves of a quarter-plate for two different pictures. This effects economy of material (cost), time, and storage space when we are—as is often the case—concerned with images which occupy only a small fraction of a quarter-plate. (The two figures 3 and 4 were thus taken side by side on one quarter-plate). The contrivance consists of a piece of cardboard, blackened on both sides. It is of such a size that one can bend and spring it into the last groove of the camera bellows just inside the camera body. When it is pushed as far as it will go to one side, it is just big enough to obscure half the focussing screen, so that when pushed to the other side it similarly obscures the other half. The procedure is: (1) push the card to right; (2) focus on the left half of screen; (3) insert the plate holder, expose, close the slide and withdraw it from the camera; (4) push the card to the opposite side; (5) focus on the other half of the screen for the second picture; (6) insert the plate holder, expose, close and withdraw it, and so on. We have now two image exposures on the plate side by side.

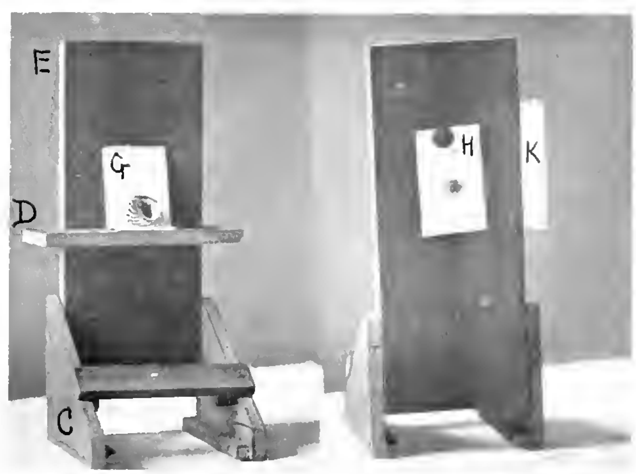


FIGURE 3. FIGURE 4.

Figures 3 and 4 show the two sides (front and back) of the sliding object holder. Figure 3 shows the shelf, D, slipped over the upright part, E, and held in place by a drawing pin below D. A small shell rests on a piece of paper to serve as a background, G. Figure 4 shows a small shell stuck to a piece of card which is held in place by a drawing pin, H. At K we have a small piece of white card pinned to the edge of the upright wood. This serves as a reflector and prevents the shadows being too dark.

The special points about this easily made piece of apparatus are that it calls for no alteration of the camera in use, though one may have to buy an extra long camera screw; and it enables one to move the object and camera *together*, so as to get any kind or direction of lighting. If a passing vehicle sets up vibration in the room where work is going on the whole apparatus is equally affected, so that the definition does not (apparently) suffer.

Figure 5 shows an ordinary result obtained by this contrivance. Figure 6 shows us a life-size view of two cowrie shells stuck on a card (*vide* Figure 4). Figure 5 shows us a magnified image, enlarged about 7 diameters, of one of these shells. It may be of interest to say at once that the negative of Figure 5 was taken not with a lens, but with a "pinhole" (*i.e.*, made with a needle) in a thin piece of sheet copper. This sheet metal, obtainable from any metal dealer, is about the thickness of a thin visiting card. A circular piece is cut as an easy fit to the inside of the lens tube. The glass parts of the lens are unscrewed and laid aside. This disc of metal is pushed up inside the tube so as to rest against the stop or diaphragm, and the centre pierced with a No. 1 needle. The hole which passes the fattest part of this needle is about $\frac{1}{20}$-inch in diameter. In this case the hole was about 14 inches from the plate and about 2 inches from the object. Although a pinhole does not give the definition sharpness of a lens at its best for any one plane, yet the pinhole give us a certain *evenness* of soft definition which for some objects is particularly effective. In photographic parlance, the pinhole gives us great depth but poor definition. As a matter of fact this $\frac{1}{20}$-inch hole is too large for best pinhole definition at 14 inches. At this distance we should get a sharper effect with about $\frac{1}{30}$-inch hole, *i.e.*, a No. 5 needle. The reader, will of course, understand that a good modern 2-inch lens, duly stopped down to say F.44 would have given a sharper picture over a certain depth of subject, but would have brought into prominence the differences of definition of the various planes in an unpleasant way. This more or less hemispherical subject was chosen as typifying a markedly difficult case as regards depth of subject, and thus showing that at times (e.g. fossils showing *form* rather than *detail*) the homely pinhole gives a more effective rendering than the costly lens. I emphasise this point because the use of a pinhole for this class of work is practically unknown to most workers.

FIGURE 5.

FIGURE 6.

The following table shows one the best size of hole for sharpest definition at various plate distances:—

Plate Distance	6	8	10	15	20	30 inches
Diameter of Hole ...	$\frac{1}{50}$	$\frac{1}{45}$	$\frac{1}{40}$	$\frac{1}{30}$	$\frac{1}{25}$	$\frac{1}{20}$ ..
Number of Needle...	9	8	7	5	2	1

The sizes of needles of various numbers vary slightly among different makers; but the above sizes, which are those of Milward's Sharps, may be taken as generally representative.

Of course, exposures with a pinhole are much longer than with ordinary lens apertures; but, beyond the matter of patience, this is of no account with non-moving objects. Although it is wrong in theory, yet it works out all right in practice to base exposure on the F. value of the pinhole. Thus a hole $\frac{1}{40}$th inch diameter, at 10 inches from the plate, may be reckoned as F.400.

To compare this with a lens working at F.32, for instance: the squares of 32 and 400, viz., 1,024 and 160,000 are roughly 1 to 160, so that ten seconds with F.32 would be equivalent to (about) twenty-seven minutes. But as a little extra exposure is better than under exposure one would in such a case give thirty minutes. There is the further consideration with pinhole exposures, viz., that the occasional periods of vibration due to passing vehicles are usually negligibly small in comparison to the total time of exposure.

F. C. LAMBERT, M.A., F.R.P.S.

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

OPHTHALMIA ELECTRICA.—L. Bell has published recently in "The Proceedings of the American Academy" an investigation on glasses used as a protection against the injurious effect of light on the eye. Bacteria are rapidly killed by radiations of a smaller wave-length than $270 \mu\mu$ in the ultra-violet, while the ultraviolet radiations are absorbed by air considerably if less than $230 \mu\mu$, and by glass if less than $310 \mu\mu$. The symbol is an abbreviation for a micro-millimetre or one-millionth of a millimetre; thus the wave-lengths of the ultraviolet region range from about three hundred and sixty millionths to about one hundred millionths of a millimetre in length, shorter than which they are so readily absorbed that they have not yet been measured. All ordinary glasses absorb the ultraviolet rays which have cell destroying power or bactericidal effects. Common amber-coloured glass cuts off all the ultraviolet region. In contra-distinction to this a yellow filter of gelatine soaked in dimethylaniline permits some of the longer ultraviolet waves to pass, but cuts off a large portion of the visible region, and can, in conjunction with other screens, cutting off the yellow (*e.g.*, cobalt glass), be used to filter through the ultraviolet rays.

Arc lamp workers, and those that work electric furnaces, which, by the way, are in use now for preparing high grade steel from rich Norwegian ores, are rarely affected by true "ophthalmia electrica" chargeable to the ultraviolet rays, but are very often affected by the intense luminous radiation. The vitreous humour and crystalline lens of the eye is capable of absorbing most of the ultraviolet radiation, but there appears to be some particular wave-length which gets through rather easier, and is apt to cause trouble. The remedy is to wear glasses when dealing with arc lamps or quartz mercury vapour lamps; while, to prevent the injurious effect of the luminous radiations, glasses should be slightly tinted.

It is interesting to compare the transparency of quartz, uviol glass and an ordinary photographic lens to ultraviolet waves. The photographic lens does not let through waves shorter than $365 \mu\mu$, while uviol glass, a glass made in the Schott and Genossen works at Jena, allows through light of $265 \mu\mu$ and quartz even shorter waves.

SELENIUM.—This element exists in several modifications called in the language of the chemist, allotropic forms. There is a red amorphous form, a grey crystalline form and a darker, almost black, form. All these three forms, though differing in their physical properties, are one and the same chemical substance though the atoms may, perhaps, be compounded into different sized molecules in the various allotropic forms. They differ in their electrical conductivity among other physical properties. Selenium cells have been constructed which are sensitive to light; when exposed to light the electrical conductivity decreases considerably. The selenium in this sensitive state contains at least two of the allotropic forms, and the light changes one form into the other, the effect being reversible when the light stimulus ceases. Metallic selenides, in small quantity, seem to improve the sensitiveness of the selenium. Selenium cells are constructed by compounding films of selenium with mica sheets, or between wires, or the selenium may be condensed on to a cold surface, in which case it possesses very little inertia and attains its maximum or minimum conductivity very quickly and without showing inertia as in the case of ordinary fused selenium. Selenium cells have been used as receivers for wireless telephony. Rühmer succeeded in telephoning along a fluctuating light beam over ten miles. A vibrating membrane controls the beam of light and causes it to fluctuate in intensity according to the intensity of the sound vibrations. The selenium at the other station receives the beam of light and alters its conductivity according to the intensity of the light falling on it. A telephone connected to the selenium cell is thus affected according to the fluctuation and intensity of the current and of the light beam and therefore of the voice transmitted.

Röntgen rays affect selenium just as light does—yellow light is most active. Some years back I made a few experiments on this point hoping to get a very marked effect with Röntgen rays owing to their penetration throughout the mass of the selenium. The change in conductivity is considerable, but no comparisons were made of the energy in the Röntgen beam with that in a light beam producing equal change in conductivity, and so the results were only of small value. The idea was to try other allotropic substances—such as tin, to see if they were influenced throughout their mass, by X rays, whether they would possess similar properties to selenium.

Another substance of considerable interest as regards electrical conductivity is silver sulphide which, as Faraday suggested, possesses a negative coefficient of resistance, *i.e.*, its resistance decreases as the temperature rises. When first heated the resistance decreases rapidly; but as it cools, though it does not return to its original high resistance, yet the resistance is greater than when hot; after considerable heating and cooling the resistance does not alter much on further subjection to change of temperature. The author, H. V. Hayes, of recent work on this peculiar substance, seems to infer that the temperature coefficient of resistance of silver sulphide is not really negative, but that the apparent effect is due to imperfect contact at the junction of the leading-in wires and the silver sulphide.

RADIATIONS FROM LATEX OF *EUPHORBIA PEPLUS*.—Chapman and Petrie find that the latex of this Australian spurge possesses the property of affecting photographic plates through paper, or even through aluminium foil. The latex seems to give off a penetrating radiation which must be comparable in intensity with the radiation emitted by uranium or thorium. It has been found that many substances affect the photographic plate, the effect in some cases being due, perhaps, to hydrogen peroxide; in other cases, and more commonly, to the production of ions in the neighbourhood of the substance, either by radiations from the substance or by a chemical change induced by moisture or other causes on the substance. It has been found to be quite difficult to obtain a paint to inscribe the numbers on the black paper in which films are rolled owing to this phenomenon. This particular latex, however, seems to possess the property to a remarkable extent.

RADIATIONS.—When describing in one of our recent issues the instrument by means of which Professor Wood was able to isolate ultra-violet waves free from visible rays, I mentioned that it was also a convenient method of isolating long heat waves. Professor Rubens has been able by means of such a quartz lens apparatus to isolate waves one-third of a millimetre in length from [illegible] ons emitted by an intense mercury vapour l[illegible] [illegible]ible rays at the extreme red end of the sp[illegible] [illegible] less than $\frac{1}{1000}$ of a millimetre in wave-length. [illegible] electro-magnetic waves of only a few millimet[illegible] [illegible] been produced by Fessenden and others. Th[illegible] range of ether vibrations has thus been nearly [illegible] [illegible]rimentally. It appears quartz is extremely transp[illegible] [illegible] long heat radiations. Diamond, selenium, and [illegible] and vulcanite are fairly transparent, much more so th[illegible] one-tenth of a millimetre waves, which can be isolated [illegible] [illegible] mantle radiations. Such invisible radiations ar[illegible] [illegible] by means of a bolometer or radiomicrometer. The [illegible] a small black very thin strip of platinum or silvered pl[illegible], which alters its resistance when radiations are absorbed by it; two such strips of equal resistance are placed close to each other and an electric current is made to pass down each strip—their resistance being the same, the current in each branch will be the same; if the resistance of one be altered, then the current in one strip is greater than in the other, and so an effect is produced on a galvanometer connecting the two branches of the circuit containing the two strips. The radiomicrometer is an exceedingly delicate thermopile. When a junction of cadmium-antimony and bismuth-antimony is heated an electromotive force is set up which tends to drive a current down a wire connected to the two. In the radiomicrometer, a silver strip is situated between such a junction and the two ends of a silver wire are connected to the two alloys and the wire is looped so as to hang vertically from a quartz fibre inside a copper tube between the poles of a permanent magnet. When the radiations, say of a candle placed 10 metres away, fall on the blackened strip of silver, a current passes down the loop, and the magnetic action is such as to turn the coil, which motion is registered by a spot of light moving over a scale.

Langley, by means of the bolometer, mapped the infra red spectrum of the sun to nearly a wave-length of $\frac{1}{200}$ millimetre, but below this the radiations are absorbed by the atmosphere. He was also able to estimate from an examination of the moon's radiation that the temperature on its surface was less than 0 C. Sir William Abney succeeded in photographing, the shorter infra-red rays. Bathed plates, to photograph objects in infra-red light, can now be bought commercially, but they do not record a wave-length of more than $\frac{1}{1000}$ millimetre. Such plates are bathed in dyes (Alizarin blue, Nigrosin, diazo black, cyanin, and so on) which absorb red rays. The energy of these rays go to change the constitution of the sensitive emulsion, and a photographic record is the result. Now Abney conceived the idea of making silver bromide absorb red light instead of blue light as is usually the case: he succeeded in obtaining an emulsion of silver bromide which transmitted blue light and absorbed red, and the plates he thus made he employed to photograph waves of even $\frac{1}{500}$ millimetre. P. V. Bevan has recently investigated the absorption and dispersion of light by alkalimetals—that is, by potassium, rubidium, lithium, caesium and sodium. The measurements are somewhat difficult to carry out with such metals owing to the fact that they attack most materials with which they come in contact. Lithium vapour even attacks steel tubes. It appears from this work that different specialised atoms are absorbing different spectral lines, so that a certain percentage of atoms in the vapour may be employed in absorbing one particular wave-length of the incident light, while another is absorbing another wave-length. This idea is distinct from the idea that within each atom the electronic arrangement is such that certain groups of electrons are responsible for the absorption of the various incident radiations. An electric current passed through such vapours of metals under diminished pressure gives rise to a variety of spectra akin to flame, arc and spark spectra according to the electric conditions. The luminosity of the vapour of sodium will mask the spectrum of helium when present in such tubes. The masking effect of the spectrum of one substance on that of another is a matter of great interest.

The salts of potassium are radio-active; they emit a penetrating radiation, which appear to be of corpuscular nature like part of the radiation (β rays) from radium.

Rubidium likewise emits a less penetrating radiation, but caesium, which is so akin to rubidium chemically, does not appear to do so, unless such particles are moving too slowly to be detected.

Radio-activity has now developed to such an extent that the knowledge of its processes leads it now to be applied to the elucidation of many problems of a less specialised character. Professor Rutherford has recently thrown much light on the structure of the atom, by a theoretical investigation of the action of the α and β particles penetrating an atom, while his theoretical deductions are well backed up by the experiments of Geiger and Marsden and Crowther. Mr. Marsden is likely to give to readers of "KNOWLEDGE" an account of this work, and I will therefore only indicate the nature of Rutherford's theory. He starts by assuming the atom to consist of a central nucleus with a charge equal to the number of electrons multiplied by the charge on each ($4 \cdot 65 \times 10^{-10}$ electrostatic units), while there is an outer shell carrying an equal and opposite charge. He investigates what would happen if an α particle (a positively charged atom of helium) emitted, say from Radium C, were to penetrate such an atom, and what the chance would be for a large deflection of such a particle. He finds that when the α particle penetrates very close to the central nucleus, its deflection will be very large and it may be deflected 150° or so, back towards the direction in which it came. It appears from experiments on the percentage of particles deflected at various angles, or measured by the number of scintillations occurring in unit time on a zinc sulphide screen placed to receive them, that the number of large deflections is greater than would be given by an atom of such a character that the large deflections would be made up of a number of smaller deflections. This effect no doubt does occur to some extent, and especially with the lighter β particles, which, although moving more rapidly, do not possess so great energy as the α particles. Professor Rutherford's theory of the central condensed charge in the atom explains well the experiments on the diffuse reflexions of α particles, on the variation in the percentage deflection at different angles with the atomic weight of the reflecting atoms, on the average scattering of the rays produced in penetrating thin plates of various metals, and on the scattering of β rays of different velocities by atoms of different weight. The outer charge of the atom is probably that of a number of electrons moving as satellites to the central charge. This idea is similar to the theoretical idea of the atom worked out by Nagaoka, which was something of the nature of a minute planet Saturn. It is likely that this scintillation work will give much information on the structure of the atom. The problem is akin to that which would present itself to a philosopher living outside the solar system, and who wished to investigate the structure of it by the orbit and perturbations of a comet passing through the system. But in our case the comet or α particle is more under control.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A.

THE LIVING EARTH.—It has been shown by Drs. Russell and Hutchinson, of the Rothamsted laboratory, that soils heated or treated with certain volatile antiseptics, and brought again under conditions favourable to plant growth, show a great increase in fertility. The soil bacteria are first reduced in numbers and then they increase enormously. To this increase is due an increase in the production of ammonia in the soil, and to this the greater fertility. But why should the decrease of bacteria be followed by their great increase?

To explain this it has been suggested by the authors named that the treatment with volatile antiseptics kills off the protozoa of the soil, some of which feed on bacteria, and thus limit their increase. The protozoa are more susceptible than the bacteria to the sterilising agents. When they are killed off the bacteria multiply without this check. But our knowledge of the protozoa of the soil is somewhat scanty and vague.

We welcome therefore a recent investigation by Mr. T. Goodey, in which he names about thirty protozoa found in cultures of soil. Eighteen of these are ciliated infusorians, and in regard to these Mr. Goodey comes to the interesting and important conclusion that they exist in the soil in an encysted, not in an active state. "In consequence, they cannot function as the factor limiting bacterial activity in the soil."

HOW LONG DO WHITE MICE CARRY THEIR YOUNG?—One would have thought that a simple question of this sort admitted of ready answer. The usual statement is that the period of gestation is twenty-one days, the same as the period of a chick's development. But J. Frank Daniel reports that there is great variability in the duration of the period—in different mice and in the same mouse. For non-suckling mothers a definite gestation period of practically twenty days may be stated; and this holds true irrespective of the size of the litter. But for suckling mothers there is great variability, from a minimum of twenty-two days to a maximum of thirty days. And it seems that the period of gestation in suckling mothers varies directly with the number of young suckled. The "how" of this relation, if it is a well-established relation, remains uncertain.

BITE OF HELODERMA.—The virulence of the venom of the Gila Monster, the poisonous lizard of Mexico and Arizona, has been often proved in the case of small animals, but we have little precise knowledge of the effect of the poison on man. This gap has been filled by the careful observations of Mlle. Marie Phisalix, who was accidentally bitten while examining the lizard's mouth. She describes the intense pain, the swelling, the profuse perspiration, the giddiness, and other disagreeable results of the bite. Even after a week the fatigue, the giddiness, and the local pain had not disappeared, but no serious consequences ensued.

SLOWING DEVELOPMENT OF HERRINGS' EGGS.—One of the methods suggested in order to secure the introduction of the herring into New Zealand waters is that of lengthening out the period of embryonic development, so that transportation of the eggs may perhaps be effected before hatching occurs. Dr. H. Charles Williamson was able some time ago to lengthen out the period of embryonic development to fifty days. He did this by lowering the temperature, which probably makes the formation of nuclein-compounds slower, and therefore retards cell-division. His further endeavours to extend the period have not been successful. Lowering the temperature still further slows the development so much that it is very apt to stop altogether.

THE HIBERNATING SNAIL.—It is interesting to connect the internal and external periodicities, and there is a great deal of interesting work to be done in comparing the details of organic structure at different times of year. Taking the common *Helix pomatia*, Spiro has recently shown that the granules and drops of fat which are abundant in the summer in the cylindrical cells lining the alimentary canal are all gone in winter; that the nuclei of these cells become poorer in chromatin; that the cilia which all the cylindrical cells have are lost. There is another kind of cell in the lining membrane, vase-like in shape, which secretes mucus in summer during digestion, but, of course, ceases to do so when hibernation sets in. We thus get the impression of the depth of the organism's reaction to the seasons. It is also very interesting to find that the whole lining of the alimentary canal is renewed in spring before the nutritive period of the year re-commences.

HABITS OF SCUTIGERA.—J. Künckel d'Herculais has been studying the well-known long-legged centipede called *Scutigera coleoptrata* which is common in houses. It is famous for the disproportionately long limbs, fifteen pairs in all, for its compound eyes, and for many other peculiarities, but what Künckel d'Herculais calls attention to is its activity as a fly-catcher. During the day it lies quiet in crevices about the doors and windows and flooring. At night it goes on the hunt and kills large numbers of flies, e.g., *Fannia scalaris*. It throws itself upon the fly, enwraps it in its posterior limbs, and injects the instantaneously paralysing venom from the forceps. It sometimes kills three or four without stopping to eat. The dead bodies are masticated, but only the soft parts are ingested.

ASSOCIATIONS.—Professor Charles Chilton, of Canterbury College, New Zealand, has recently described some interesting examples of what he calls "commensalism,"—a term which should, we think, be restricted to cases of mutually beneficial external partnership. One of these cases is that of a crab (*Paramithrax longipes*), which seems to be almost invariably accompanied by specimens of *Balanus decorus* growing on its carapace, the cirripedes being in some cases so large and numerous that they exceed in size the body of the crab itself. Here we have to deal with an "epizoic association," probably quite unimportant in its initial stages, but gradually, as the cirripedes grew, becoming inimical to the welfare of the bearer.

The second case is that of a hermit-crab (*Eupagurus stewarti*), which has a straight abdomen, and inhabits tubes formed by a *Millepora*, or, in other cases, "a massive calcareous Polyzoön, which is very much larger than the crab, so much so that it seems doubtful if the crab can drag its large, solid dwelling-place about with it." Professor Benham has suggested that the cylindrical cavity inhabited by the crab may be due to the decay of a branch of seaweed around which the Millepore or the Polyzoön grew.

Some of the associations that have been reported from time to time are very remarkable, and Professor Chilton refers to Dr. Alcock's description of the intimate commensalism between an Indian Ocean hermit-crab, (*Paguristes typica*), and a sea-anemone of the genus *Mamillifera*. The sea-anemone settles on the hinder part of the young hermit-crab's tail, and the two animals grow up together in such a way that the spreading anemones "form a blanket which the hermit-crab can either draw completely forward over its head or throw half back as it pleases."

BEE DISEASE.—We notice that Dr. H. B. Fantham and Dr. Annie Porter have found bees and combs, from Cambridgeshire and Hertfordshire, infected with the Microsporidian (*Nosema apis*) which was found by Zander in Bavarian bees. This parasitic Protozoön belongs to the same genus as the organism which causes pébrine or silkworm disease, and the authors think that it has been responsible for a good deal of the "bee disease" of recent years. It causes a sort of dry dysentery. Infection occurs by means of spores, as was experimentally proved. Unluckily, the only certain destructive agent is fire. It must be noted that according to Dr. Malden there is also a bacillary infection in bees, the parasite being called *Bacillus pestiformis apis*.

A TELL-TALE CARTILAGE.—In the inner upper corner of our eye there is a minute half-moon-shaped fold, the *Plica semilunaris*, an item in that museum of relics of past history which we carry about with us in our body. For it corresponds to the third eyelid (in whole or in part) which is well-developed in most mammals and helps to clean the eye. It is vestigial not only in Man, but in Monkeys and in Cetaceans. Its practical absence in the Cetaceans is compensated for by the continuous washing of the eye with water, and in the other cases to some extent by the frequent movements of the upper eyelid. It seems to be a very old structure, this third eyelid, for it is the "nictitating membrane" that is drawn across the eye of birds, and it is also represented in most Reptiles. What prompted these remarks, however, was not the *Plica semilunaris* itself, but a minute cartilage which it sometimes includes even in Man. This is a great rarity in white races, occurring in less than one per cent. Giacomini found it in four cases out of five hundred and forty-eight whites. But he found it twelve times in sixteen coloured people, and Adachi found it five times in twenty-five Japanese. Dr. Paul Bartels has recently examined twenty-five South African natives (eight Hereros and seventeen Hottentots) and has found the cartilage in twelve. Now as the cartilage is found in all Apes and Monkeys it seems fair to say that, so far as the cartilage of the third eyelid vestige goes, some races are more theromorphic than others,—more conservative of their historical relics.

YEASTS OF INSECTS.—We are continually impressed with the inter-relatedness of organisms in the web of life, and an interesting fresh case has been recently reported by Dr. Karel Sulc. He has been studying accumulations of reserve material which occur in Aphides, Scale-insects, Coccids, and related insects, and finds circumstantial evidence of a wide-spread symbiosis between the insects and various specific yeasts of the Saccharomyces type, which seem to work out changes in the stores within the body.

SENSE OF DIRECTION IN THE BLIND.—It is well known that most blind people become aware when they are approaching an object or even when an object is very quietly brought near them. There has been a great deal of speculation and not a little experimenting concerning this sense, which has received many names—sense of obstacles, facial perception, sense of direction, feeling at a distance, and so on. The accounts that the blind themselves give of their perception are very contradictory. Some investigators have regarded the sense as a fine facial touch-sense, others as due to heat-waves, others as sensitiveness to changes of pressure in the air, others as auditory. Recent experiments of an ingenious kind made at the Institution for the Blind in Paris, have led M. Truschel to the conclusion that the perception is of an auditory nature and due to the fact that the object reflects and alters surrounding sounds. To the objection that a deaf-mute has been reported as showing the power, he answers that those deaf to music and speech are often sensitive to very feeble noises.

LOADING BRICKS BY GRAVITY.

By FRANK C. PERKINS.

By using ball-bearing rollers the force of gravity may be utilized for conveying bricks a long distance for loading on cars as shown in the accompanying illustration (Figure 1). No hand labour whatever is required, and no power is utilized with this carrier system, which takes advantage of gravity to do the work. The bricks are simply placed on the carrier within the kiln and they are started on their way to the car, where they are loaded by another operator and placed in position for shipment. The friction is so small on the ball bearings of the rollers that only a very slight incline is necessary on the conveyor system to automatically carry the bricks long distances, and the various sections of the conveyor may be shifted as desired, the material to be loaded taking single and double curves when necessary without difficulty.

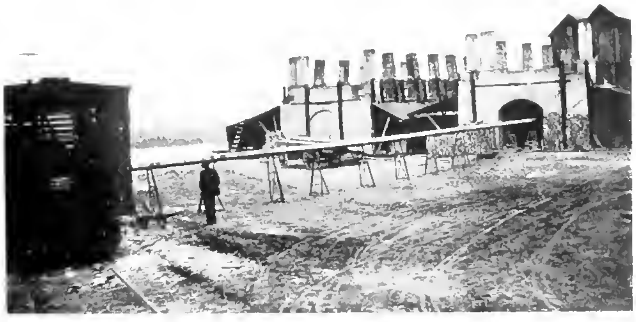


Figure 1.

SOLAR DISTURBANCES DURING SEPTEMBER, 1911.

By FRANK C. DENNETT.

During September the Sun's disc appeared to be without disturbance, bright or dark, on the 13th, 15th to 20th, 25th and 30th. All disturbances after the 10th were faculic only. The longitude of the central meridian on September 1st was 325° 45'.

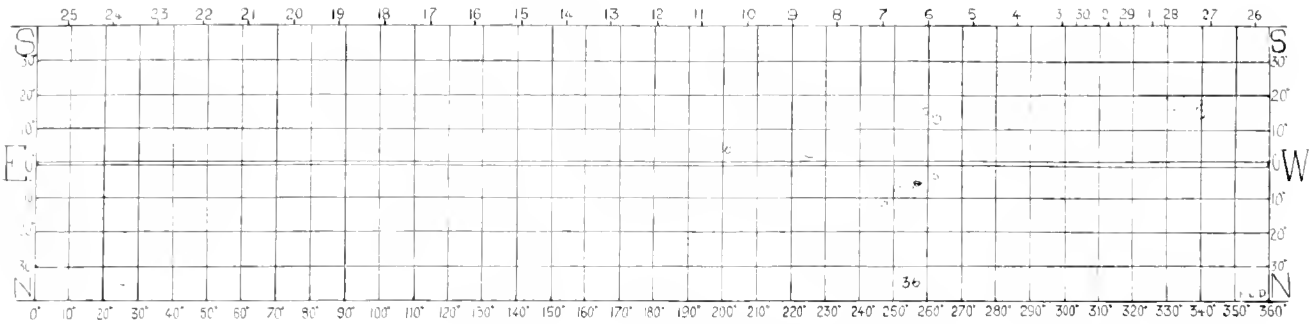
No. 36. The only spot disturbance during the month. It was first seen as a moderate spot, about eleven thousand miles across, with a bright bridge over its umbra, on September the 1st, and a trail of spotlets extending towards the North-East. The bridge over the umbra was an interesting object until the 6th, and on the 5th it showed complicated detail, and was double in a part of its length. On this date the spot seems to have attained its greatest area—fifteen thousand miles by eleven thousand miles. From the 1st until the 7th, the inner edge of the penumbra appeared to be fringed more brightly, and on the 7th and 8th, the bright photospheric substance broke through the penumbra on the southern side. On the 10th, the place of the spot was marked by three closely packed umbrae which had disappeared by next day, the site being marked by faculae seen also on the 12th. On the 2nd the three more distant spotlets had broken into one with a long umbra, which again broke up very quickly. The pores were subject to rapid change. On the 4th, 6th and 7th, a little pilot pore was evident just west of the leader, and on the 6th and 8th, pores showed a little towards the south. The maximum length was fifty-six thousand miles. On the 2nd a faculic knot showed just ahead of the group in which pores appeared to be developing, but it disappeared again. The group sometimes presented a very interesting appearance in the spectroscope. On the 1st the H_a line showed displacements both on the red and violet sides, with dull reversals, whilst the D_3 line of helium was seen dark. Next day the distortion was less, but small dark hydrogen flocculi were visible around, as well as small projected prominences. On the 5th a pale prominence in the rear of the leader was visible, and also small dark hydrogen flocculi, with the helium line showing dusky.

The dotted areas in the diagram show the position of faculic disturbances. Faculae were seen on the 1st and 2nd near longitude 256°, N. latitude 50°, and 26°, N. 33°. On the 1st, 2nd and 12th near 260°, S. 13°. On the 4th and 5th, at 225°, S. 3°; another at 215°, S. 15°, on 4th, with another at 202°, S. 4°, on 5th and 6th. The group at 320°—340°, S. 13°—20° were visible September 22nd to 24th.

Notwithstanding the fewness of disturbances visually seen upon the disc, there are still a fair number of prominences around the limb. On the 24th there were a number of eruptions recorded showing that the chromosphere was in a very active condition.

The Chart is constructed from the observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and F. C. Dennett.

DAY OF SEPTEMBER, 1911.



NOTICES.

MUSEUM WORK.—Particulars of a vacancy for a pupil (who will be paid a small salary) in a museum, can be obtained on application to the Editors of "KNOWLEDGE," at 42, Bloomsbury Square, London, W.C.

CHEMICAL APPARATUS. We have received from Messrs. Gallenkamp and Company, Limited, Part I of their catalogue of General Chemical Apparatus and Laboratory Accessories for the Session 1911-12. It measures seven by eleven inches and consists of more than eight hundred pages. Messrs. Gallenkamp claim to have the most varied stock in England, and their price list is certainly excellent evidence in favour of this contention.

HORTICULTURAL BOOKS. Messrs. John Weldon & Company's Catalogue of Gardening Books and Papers, which has just reached us, contains no less than one thousand and eighty-five items and should prove exceedingly interesting to all who are occupied in the art which we are told "doth mend nature."

A Gibraltar Ape.

BARBARY APES AT GIBRALTAR. In *The Selborne Magazine* for November, Mr. G. B. Hony gives the following account of the Apes of Gibraltar. He says: "At the present time there are only eleven apes on the rock, eight females and three males. Of these only three are of the original Gibraltar stock. The remainder have been imported from various parts of Africa, and there are altogether specimens of four distinct races. They have not bred on the rock for years, but fresh stock having been imported, it is hoped that there will soon be some 'home-bred' ones. The first time I saw them there were six together; they were very shy, and my repeated efforts to get photographs failed." Afterwards Mr. Hony succeeded, and one of his pictures is here reproduced.

Knowledge.

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

A Monthly Record of Science.

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

DECEMBER, 1911.

THE NEW ASTRONOMY.

IV.—THE GALAXY AND AN IMMORTAL COSMOS.

By PROFESSOR A. W. BICKERTON.

THE more we study the stars, the more we are impressed with the fact that the stellar system is not a chance distribution, but on the contrary, that almost the entire content of the celestial vault that we can see, whether it be nebulae or stars, is a single organized system and has a definite boundary.

White, planetary and diffused nebulae; star clusters; temporary, variable and double stars, each and all occupy definite positions, every one of which offers striking evidence of a system of evolution as consistently simple as it is conclusively demonstrated.

Taken roughly as a whole, the Galactic Universe consists of a belt of stars, containing lateral streams, dense aggregations in parts, and equally striking defects of illumination in other parts. This rough ring or belt is possibly of a double spiral character: this opinion is very firmly held by Professor See and a number of other able astronomers. This belt of stars, which varies from some ten to twenty degrees in width, is almost exactly bisected by a great circle of the heavens. Leaving the margins of this stellar belt, we come upon two belts of the celestial sphere that are somewhat sparsely inhabited. Then, as we approach the two poles, we meet with an increasing number of nebulae. These seem to have their maximum density in both hemispheres in a position approximately that of the poles of the great circle of the Galaxy. (See Figure 1.) It is well to look upon this great circle as the equatorial plane of the Sidereal Universe. A vast number of these nebulae are, as described in our last article, of a double spiral character. They are, as a rule, what are called White Nebulae, that give continuous spectra, suggesting that they are dust swarms. There are comparatively few stars in the polar regions of the heavens. Stars are mostly confined to the equatorial belt, and it is in this same belt that we find nearly all the gaseous nebulae of the heavens. These vast masses of diffused gas are of two kinds, the one the planetary nebulae, already described. Usually, although very rare, these are extremely definite. The other class of gaseous nebulae, such as the great nebula in Orion (see Figure 4), is of extreme irregularity, usually quite devoid of any symmetry of form, yet exhibiting marked structure that often seems to suggest drifting motion. In this same Milky Way belt, in addition to gaseous nebulae, are to be found most of the beautiful star clusters. Nearly all the temporary stars have blazed out in this belt, and it is in this same belt that we find most of the variable, or wonder stars, most of the telescopic double stars, and spectroscopic binaries, and here also, although somewhat singularly situated, we find the Wolf-Rayet stars. But very few White Nebulae are found in the belt of the Milky Way. (See Figure 2.)

Independent Sidereal Systems.

In addition to all that has been described, that seem to be parts of one consistent whole, we have other systems which it is not certain belong to our Galactic Universe at all. It is the opinion of Sir

David Gill that the great nebula of Andromeda (see Frontispiece) is a distant Sidereal system not unlike the Galactic system. This opinion of Sir David Gill is shared by other astronomers, who believe that in this beautiful oval patch of light we are looking upon an orderly system of millions of suns. From the brilliant centre it possesses it is probably in an earlier stage of evolution than is our own Sidereal Universe.

The exquisite photographs of the Magellanic Clouds suggest that each of these two gigantic systems is an independent double-spiral Sidereal universe, for spread through each of them we have star clusters, double, and wonder stars, just as in the belt of the Milky Way. Their appearance suggests that they are not much more distant than some parts of the Milky Way itself. Hence, they may at one time have been subsidiary parts of our great Stellar system. The Pleiades also seem to be somewhat independent in character, both from their position as well as their appearance, as shown in Figure 3. There are other minor systems that also suggest independence. Every star in the entire heavens seems to be moving. The name Proper Motion is given to this independent travel of the stars. It seems to have a mean value of something less than twenty miles a second, but some of the stars rise to speeds of some hundreds of miles a second: "runaway stars" these are sometimes called.

The motion of the stars is not indiscriminate: most of the stars appear to be moving in two stately processions in opposite directions. The distances they are apart are so enormous as to suggest that they do not often collide, but impact is undoubtedly a law of nature, and a surprising number of agencies have already been found that, in spite of the enormous distance of the stars from one another, must tend to produce impact. In addition to these two stately streams a number of minor drifts occur. This, then, is roughly the character of our Sidereal Universe. It will now be our task to attempt to show the mode of its origin. I speak of it as an attempt, but it is more of the character of an induction that has been demonstrated to be true by the fulfilment of endless anticipations based on dynamical deductions. The able mathematician Gifford says: "It has many of its predictions verified by subsequent discoveries in a manner as striking even as the fulfilment of the predictions of Mendelieff, based on the periodic law."

The Origin of the Galactic Universe.

The character of the Milky Way, as seen in the Southern Hemisphere, is much more suggestive of the mode of its origin than the portion we can see here in England. A centrifugal tendency is most strikingly exhibited. Lateral streamers seem to travel away from the main drift, suggesting the sprays of splashes left by a twirling mop.

It was in the Southern Hemisphere that, probably for this reason, some thirty-two years ago, a study of a beautifully clear sky suggested that the Milky Way was the result of the whirling coalescence of two previously existing independent cosmic systems. A careful study of Proctor's book on "The Universe" aided by Sidney Walter's exquisitely coloured charts of the two hemispheres, quickly convinced me that the induction was right; and every discovery made by astronomers since that time has tended to strengthen the conviction, and nothing more strikingly than the concluding remarks of Professor Kapteyn, before the Dutch Science Congress, on the Cosmic Cycle, which are quoted in the last section of this article.

The Dynamics of Coalescing Cosmic Systems.

Let us try and imagine the dynamical conditions that could bring about a configuration and distribution of material similar to the contrasted system that forms the Galactic Universe.

Later on in this article, the mode of formation of primordial cosmic systems will be described. It is deduced that they must consist chiefly of the lighter elements, taken by the high kinetol of the atoms out of cosmic systems. Through this primordial matter denser material is somewhat sparsely distributed. We have already seen there is a continuous tendency during the whole existence of Sidereal systems for light elements to be expelled. The many different processes are debated in the article of the September number of *Harper's Magazine*, "On the Cycle of the Eternal Heavens." They are also discussed in some fulness in the "Birth of Worlds and Systems," Harper's Library of Living Thought. Hence decadent cosmic systems tend to consist of compact suns, chiefly of heavy elements. Many of these bodies are dark stars, commonly known as dead suns. Thus we have two classes of cosmic systems, the incipient ones, consisting chiefly of light gas, and the decadent, consisting largely of compact masses of heavy elements.

Imagine two such systems to have come within the sphere of one another's attractions. Lateral attractions would prevent the encounter being quite centre to centre. Thus it is a case of whirling coalescence. As the two systems close in, the one upon the other, an immense friction ensues. The mutual attraction of the advancing suns, aided by this resistance, would cause collisions: a vast central furnace would thus grow up. The field of collision must for ages have gone on increasing both in density and dimensions. The furnace is walled around by the advancing material in all directions in the plane of impact. Presently, as temperature and density increase, the pressure becomes enormous. This explosive matter can find no relief in the plane of impact, for, as already shown, the material of the two vast systems is crowding in all around it and walling it in. But axially there is a chance of escape. The material is ejected towards both poles, and this action goes on increasing in intensity for ages, as the vast masses of the two systems continue to crowd in upon one another. In my early paper the name "axial extrusion" was given to this dynamical action.

as we have said, n... t ... Sir David Gill, is a system of similar ... Way.

It should be unders... the case of whirling coalescence th... the third

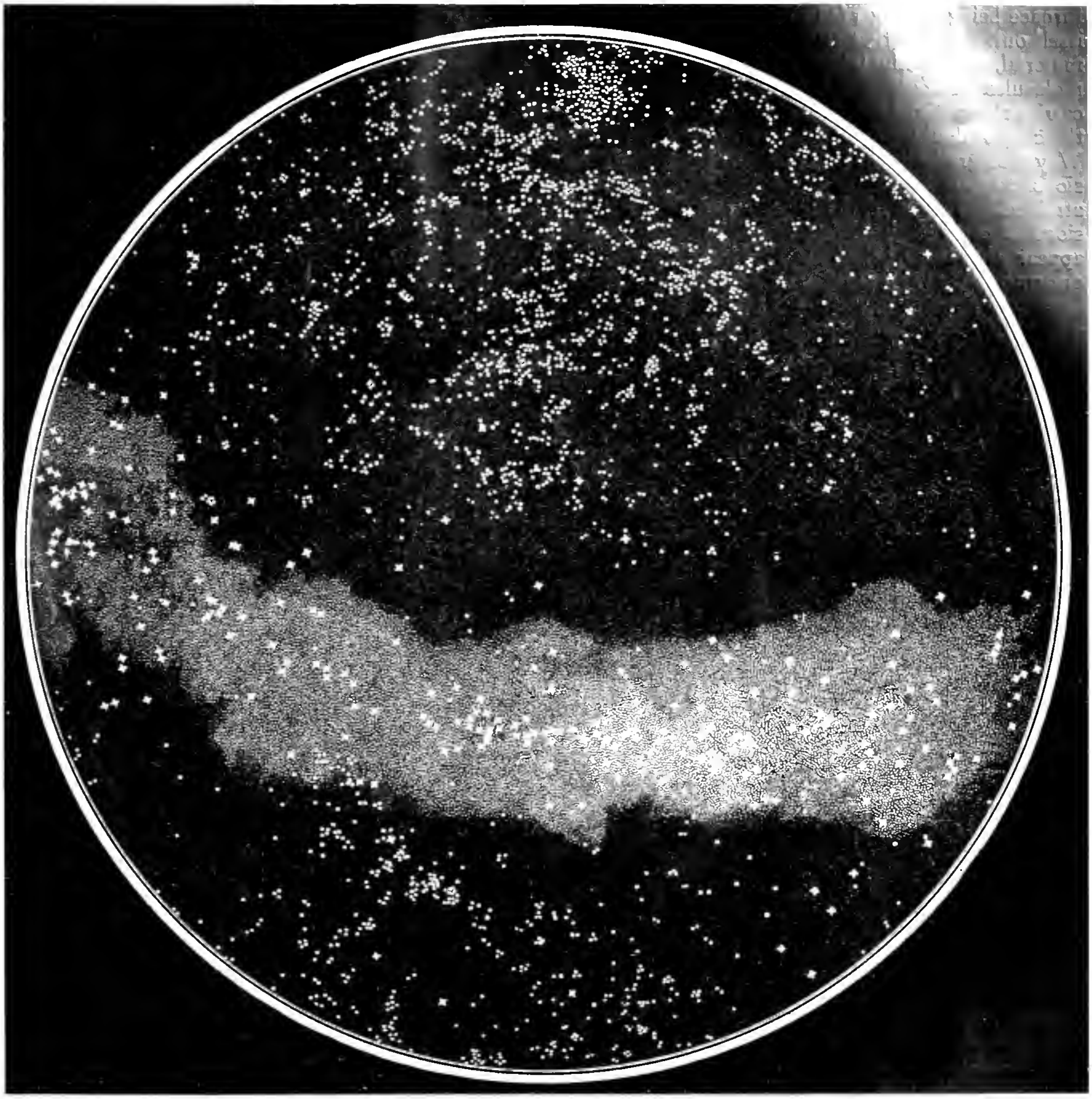


FIGURE 1.

The White Nebulæ, largely double spiral, and Clusters in the Northern Hemisphere, plotted on equal surface projection by Mr Sidney Walters, from Sir John Herschel's catalogue. The Nebulæ are represented by dots, the Star Clusters by crosses. In this same belt are temporary, variable, double, and Wolf-Rayet stars. This belt is the Milky Way, it contains the bulk of ordinary stars. Identically the same general distribution exists in the Southern Hemisphere.

Presently such an enormous quantity of material has been expelled that the capturing power of the third body diminishes. Selective molecular escape expels still more material, and the great central furnace begins to burn itself out. This seems to be the state of the great Nebula of Andromeda, which,

body formed by the two coalescing portions. It possesses the thermodynamic intensity, and possesses also the capturing power. When axial extrusion occurs it may be pointed out that the capturing power diminishes, as it does in the formation of the orbits of a double star.

Presently the capturing power of the third body lessens so much that the central attraction almost ceases, and the walling-in material is now urged forward by its own onward velocity. The onward motion takes it away from the centre, and the great furnace being no longer fed will soon have quite burnt itself out. Notice that after pressure ceases to expel material, atomic kinetol will continue to carry away molecules of low weight. This tangential motion carries the material forward in the mode described in the case of double spiral nebulae. The great Milky Way thus gradually spreads itself to the vast dimensions to which it has attained. The dimensions of cosmic systems appear always to be of enormous areas, and consequently the great central furnace would probably occupy but a small ratio of the whole. The two vast systems would be proceeding onward, in opposite directions, outside of the sphere of central influence, and it is this continued original motion that gives us the two majestic streams of stars whose existence has been demonstrated by a number of independent workers.

It is probable that every body and system in the universe possesses more or less rotation, and the old cosmic system that, by interpenetrating the primordial, went to the making up of our virile universe, most probably had a rotation of its own: this rotation would continue even during the impact, and it is almost certainly a continuance of this motion that is seen in those great streams of stars that called my attention to the probable origin of the Galactic Universe. There is one very definite principle of impact. It is that all motion developed during the collision tends to regularity, and all previously existing motions tend to disturb this order.

Figure 2.

Diagram—oblique view—of the constitution of the Galactic System. It is made up of three parts:—

I A vast double spiral ring of stars In this belt the dots represent the star clusters, the temporary, variable, double, and Wolf-Rayet stars and planetary nebulae, these last being gaseous The vast irregular nebulae such as that of Orion are also here

II and III The two polar caps of the same System, mainly composed of White Nebulae with, as a rule, continuous spectra These are largely double spirals, as shown in the diagram

Summary.

This, then, appears to be the mode of origin of the Sidereal Universe. Two cosmic systems of vast dimensions, one primordial and the other mature or decaying, approached one another, drawn together by mutual attraction. They obliquely interpenetrated one another and produced a vast central furnace, from which were expelled the extensive caps of nebulae that now clothe the two polar regions of our sidereal system. This axial extrusion, and selective escape, caused the central furnace to burn itself out; the released centrifugal force carried the walling-in material, stars and so on, to vast distances in space, and formed the Milky Way. In this Milky Way the opposite procession of the two streams of stars, aided by attraction and other agencies, caused collisions of dead and vivid suns, and these collisions produced, as already described, temporary, variable, double, and Wolf-Rayet stars, planetary nebulae and star clusters. The whole of these bodies represent the wreckage of colliding suns, and are all found wherever stars crowd and probably collide. Because these impacts possess such a wonderful building power this theory of impact is sometimes called "the principle of constructive collision."

The above sketch shows how remarkably the actual facts of the order of distribution of the Universe correspond with the dynamical deduction made so many years ago. It must be remembered that the most strikingly confirmatory facts are discoveries made many years after the deductions were worked out. Some of the more convincing and sensational of these will be better understood when we have studied the agencies that show the possibilities of an Immortal Cosmos, agencies that Lord Kelvin overlooked when he, in founding his doctrine of dissipation of energy, looked upon this principle of degradation and death as applicable to the Cosmic Whole.

An Immortal Cosmos.

Dissipation of Energy.

On this Earth, and apparently in the Solar system, there seems no possibility of perpetual motion. Coal burns, steam is produced, electricity is generated, cars travel, rooms are warmed, and light appears. But as the outcome of it all, low temperature heat is almost entirely the final result. To get energy out of heat, there must be what is called a refrigerator, in order that this fall of temperature may partly be converted into motion of mass. This motion of mass will do work, and the work changes the motion of mass into motion of molecule, and this into the vibration of the trembling ether. So again the volume of the Sun diminishes and the pressure is increased. The fall of the molecules towards the centre makes them move faster and so the general temperature of the Sun is increased. But vast quantities of this augmented heat are poured out in a ceaseless flow of radiation, some of which falls upon the planets to be radiated again into space, but most of it speeds outwards in all directions in an apparent prodigality of waste that philosophically appears to be surprising. It is the general idea that this falls partly upon the dust of space and is partly sent to almost infinitely distant regions. We get from all these ideas Lord Kelvin's theory of dissipated energy, which the Germans call "warm death."

AGGREGATION OF MATTER.

On the other hand matter tends to aggregate. Suns are of all ages, incipient, young, mature, aged, and dead. A pair of dead suns in coming into complete collision become vivid again, and their luminosity may last a hundred million years, but this period is a mere breath in eternity. They again die, and may again live by another collision. Is this rolling up to go on until the entire contents of the great celestial vault is one huge dead cinder?

From a photograph FIGURE 3. *by Isaac Roberts.*

Nebulae in the Pleiades, December 8th, 1888.

Yerkes Observatory FIGURE 4. *October 19th, 1901.*

Great Nebula in Orion.

all the matter of the Universe collected into one lifeless globe, and all the energy of the Universe dispersed into endless space? Such was the opinion firmly held some fifty years ago, and it continued to be held for fully a quarter of a century. Then chinks began to appear in the walls of this dismal dungeon of thought, and a little light has entered. Although official science still refuses to use this hopeful light, average humanity never quite entered the dungeon, and many minds now stand in the full light of the optimistic thought of a scheme of creation, infinite, eternal and flawless.

TWO NEW AGENCIES.

We have to ask: Are there agencies that in addition to concentrating matter, can distribute it: in addition to degrading energy, can elevate it. Certainly there appear to be such agencies. The collisions of suns can scarcely ever be directly centre to centre; every law of cosmic motion tends to make the orbits of colliding suns into curves, and no pair of bodies that are moving in independent orbits can possibly collide directly centre to centre. Hence oblique impact must be the cosmic law. These grazing impacts have already been shown to take place with such stupendous speed that the partial impact cannot stop the stars. A third body is produced. If the graze be of a small ratio, this third body will form an independent star of such supreme power, so stupendously hot, as to be thermodynamically unstable, and to blow itself to isolated atoms. When the temperature of the mass becomes approximately uniform the kinetol of the light elements becomes so excessive that they escape not merely the new star, but the influence of the three stars. A high-velocity atom escapes the very cosmic system of which it is a part, and wanders away to the empty parts of space. All the while it is doing work against the gravitation of the cosmic system it is escaping from, and it will linger in the portions of space where there is a minimum of matter. Thus is matter distributed. Sometimes again three stars approach one another and in the manner described in "The Birth of Worlds and Systems" one of the three may acquire a speed of sufficient power to project it beyond the limits of the cosmic system of which it is a member. There are other agencies by which material is carried out of systems, so that the process of rolling up of suns into bigger and bigger suns is not the only mode of the mechanism of the universe. Just as we saw that impact is not a random, chance, or accidental occurrence, but a definite law of nature, do not these distributing agencies show that there is a law tending to a constant rough equality in the distribution of matter?

Elevation of Degraded Energy.

It is now our task to ascertain if any law exists by which the degraded energy that we call low temperature heat, can be raised into that highest form of energy which is known as the potential energy of separated gravitational masses. What becomes of this torrent of vibratory energy that is pouring out from the hundred million suns of our system? It probably travels to enormous distances: it is exceedingly likely that it will ultimately fall on the dust of space and warm it, and, if there were no other agencies, give us the condition that Kelvin deduced, and the Germans named "warm death." But another exceedingly complex series of factors must apparently be brought into play. Bodies, whether dense masses or isolated light atoms, when not entrapped into orbits must occupy but very little time at high velocity. As the speed grows less the duration grows greater, until when nearly at rest they must occupy durations that are almost immeasurable. Now a particle of gas at rest is at absolute zero. So that much of the free molecular matter of space must be very cold, as it is moving slowly. A slowly moving particle of helium or hydrogen coming in contact with a warm particle of cosmic dust will acquire its temperature, and this heat will become molecular motion, and the molecule will leave the particle with an increased velocity. This increased velocity will cause it to travel away, often in the direction that will convert its atomic motion into potential energy of gravitation. Coming nearly to rest again the process will be repeated, until, as a final result, the molecule will wander until it reaches the position of high potential in space, where it will necessarily linger longer than anywhere else.

Another Aggregating Agency besides Gravitation.

In a position where bodies moving indiscriminately linger longest, there they tend to accumulate. In 1879, when this principle was first detected, it was called the Aggregating Power of the Position of High Potential. This principle, which no mathematician has ever disputed, and which one of our ablest has called "a mathematical *vera causa*," shows us that we have a second aggregating tendency in nature in addition to gravitation. Do we not again perceive another law of nature tending to elevate degraded energy so that it shall be perpetually available for the purposes of life eternal? Do not these three laws of nature, added to our former knowledge, show us a cosmos infinite and deathless? First we have the set of agencies that produces the constructive impact of cosmic bodies and systems; then the one that tends to distribute as well as aggregate matter; and, lastly, this complex series of agencies, made up of the high kinetol of light atoms, the elevation of degraded energy, and the aggregating power of the position of high potential. The whole gives us a series of wonderful laws of nature that, together, present us with the possibilities of an immortal cosmos of infinite extension and perfection of design.

The Theory a Demonstrated Deduction.

Finally comes the question: Is this beautiful optimistic picture of the Cosmic scheme a true one? Grant grazing impact and, as Sir David Gill has stated, the idea of the formation of the third body is true. When we consider the dozen agencies that tend to produce impact we cannot doubt its happening. Even did we, without evidence, doubt, when we consider the coincidence between deduction and observation every trace of doubt absolutely disappears. It is quite certain that Nova Persei was the third body produced by the graze of suns. Every thermodynamical, chemical and physical deduction made thirty-three years ago, has been confirmed. Sudden appearance, rapid increase in brilliancy, quick disappearance, all agree. Every character of the abnormal light curve agrees. Every one of the series of complex spectra tells the tale of the physical changes of nucleus and ensphering shells in exquisite minuteness of corresponding detail. The star, as was deduced, passed into the planetary nebula stage. Any one of these striking confirmations, in the absence of opposing evidence, would suffice for a demonstration. What shall we say when we think of the fact that the several different series all correspond in each and in every step?

Novae Demonstrated to be Third Bodies.

Hence, emphatically, Nova Persei was a third body, and as all novae are so typically alike in their many characteristics, we must infer that all novae are the exploding third bodies struck from grazing suns.

Then take the mass of evidence that variable and double stars are the torn suns, and again how overwhelming is the evidence. Every deduced salient physical feature has a representative in fact, often in a multiplicity of confirming facts. Why should variables be in pairs? Why should binaries be variable and often doubly variable? In each case the probability against chance runs into sextillions. Why are they associated with nebulae? Consider again the form and character of nebulae. Why should the spirals be always double? Why are the planetary nebulae often sphere in sphere and have centres exactly as deduced? Why should double spiral nebulae be amongst nebulae where stars are scarce, save that, as deduced, they are formed by the impact of nebulae? Why should the planetary nebulae be where the stars are thick, clearly because, as deduced, they are produced by the impact of stars? Are not the temporary variable, double, and Wolf-Rayet stars also where stars are thick? Is not the answer obvious, because, where stars are thick, there will be a maximum of stellar collisions, and all these kind of stars are deduced as the offspring of stellar collisions.

The Dual Character of The Galaxy Demonstrated.

Then, when we come to the Galaxy, what other conception is possible that could produce such a marvellous and singular set of contrasts and correspondences, but the impact of two formerly independent stellar systems? Here Professor Kapteyn's demonstrations are all-important. He concludes his magnificent address to the Dutch Science Congress in the following words:—"The stellar system was not originally a single system in which the two known star currents have developed; but the present system is the result of the encounter of two systems which originally were entirely independent of each other.

The primordial matter is now most abundant in the drift of less star-density, and is almost entirely absent from the opposite drift, which is richer in stars."

Clearly in this primordial material we have the cosmic system of the first order that a study of natural law has shown must grow up in the unoccupied parts of space, and the other constituent is clearly a stellar system of greater maturity.

Surely such a fertile generalization should be used as a working hypothesis to guide research, and that at once. If it is true as able thinkers say that the neglect to use it in the past has retarded astronomy a decade, all haste should be made that the several threads suggested should be followed and woven into a fabric in which every thread has its allotted place and purpose: so that this glorious science, astronomy, instead of being a mere chaos of facts, instead of apparently pointing to eternal death, shall show itself to be a consistent system of creation without evidence of a beginning or promise of an end, infinite and flawless.

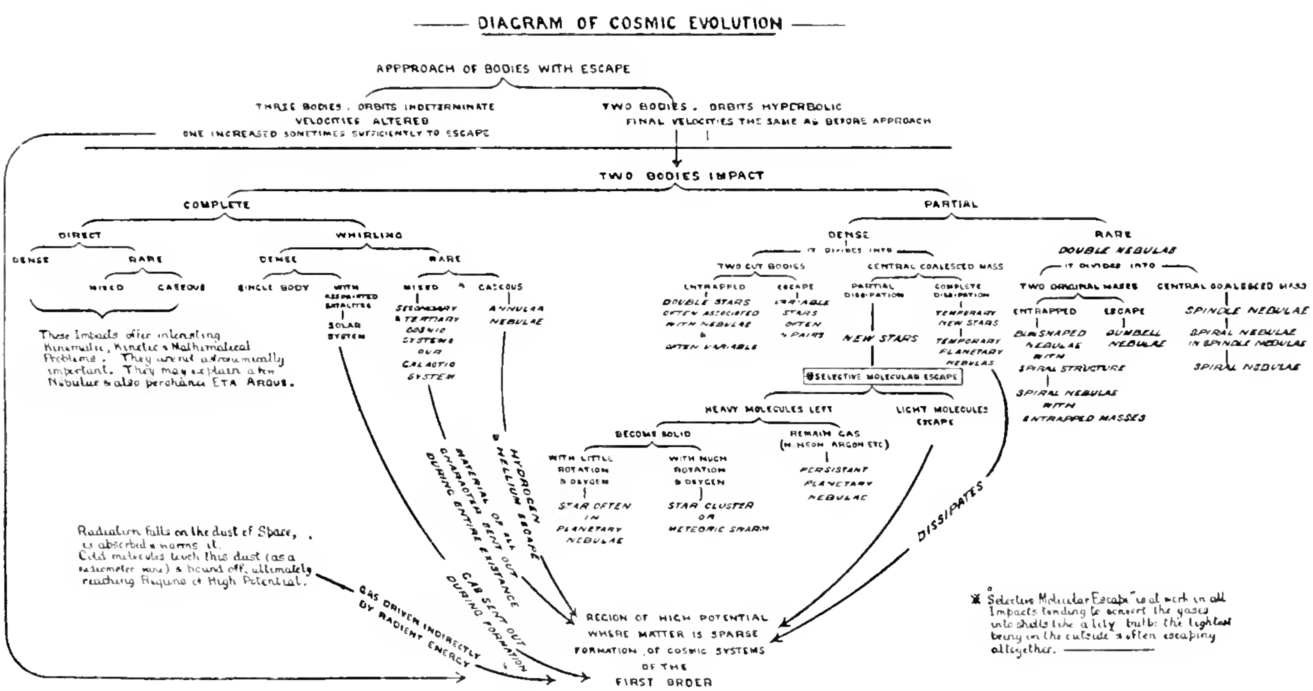


Figure 5.

Diagram taken from Professor Bickerton's "Romance of the Heavens," 1900.

Kapteyn, by summing up his own theory, Greenwich and others' observation, has now satisfied himself that our Galactic Universe is made up of two interpenetrating systems, one of them primordial, that is of the first order, as shown to be forming below the centre of the diagram

FIGURE 1. The Cameras and methods of illumination.

THE PROCESS BLOCK.

By H. E. REA.

PROCESS blocks are used now for printing illustrations in all sorts of periodicals—in the halfpenny newspaper, as well as in the finest book or art catalogue.

A block must be made capable of printing side by side with type, and it must be able to give all the range of tones of the original from black to white. It is made to do this by having its surface cut up into a very large number of "dots" or squares—so small as to be, as a general rule, unnoticed by the naked eye—which catch the ink when the roller goes over them and which immediately afterwards print the picture.

The block-maker has first to consider—when he gets the photograph or drawing which is to be reproduced—what sort of paper the block is to be used upon, whether rough or with a smooth surface, or art paper. The better the paper is, the greater is the number of "dots" which can be made and the closer they will be together. The original is then pinned up on the copying-board (see Figure 1), which is illuminated by two powerful arc lamps, and a photograph is taken of it, which may reduce or enlarge it, according to the size of the block wanted, and which, at the same time, brings the "dots" into existence. This photograph may be taken by means of the wet collodion process, the collodion emulsion process or on a dry plate. In the first two cases the operator has to prepare his own plates, but dry plates made especially for process-workers can be obtained from the dealers. The writer uses dry plates.

FIGURE 2. The Camera with the screen in position.

The "dots" are obtained by interposing in the camera, between the photographic plate and the lens,

Figure 3.

One half of the screen.

Figure 4. The dots enlarged from a screen negative.

If this picture is held at a distance from the eye the effect of the photograph will be seen. It is part of Figure 10.

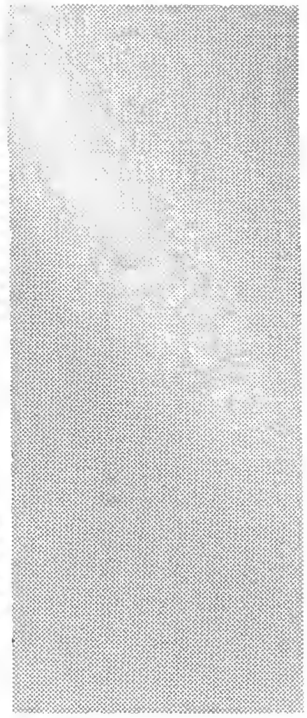


Figure 5.

The cross lines of the screen.

a ruled screen (see Figure 2), which is made by having two diagonally-ruled glass plates sealed together — the result being a cross-lined mesh (see Figure 5). The image passing through this gets cut up into a series of dots and squares —ranging gradually from fine black dots in the transparent parts of the negative to squares in the half-tones and transparent dots in the high

Figure 6. Printing.

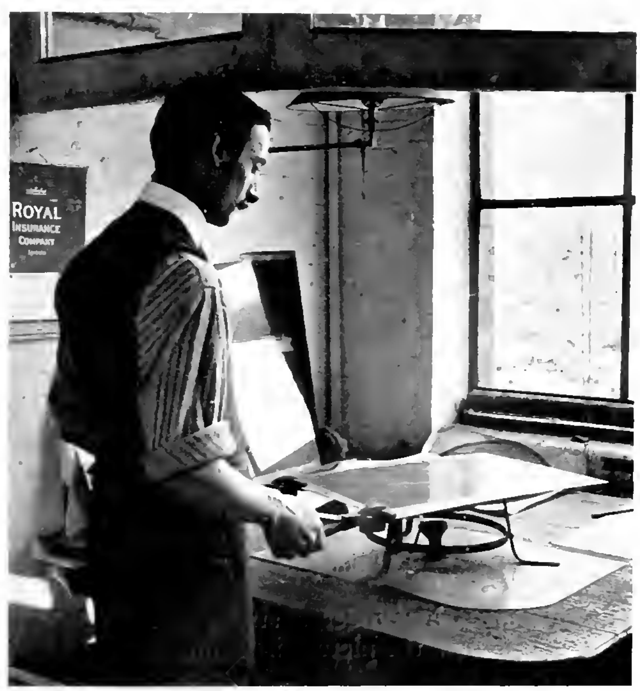


Figure 7. Firing the Plate.

lights. The mesh of the screens varies much—ranging from fifty lines to the inch for very heavy or rough printing to four hundred lines to the inch for the most careful and finest art printing. The most useful screens have one hundred and twenty, one hundred and thirty-three and one hundred and fifty lines to the inch, and these are, as a general rule, the sizes used in connection with illustrations for magazines. In the case of the daily papers — which are very rapidly printed on fast-running machines — the illustrations require screens with a much more open mesh—usually of from seventy-five to one hundred lines to the inch. If the reader will examine one of the illustrations in this magazine under a strong magnifying glass he will see how the picture is formed by the "dots" and squares.

Figure 8. The Etching Bath. Examining the plate for depth.

When the operator has adjusted the screen to the required distance from the plate—so as to give the kind of "dot" desired—he makes his first exposure, which is to give the "dot" formation in the darker parts of the subject. He then places the cap on the lens, puts in a larger stop and exposes again. He, in this way, gets a "dot" formation of the detail. The third exposure — with a still larger stop—is for the "dot" formation in the high lights (see enlarged illustration of the screen effect in Figure 4). Some operators make only two exposures. The different stops used vary a great deal. Some operators favour one kind — others another. The writer uses three kinds—a very small one to give the "dots" in the blacks, one about three times as big to give the detail, and a square one, about three times the size of the one last mentioned, for the high lights. The exposures are very short—whichever of these stops are used. Their whole aggregate length—from

Figure 9. A Fine Etcher at Work. "Stopping out."

Figure 10. Engraving the Plate. "Taking out blemishes."

the beginning of the first till the end of the third—varies from a minute and a half to three minutes if an arc lamp of the enclosed type is used, as this gives the greater percentage of violet or active rays of light, to which the plates are most sensitive. The exposure with the open type of arc lamp is about three times as long

The exposed plate is now developed in the ordinary way, and it is afterwards reduced (in density), or, to use a trade term, "cut in," by letting a solution which diminishes the size of the "dots" flow over it. This is done until the "dots" are of the size necessary to give the requisite brightness.

The object of the burning or baking is to make the coating into a hard enamel.

The plate is now passed on to the etchers, who place it in a solution of perchloride of iron. This eats away the copper between the dots, and thus leaves the image standing up in relief, the enamel not allowing the solution to touch the "dots." A rough proof is now taken of the print in order to see what further etching is required. This fine etching (see Figure 9) is done by stopping out, with a resisting varnish, parts which do not require any further etching, and the high lights are then etched up so as to give more brightness and detail.

Figure 11. Routing away useless metal.
By using the two handles the router can be made to go in any direction desired.

Figure 12. Lining and bevelling the plate.
In this way it is got ready for nailing on to the wood when it will be type-high.

The finished negative is now dried and given to the printer. After he has examined it to see how long it will take to print, he places it in contact with a piece of copper, which has been made sensitive to light—both being put into a printing frame, which enables great pressure to be exerted to bring the two close together. The piece of copper is sensitized with a solution, composed of white of egg, fish glue and bichromate of ammonium. The frame is put in front of a strong light, which, acting on the sensitized copper through the transparent parts of the negative, prints the image on to it. The print on the copper plate is then developed in water, which dissolves away the solution not acted upon by the light, and it is afterwards burnt in over a Bunsen burner (see Figure 7). The result is a print made up of a series of "dots" and squares, ranging from fine white "dots" in the blacks to fine black "dots" in the lightest parts of the subject.

When the etchers have done all that is necessary the plate is then passed on to the engravers (see Figure 10), who take out unnecessary spots and engrave up what lights require brightening or what darks require a little burnishing so as to give a greater depth of colour.

The block—as it may now be called—is now ready for the finished proof to be taken, and after that is done it is given to the mounter, who fastens it on to wood of such a depth as to make it as high as type. It can now be printed side by side with type.

The methods of working and the apparatus used have, within the last few years, been brought to such perfection that it is now possible for a block to be completely made—ready to be put on the printing press—within one hour from the time the photograph or drawing is placed in the operator's hands. This, of course, is only for a hurried illustration: the usual time taken over a block is from four to five hours.

A SCANDINAVIAN TRIBE IN THE ARCTIC NORTH-WEST.

By COMYNS BEAUMONT.

THE "new" race of Arctic men which Herr Villijmar Stefanssen, the leader of the American Museums' Scientific Expedition, has discovered in the Arctic regions north of British Columbia, provides an invaluable link in the chain of evidence which the advanced school of ethnology is forging.

Herr Stefanssen is astonished to find that this race of men are Scandinavian in appearance. Everyone asks how can it be? Students of Polar research, at a loss to interpret the phenomenon, wonderingly suggest that the men are descendants of the crews in Sir John Franklin's expedition, who had inter-married with the Eskimos. If this were so, in such a comparatively short period these men would be able to make their identity clear. In less than one hundred years men belonging to a virile race do not lose their language, their customs, or forget the fatherland. Indeed, it requires immense periods for colonisers or emigrants to change their language, to forget their national customs and to allow their earlier history to pass into myth or legend.

Stefanssen as yet has given us few particulars respecting these Polar Scandinavians, excepting that two of the men had red beards and that they were markedly European in type.

If the description, meagre though it be, proves correct, they should be a remnant cut off from the great Scythian family, and as such can have no relationship whatsoever with the Eskimo, who belong to the same family as the African Bushmen.

Who were the Scythians? What limit may be imposed on their ramifications? If these two questions may be answered, a solution will probably be found to the mystery of Scandinavian types in the Arctic north-west. The Scythians were people of fair complexion, blue or light eyes, with flaxen brown or red hair and of strong physical build. From the remotest times they descended from the north, a people possessing a restless unconquered spirit, apt to take fire at the very mention of subjection and restraint, and overrunning the globe in more than one continent. The Scandinavians, or Goths, were Scythians.

There is no vaguer term in ancient geography than Scythia. Blackwell, the editor of Mallet's "Northern Antiquities," says that it would embrace all the countries lying between the river Don in the west, the great desert of Gobi in the east, the Hindoo Koosh mountains in the south, and the plains of Siberia in the north, "in which direction the boundaries might be limited or extended to suit any particular theory, being for the ancients *terra incognita*." But the original name of the Scythians extended over a much wider field than Blackwell considers adequate. We find undoubted Scythian traces in America. Major P. H. Fawcett, F.R.G.S., has collected evidence, hard to dispel, of a race of white people with red hair in the hinterland of Brazil. Short, in his "North Americans of Antiquity," confesses that the standing puzzle to ethnologists is the wide range of colour and complexion found among the American Indians. The Menominee, Dakota, Mandan, Allegheni and Zuni tribes, among others, very often possess auburn hair, blue eyes and white skins. Who were the famous Chichimecs of American legendry? The Chichimecs entered Mexico from the north: they came from "Amaquemecan," a "land of vast extent": their titular deity was Votan, or Odon, whom the erudite Humboldt was astonished to find corresponded in every particular with the Wodan, or Odin, of the Scythian nations: this Votan (also called Odin, or Oton) was a white man, with a long beard, attired in white garments bearing the insignia of the Cross in red. The ancient and mythical capital of this people preserved in records like the Popol Vuh, was a city called Tula, Tulan or Tulla. The Popol Vuh tells us that Tula was bitterly cold: for instance, Part III, Chap. V, verse 5, says: "But then began a great rain that extinguished the fire of the tribes and much snow fell on the head of all the tribes and their fire was extinguished then because of the snow; there was no more of this fire which had been made." And verse 8: "And they were able to do nothing because of the cold and of the ice, trembling (as they were all) and chattering their teeth the one against the other, having no more life in them, feet and hands benumbed, to the point that they could no longer hold anything." It must be remembered that the Popol Vuh is the equivalent of the Pentateuch among the Quiché people, who were, like the Hebrews, wanderers for long periods over large extents of territory, and who, like them, were enslaved by a Pharaoh through whose country they passed. The people who enslaved them were the Chichimecs. Another deity of the Chichimecs was Toras, whose name and character closely resemble the Scandinavian Thor.

At a comparatively recent date, even as records go (opposed to legend), there is no doubt that the northern portions of the world were much more closely linked together than is the case to-day, and that the adventurous peoples from the northern parts of Europe were not uncommonly accustomed to make voyages to Greenland and Northern America, owing to an almost continuous land connection. In the Icelandic sagas, that part of America embracing Texas, Florida, the valley of the Mississippi, Georgia and the Carolinas was designated under the name of Ireland-ik-Mikla, or Great Ireland, and was considered to be a land of white men. (See Beauvais, "Decouvertes des Scandinaves en Amerique.")

We have, then, undoubted traces of Teutonic, or Scythian, descent in America; the same race over-ran the north of Asia and Europe; tucked away in a corner of the Arctic regions is a small tribe of apparent Teutonic characteristics. Were the Scythian peoples always unsettled, always wanderers over the north, or is there some truth in the Chichimec legend that they inhabited Amaquemecan, "a land of vast extent"?

What does the geology of the Arctic regions teach us?

There was a period when lands stretching across the Atlantic Ocean, and which linked up the Atlas range with the West Indies and Central America, were gradually breaking up. At this time the United States proper did not exist; its place was occupied by a brackish sea containing a number of islands; but in the northern portions of the Atlantic region definite evidence exists of the presence of dry land, while a good deal of modern Europe, North America and Asia were occupied by the ocean bed. Certain flora of the Tertiary period, covered by basalt, occur in County Antrim; the same flora—*Taxodium distichum*—has left deposits in lignite in Spitzbergen, Ireland, the Hebrides, the Faröe Islands, Iceland, Greenland, and even beyond; Fielden found Tertiary plants in British Columbia containing examples belonging to Mexico and the South, and the existence of this flora, says Professor Suess, "has been frequently regarded as a proof of the existence of a great continent, richly covered with vegetation, which occupied the site of the present North Atlantic Ocean."*

Elsewhere† in his magnificent work, Suess points out that the Tertiary land faunas of North America correspond with those of Europe, demonstrating clearly that a once vast northern area definitely connected, has been broken up, of which parts disappeared. This reconstruction of lost Hyperborean lands is, curiously enough, borne out by the celebrated map of America added to the edition of Ptolemy's Geography, which showed not only Greenland and Newfoundland, but separated the north entirely from the American Continent, and carried this northern land across until it united with the north of Asia.

The Greeks and Romans preserved lively recollections in their mythology of this great Hyperborean Continent, situate far to the north-west, and which enjoyed a mild and beneficent climate. It was the Saturnian Continent, where Saturn, Hercules and Apollo were honoured. Thence Hercules led an expedition whose first destination was to such a northerly clime that, according to Plutarch, during thirty days the sun set for only one hour, and even during that time a twilight reigned. Ogygia was distant further still, where Saturn slept in a deep cave where he had been placed by Jupiter. Indeed, the trend of opinion to-day is gradually coming round to believe that the Hellenes themselves originated in this part of the world, and that their heroic stories refer to that early period of flux when the Scythian peoples lived in the regions now given over to the iceberg.

Without question there was a period, not geologically far removed from our time, when the Polar regions rejoiced in a soft and beautiful climate. It used to be said that this was before man lived. Now, on the contrary, the weight of evidence indicates that man not only lived then, but that the north, as said the Goth Jornandes, was the forge of mankind. When the north enjoyed a beneficent climate, prior to events of the utmost magnitude which changed the entire climate of the world and altered the face of the earth, we cannot surely escape from the conviction that all the evidence is in favour of its being the original home of a great portion of the human race. We know that the earth has constantly shifted its axis, and by a study of the other planets we are enabled to foretell with some exactitude the result of any great change. The causes which lead to a shifting of the earth's axis need not be discussed here, but the effects must be considered. According to the esoteric belief of the ancients, including Plato, the planet Jupiter caused a world conflagration, and whether it did so or not, there is no question but that, prior to the Glacial Period, certain lands became submerged, which interfered with its equilibrium and caused the earth to shift its axis, owing to the change in its centre of gravity. "As the centre of gravity of the earth varied," said Major-General Drayson, F.R.A.S., in a paper read to the Royal Astronomical Society in 1896, "due to the elevation and depression of lands and the consequent transferal of hundreds of millions of tons of ocean water so must the centre of gravity of the earth have varied, and consequently the angle formed between the poles of daily and second rotation, and hence the climatic changes. . ."

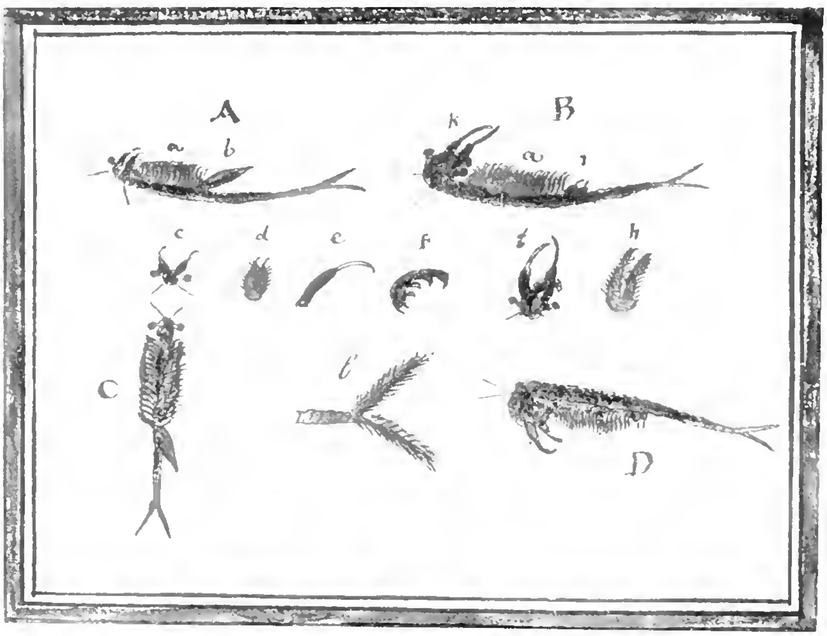
The Glacial Age drove the Hyperboreans south. Thus began that period of enormous migrations among which the Israelites comprised but one small portion. Millions of people perished, and hence the universal Flood Story. But, as though it were by chance, here and there communities were isolated and spared. Some of these in turn sought more friendly climes, but others remained; and thus we have a rational and natural explanation of Herr Stefanssen's Scandinavian tribe in the Arctic regions of the north-west.

* "Face of the Earth," Vol. I, p. 287.

† Vol. I, p. 13.

J

A Description of a very remarkable Animalcule, found in a ditch of standing water, near Norwich, April, : 1762. :



A is the female, and B the male, both placed on their backs, in the posture in which they usually swim. a a are a number of small transparent ^[fins] fins, (much resembling the anatomical preparation of the pia mater,) placed parallel, and contiguous to each other; and which are almost always in motion; the animals seeming to keep themselves suspended in the water by means of them. d is one of those fins seen front ways, on the female, and h one of the same belonging to the male. — c is the head of the female, and g that of the male, distinguished by three projecting substances like horns or tusks, which are marked k in the figure B. one of the long ones on the side is drawn seperately at e

The above reproduction of a manuscript note is of interest in connection with our article on the occurrence of *Chirocephalus diaphanus* in "KNOWLEDGE" (Volume XXXIII page 169). The page was discovered among a series of coloured drawings of Natural History objects, in the possession of Mr. Alexander Gordon, which apparently once belonged to Edward King, F.R.S., the Recorder of King's Lynn, whose father lived at Norwich. Edward King wrote chiefly on archaeology and religion, but also took some interest in natural history. In the original, which is reproduced by kind permission of Mr. Gordon, the lines are in red ink.

PLANT HAIRS.

By K. E. STYAN.

(Continued from Page 15[illegible].)

PART VI. (a) HAIRY AWNS AND (b) PAPPUSES.

IN the great work of dissemination of fruits and seeds which is being carried on by various agencies, daily, over the length and breadth of the world, hairy outgrowths play a very important part: for they ensure the structures on which they spring being wind-wafted, whether or no they take the form of true coverings to the seed, "pappuses," or feathery, silky awns, or appendages. Usually the hairs found on seeds and fruits are extremely numerous, so numerous that it is quite out of the question to attempt to count them, but instances do occur in which only quite a limited number are present, of which one good example may be seen in the case of a plant called *Aeschynanthus*, whose fruit only bears *three* hairs on it, one on one side and two on the other. But these three are specially adapted for the great use to which they are called into being by being remarkably flexible, which not only causes them easily to adhere to, but also to curl round the wool or fur of animals after they have been wafted by the wind on to the creature's body. Thus the hairs in this case cause the fruits to be disseminated both by wind agency and animal conveyance.

Exquisitely beautiful are many of the hairy prolongations t[illegible] land. Our hedgerows in autumn are ma[illegible] in the presence of silvery clusters of [illegible] clematis (see Figure 2), which is most truly a Traveller's Joy. Each tiny part of one of these clusters consists of a tiny fruit, called an achene, bearing a very, very slender, silky, hairy appendage, which is so light that the slightest puff of wind catching it when the fruit is ripe, enables the latter to be wafted away through the air like a bit of gossamer. Another lovely example may be seen in the grass *Stripa pennata* (see Figure 1), one that is often grown in gardens for decorative purposes. The fruit of this plant is an elongated, *very* sharp, needle-pointed achene, covered with short, soft, silky hairs, which are reflexed: from its upper end springs a slender, string-like stem that becomes cork-screwed for part of its length and then straight: above this portion rises a very long (often more than a foot in length) delicate hairy awn. In its own native haunts abroad these awns

FIGURE 2.

Awned achene of Traveller's Joy. *Clematis vitalba* (life size).

FIGURE 3.

Awned achene of Water Avens. *Geum palustris* (enlarged).

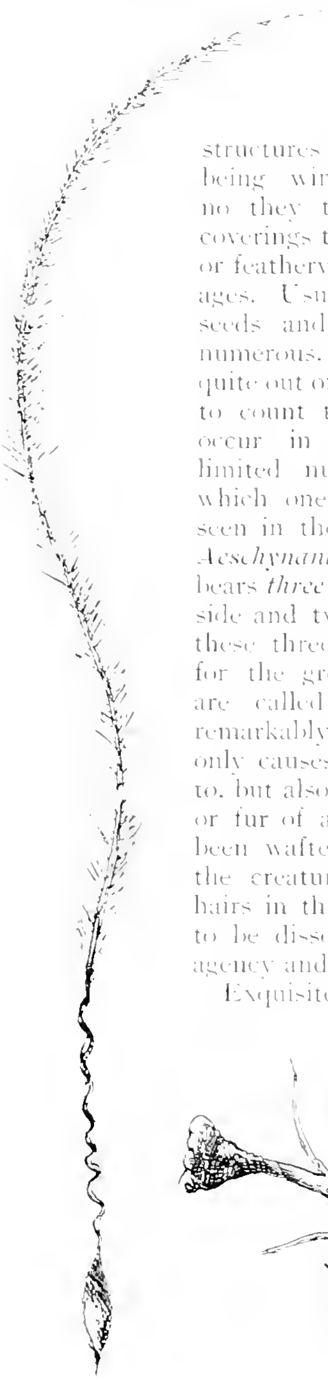


FIGURE 1.

Awned achene of *Stripa pennata* (two-thirds natural size).

FIGURE 4.

Tip of hairy awn of *Geum palustris* (greatly enlarged).

FIGURE 5.

Base of the hairy awn of *Geum palustris* (greatly enlarged).

catch the wind and bear the fruits miles and miles over dry, bare land, till some damper spot is reached, when, surrounded by herbage, which arrests the progress of the awn, and by the unwinding of the corkscrew owing to the moisture, the achene is forced into the ground by its sharp point and there produces a new plant. The Water Avens (*Geum palustris*) (see Figure 3) produces an awned fruit something like that of the Traveller's Joy, and the accompanying illustrations (Figures 4 and 5) show a series of magnified parts of the awn. The tip is slightly swollen and sticky, and along the sides, amidst the long, slender hairs, are some that are glandular. The stickiness of these may be another means by which the awn, after being carried by the wind, can adhere to any foreign body with which it may come into contact.

FIGURE 6.
Pilose sessile pappus of Rough Hawkbit.

What are known as "pappuses" are the structures formed as "after-growths" from the calices of many plant-species as soon as the blossoms die and their fruits begin to ripen for dissemination. So light are they, even if stemmed, that the wind can carry them great distances; the faintest puff, and away flies the fairy "clock" or ball of silver "down," over meadow and hedge, away—far away—till it gets beyond our sight; or we may see the wind drifting over countless myriads of pappuses on some area of bog-land where the Cotton Sedge grows in rank luxuriance, swaying the snow-white hairy heads till they look like breaking wavelets, gleaming as they catch the glint of passing sunbeams. In this plant each pappus consists of a tuft of soft, long, slender white hairs encasing one tiny fruit.

FIGURE 7.
Plumose sessile pappus of Mouse-ear Hawkweed.

Then, upon the Black Poplar tree, in early summer, or on the ground beneath it, we may see hairy catkins that look just like tiny lambs' tails. In reality these "tails" are only aggregations of satiny pappuses, each attached to a small seed.

Of all the natural orders, the Compositae show most pappus heads, indeed they abound in the species of Filago, Cud-weed, Groundsel, Hawk's-beard, Ragwort, Hawkweed, Hawkbit, Cornflower, Knapweed, Fleabane, Colt's-foot, Dandelion, and Goat's-beard. Figure 6 shows one separate pappus from Rough Hawkbit. This has the hairs springing from the achene *without* a stalk (hence is called sessile), and its slender hairs are unbranched, or "pilose." In the Mouse-ear Hawkweed (see Figure 7) the hairs are branched, or "plumose" as the botanical term is; and in Dandelion (Figure 8) they are unbranched but have a stem, and hence are said to be pilose, "stipitate."

FIGURE 8.
Pilose stipitate pappus of the Dandelion.

The largest and most beautiful of all English pappuses is that borne by the Goat's-Beard, one of the Compositae, in which each separate fruit has a mass of webbed hairs at the top of a long slender stalk, forming a miniature parachute; and the massing together of the many fruits into one head forms a large, silvery, hairy ball, that is one of the most exquisite structures one can ever wish to study in all the wide field of wild nature.

METEORIC SHOWER OF SEPTEMBER 30TH.

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

IN the October number of "KNOWLEDGE," I gave some particulars of several fine meteors witnessed on September 2nd. There occurred a somewhat similar display on September 30th.

The night was beautifully clear, and offered an unusual exhibition of cometary as well as meteoric phenomena, for no less than three comets were visible to the naked eye—two in the evening, and one in the morning just before sunrise.

I watched for meteors for about one-and-a-half hours before midnight and saw sixteen, of which four were fairly conspicuous. Mr. Sidney Wilson and Mrs. Fiammetta Wilson, of Bexley Heath, saw thirteen meteors, and three of these were seen at Bristol.

A fireball brighter than Venus appeared at about 9.5, and it was observed by Mr. H. Corder, at Bridgwater. He says it gave a rather bright flash as it fell towards the western horizon, and disappeared behind the Quantock Hills. He only caught about 6° of the terminating portion of the flight, which was directed from α Herculis from about 3° above δ Cygni.

The same (bluish-white) meteor was noticed by Mr. Joseph MacDermott, of Glasnevin, Dublin, who describes it as of twice the brightness of Jupiter as seen with the naked eye. Its observed position was a little S. of S.W., and it fell from about 30° to 15° of altitude in a direction from Pegasus.

A bright meteor was noticed by Miss Irene Warner, of Bristol, at 10.5, falling from about 28° + 35° to 14° + 15° and leaving a long red streak.

At 10.40, Mr. H. Denning saw a fireball descending in N. by W. He could not, however, exactly locate the place of the phenomenon as he saw it from Stokes Croft, Bristol, where there is a good deal of artificial illumination and obstruction by buildings.

At 11 o'clock Mrs. Warner witnessed a bright meteor from Horfield Common. It travelled slowly upwards from under Aldebaran to the planet Saturn and probably from a radiant in the southern part of Taurus. The following are the real paths of four meteors doubly observed on this notable night.

Sept. 30. H.	M.		Height at first. M.	Height at last. M.	Path. M.	Velocity per second. M.	Radiants.
8	20	2—4	66	59	45	30	106 + 47°
8	42	2—3	79	52	34	16	4 + 28°
9	5	> ?	81	48	41	14	6 + 27°
9	20	1—2	69	69	54		119 + 34°

Other observations of meteors on September 30th would be very acceptable for comparison.

THE FACE OF THE SKY FOR DECEMBER.

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

THE SUN.—On the 1st the Sun rises at 7.44 and sets at 3.54; on the 31st he rises at 8.8 and sets at 3.58. The equation of time on the 25th at noon is only 13 seconds, and for ordinary purposes is negligible. Winter commences on the 22nd, when the sun enters the sign of Capricorn at 10.54 p.m.; this is the shortest day, the Sun rising at 8.5 and setting at 3.51. Sunspots and faculae may usually be observed on the solar disc, though of late Spots have been rather small. The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given below:—

Date.	Axis inclined from N. point.	Centre of Disc N. or S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Dec. 2	15° 50'E	0° 40'N	192° 10'
,, 7	13° 57'E	0° 2'N	126° 16'
,, 12	11° 40'E	0° 37'S	60° 23'
,, 17	9° 33'E	1° 14'S	354° 31'
,, 22	7° 12'E	1° 52'S	288° 38'
,, 27	4° 49'E	2° 29'S	222° 47'
Jan. 1	2° 22'E	3° 5'S	156° 56'

THE MOON:—

Date.	Phases.	H. M.
Dec. 6	○ Full Moon ...	2 52 a.m.
,, 12	◐ Last Quarter	5 40 p.m.
,, 20	● New Moon	3 49 p.m.
,, 28	◑ First Quarter	6 48 p.m.
Dec. 7	Perigee	1 0 a.m.
,, 22	Apogee	2 0 a.m.

OCCULTATIONS.—Particulars of the principal occultations visible in this country are given in the table below:—

Date.	Star's Name	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. point. E.	Reappearance. Mean Time.	Reappearance. Angle from N. point. E.
Dec. 3	20 Arietis	6·1	p.m. 8.10	102	p.m. 9.0	104°
,, 6	B.A.C. 1754	5·7	6.42	37	7.24	200
,, 7	130 Tauri	4·6	a.m. 1.40	10	a.m. 2.11	337°
,, 8	47 Geminorum..	5·6	5.23	96	6.22	200°
,, 8	ω^1 Cancri ...	6·1	p.m. 9.31	65	p.m. 10.24	305
,, 8	ω^2 Cancri ..	6·2	9.54	127	10.40	244
,, 9	λ Cancri ..	5·9	a.m. 6.48	123	a.m. 7.44	270
,, 24	33 Capricorni	5·3	p.m. 5.25	22	p.m. 6.21	280

THE PLANETS.

MERCURY:

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 1	17 51	S 2[illegible]° 52'
,, 11	18 38	S 24° [illegible]
,, 21	18 34	S 22° [illegible]
,, 31	17 43	S 20° 14'

Mercury is an evening star in Sagittarius setting about 5 p.m. from the 10th to the 20th, but unfavourably placed for observation. The planet is at greatest easterly elongation from the Sun of 20° 58′ on the 7th, whilst on the 16th he is stationary, after which he describes a retrograde path, and is in inferior conjunction with the Sun on the 25th.

VENUS:

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 1	13 23	S 6° 26'
,, 11	14 4	S 9 55'
,, 21	14 47	S 13 22'
,, 31	15 33	S 16 31'

Venus is a morning star first in Virgo, then in Libra; she rises in the E.S.E. at 3.15 a.m. on the 1st, and at 4.21 a.m. on the 31st. As seen in the telescope the planet appears gibbous, 0·6 of the disc being illuminated; the apparent diameter of the planet is 20″.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 1	3 48	N 21 31'
,, 11	3 35	N 21° 16'
,, 21	3 27	N 20 58'
,, 31	3 26	N 21° 6'

Mars is a very conspicuous object in the S.E. portion of the sky at sunset; he appears as a bright reddish star about 3° South of the Pleiades, where he is describing a short retrograde path; the planet is at the stationary point on the 29th.

On the 1st he is due South at 11.9 p.m., on the 15th at 9.57 p.m., and on the 31st at 8.49 p.m.; he remains above the horizon till the early hours of the morning.

The latitude of the planet's centre is −13°, hence the South Polar Cap is visible. The time of rotation is $24^{h}\ 37^{m}\ 22^{s}\cdot65$, which is equivalent to 14°·62 per hour, and the time of transit of the Zero Meridian of the planet is as follows:—

Date.	Transit of Zero Meridian.	Date.	Transit of Zero Meridian.
	h. m.		h. m.
Dec. 2	2 51 p.m.	Dec. 19	0 35 a.m.
,, 4	4 4 ,,	,, 21	1 49 ,,
,, 6	5 16 ,,	,, 23 ...	3 3 ,,
,, 8	6 29 ,,	,, 25	4 17 ,,
,, 10	7 42 ,,	,, 27	5 32 ,,
,, 12	8 55 ,,	,, 29	6 46 ,,
,, 14	10 8 ,,	,, 31	8 1 ,,
,, 16	11 21 ,,		

With the above data the longitude of the centre of Mars can easily be calculated for any moment. It may be noted that the zero meridian passes through the bay of the Sinus Sabaeus. The following well-known markings are visible at 9 p.m. on the dates mentioned below:—Aurorae Sinus on the 6th, Sinus Sabaeus on the 12th, Syrtis Major on the 19th and the Mare Cimmerium on the 28th. Most of the markings require at least a telescope of six inches aperture and good seeing to discern any detail, though dusky patches can be made out on the planet's disc with telescopes of smaller aperture. The Moon appears near Mars on the morning of the 5th, conjunction taking place at 3.55 a.m., Mars being 0° 50′ to the South.

Jupiter:—

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 1 ...	15 44	S 18° 50′
„ 11 ...	15 53	S 19° 28′
„ 21	16 2	S 19° 55′
„ 31	16 10	S 20° 18′

Jupiter is a morning star, rising at 6.50 a.m. on the 1st and at 5.22 a.m. on the 31st; owing to his apparent proximity to the Sun, the planet is not observable till the end of the month, and for the same reason his satellites are inobservable. The planet appears in Scorpio and is in conjunction with β Scorpii on the 20th, the planet being about 16′ to the South of the star.

Saturn:—

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 1	2 53	N 13° 58′
„ 16	2 50	13 44
„ 31	2 47	N 13 37

Saturn is a very conspicuous object in the evening sky looking S.E.; he appears about 10° to S.W. of the Pleiades and Mars. He appears due south at 10.15 p.m. on the 1st, 9.12 p.m. on the 16th, and 8.11 p.m. on the 31st, that is, about four minutes earlier each day.

On the meridian he appears about 52° above the horizon as the brightest star in that portion of the heavens, excepting Mars, but he may readily be distinguished from Mars by his lustreless appearance.

The planet may be seen in detail in quite small telescopes; even telescopes of only 2-in. aperture are sufficient to observe details on the disc as well as the Cassini division in the ring, using a magnification of 100, whilst the ring itself may be seen with a magnifying power of 50. The dark or crape ring requires at least a 4-in. telescope, but it is seen to better advantage in larger telescopes. The diameter of the ball is 18″, whilst the diameters of the outer major and minor axes of the ring are 45″ and 16″ respectively. The Southern surface of the ring is presented to us at an angle of 21° to our line of vision; thus the ring appears well open.

The Moon will appear near the planet on the evening of the 31st, Saturn being 4° to the South.

Uranus:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Dec. 1 ...	19 55 23	S 21° 20′ 55″
„ 31 ...	20 1 47	S 21° 2′ 40″

Uranus is approaching conjunction with the Sun, which takes place 20th January, and hence is practically unobservable, as he sets about 6.30 p.m. near the middle of the month.

Neptune:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Dec. 1	7 40 55	N 20° 50′ 8″
„ 31 ...	7 37 58	N 20° 57′ 11″

Neptune rises at 7 p.m. on the 1st, and at 5 p.m. on the 31st, whilst on these dates he is due south at 3 a.m. and 1 a.m.

He is becoming more favourably placed for observation in the evenings, as he is in opposition on January 13th.

The planet is situated in Gemini, where he is describing a short retrograde path about 7° due south of Pollux and about 5° E. by S. of δ Geminorum, but in small telescopes without setting circles it is difficult to identify from the numerous small stars in the same field of view. He may, however, be detected by his motion, if observations are made on several successive nights.

Meteors.—The principal shower of meteors during the month is the Geminids, December 10th to 12th; the radiant is near Castor, in R.A. VII^h 12^m, Dec. $+33°$. The meteors are short and quick, and difficult to record accurately.

Minima of Algol may be observed on the 14th at 11 p.m., the 17th at 8 p.m., and the 20th at 4.30 p.m. The period is 2^d 20^h 49^m, from which other minima be calculated.

Telescopic Objects:—

Double Stars.—1 Pegasi 21^h $17\cdot5^m$, N. 19° 20′, mags. 4·5, 8·6; separation 36″·2.

π Andromedæ 0^h $31\cdot5^m$, N. 33° 11′, mags. 4·0, 8·0; separation 36″·3.

α Piscium 1^h $56\cdot9^m$, N. 2° 17′, mags. 3·7, 4·7; separation 3″·6.

ι Trianguli 2^h $6\cdot6^m$, N. 29° 50′, mags. 5, 6·4; separation 3″·5.

Clusters.—(H VI. 33, 34.) The Perseus clusters visible to the naked eye and situated about midway between γ Persei and δ Cassiopeiæ. These magnificent clusters are described by Smyth as "affording together one of the most brilliant telescopic objects in the heavens."

(M 34.) A mass of small stars about the 8th magnitude; not very compact. The cluster is just perceptible to the naked eye about 5° North-West of Algol.

NOTICES.

ROYAL INSTITUTION.—A General Monthly Meeting of the Members of the Royal Institution was held on November 6th, the Duke of Northumberland, K.G., President, in the Chair. The Chairman reported the decease of the Right Hon. Earl Cathcart, D.L., J.P., a Manager, Professor G. L. Van der Mensbrugghe, Professor W. V. Spring and Professor L. J. Troost, Honorary Members of the Royal Institution, and resolutions of condolence with the families were passed. The Eighty-sixth Christmas Course of Juvenile Lectures, founded at the Royal Institution in 1826, by Michael Faraday, will be delivered this year by Dr. P. Chalmers Mitchell, D.Sc., LL.D., F.R.S., Secretary of the Zoological Society, his subject being "The Childhood of Animals." The Lectures will be delivered on the following dates, at 3 o'clock: Thursday, December 28th; December 30th, 1911; January 2nd, 4th, 6th, and 9th, 1912.

INTERNATIONAL CONGRESS OF ENTOMOLOGY. CORRECTED DATE.—The Second International Congress of Entomology will be held at Oxford, from August 5th to 10th, 1912, and not as previously announced. The President of the Congress is Professor E. B. Poulton, D.Sc., F.R.S. All communications and enquiries should be addressed to the General Secretary of the Executive Committee, Dr. Malcolm Burr, c/o Entomological Society of London, 11, Chandos Street, Cavendish Square, London, W.

CORRESPONDENCE.

THE FLIGHT OF THE ALBATROSS.

To the Editors of "KNOWLEDGE."

SIRS,—We often hear of the mystery of how the Albatross can fly without flapping its wings. I have often by the hour closely watched these birds on the wing, and seen that they make no movement save slight guiding and directing alterations of tail and wing. The head is moved about freely to look in all directions, and the bird will occasionally scratch itself with claw or beak, for they always swarm with vermin, but usually there is no flapping of the wings at all.

In these days of fast steamers, as there are few opportunities of watching their flight, may I record my evidence of how one of these birds will thus follow a ship for many days and nights together?

First, they only fly in their characteristic manner while the wind is blowing. As the wind drops they begin to flap; and as a calm comes on they soon tire of flying by flapping and settle on the sea like great ducks. Then when enough wind remains to move the ship they are usually left behind and not seen again. Why they so soon tire of flapping is because the humerus (arm-bone) is very long, while the pectoral muscles are comparatively small and supported by a small keel to the sternum.

Presumably they use the wind to help them to fly. But how?

All the while they are flying they are repeatedly rising high into the air, then swooping down close to the sea surface, and then up again. If there was no friction nor other loss of energy, the impetus of the swoop would enable the creature to rise to as high a spot as it came down from. Or if it could get from the wind a little impetus to replace the certain loss of energy the bird could continue to rise and fall as long as the wind blew. It does this.

When there is wind at sea there are also waves. As the wind slides up the back of a wave towards the crest it is directed upwards. The Albatross always swoops deep into the trough of the sea, where it is somewhat sheltered from the wind, and there, facing towards the on-coming wave, it begins to rise close to the front surface of the wave. When it crosses the crest the bird may be seen to get a distinct "lift" from the up-current of air.

To fly by this method across the wind, or in the direction of the wind, the Albatross has to make curious gyrations, so as to face the wind after each swoop. If this manoeuvre is prevented, as by the distraction of some tit-bit or a quarrel with a companion, the bird has to flap and fly like any other gull.

This mystery is as usual made by omitting a necessary detail of description; as also when we are told that often when placed on deck this sea-bird is sea-sick! If we were told that while it was being hauled on board the bird had gaped its beak wide open to get the hook out, and being dragged through the crests of several waves it had thus swallowed large quantities of sea water, then we should guess that it was sick from sea water, not from the motion of the ship.

How the Albatross can do without sleep for so long remains a mystery. It sometimes looks half asleep while it executes its monotonous movements.

T. ARCH. DUKES.

ROTATION OF VENUS.

To the Editors of "KNOWLEDGE."

SIRS,—The April Number of "KNOWLEDGE" contained a short article of mine on the above subject, in which I advanced some reasons for assuming that Venus still has a rotation period shorter than its year, even though this rotation might be too slow to be detected from observation. It is interesting to learn that since then M. Belopolsky has confirmed some of his previous spectroscopic [illegible] period of 1·44 days. This result is in [illegible] and corroborates to a great extent the [illegible] of Schröter and De Vico. On the other hand [illegible] obtained no indication of a rapid rotation [illegible] of Venus, which agrees with the direct visual [illegible] relli and Lowell.

These conflicting observations of [illegible] are very unsatisfactory, and are the more [illegible] as each result has been confirmed by an independent [illegible] of research. We can only hope that ere long [illegible] evidence may be obtained upon this, at present [illegible] question.

B. G. HARRISON.

CLUSTERS AND NEBULAE.

To the Editors of "KNOWLEDGE."

SIRS,—Referring to my article "Clusters and Nebulae" in your September number, I have just received a letter from Dr. Fath, of the Mount Wilson Solar Observatory, Pasadena, California, together with a minute print of one of his Lick Spectrograms of the Andromeda Nebula. Notwithstanding its small scale there appear to be indications of lines corresponding to those in the solar spectrum, and he states there are other fainter lines (lost in the print).

I am accordingly sending you this note at his desire, so that it may be seen that his opinion (quoted on page 344, column 1) was not given without evidence. Dr. Fath also states in his letter "Dr. Lockyer and Mr. Frank McClean were here a few months ago, and saw some of the original negatives. I believe they will agree that these absorption lines are well marked in the originals."

F. W. HENKEL.

THE VELOCITY OF LIGHT.

To the Editors of "KNOWLEDGE."

SIRS,—Surely your correspondent, G. R. Gibbs, is trying to hoax your readers with his suggestion that light has its velocity reduced by the earth's atmosphere to some twenty miles a second because he can see a flash of lightning. Considering that he admits that the observations for computing the velocity of light actually showed a velocity of one hundred and eighty-six thousand miles a second near the earth's surface, it is difficult to see on what principle of logic he yet considers that twenty miles is the correct figure. Does he really imagine that a brilliant spark will become invisible if it takes less than one-tenth of a second to accomplish its path? Considering that the spark of an electric machine is visible when one-tenth of an inch long, are we to infer that such sparks only travel one inch in a second?

CHARLES L. BENHAM.

To the Editors of "KNOWLEDGE."

SIRS,—Theosophists state that the Earth has a motion which has not yet been discovered by Astronomers.

This motion consists of the rotation of the Earth's axis about its centre thereby causing the Earth to "turn turtle" as the saying is, in other words that in time the Southern Hemisphere will face the Pole star in a similar manner that the Northern Hemisphere does at present.

If this statement is correct it would fully account for the various large changes in temperature which appear to have taken place in the different parts of the Earth.

Does not the difference in the inclinations of the axes of the planets to the planes of their orbits point to the possibility of all the planets being subject to this motion?

F. G. STOPFORD (Admiral).

THE COAL RESOURCES OF THE UNITED KINGDOM.

To the Editors of "Knowledge."

Sirs,—Attention has again been attracted to the contents of our natural coal store. Experts have pointed out that we are rapidly exhausting the coal resources of our country, and they estimate the life of our coalfields to be less than two hundred years. Half a century ago, experts gave a similar estimate, and we have during the last fifty years withdrawn millions of tons from the natural store.

It is of interest, and as well assuring, to note that whilst the Royal Commission of 1871 estimated the "available coal" at 90,207,285,000 tons, the final report of the 1905 Commission gave the quantity of available coal as 100,914,668,167 tons. Thus the figures of the last Commission exceeded those of 1871 by 10,707,383,167 tons, and it must be considered that during the period 1871-1905, no less than 5,694,928,507 tons had been brought to bank.

Since the last Commission sat, there have been considerable additional coal areas proved in Lincolnshire and in the South of England. A reasonable survey of the coal "in store" within the United Kingdom gives ample assurance that our coal supplies are safe for the next five hundred years.

National economy requires a periodical stocktaking of available coal, and demands that the coal drawn from the natural store shall be economically utilized.

Every ton of coal mined reduces the assets of the nation, and it is a national duty to prevent avoidable waste, in (*a*) winning coal from its natural bed, and (*b*) in the conversion of the potential energy of the coal into useful work.

Few people realize the amount of power which is stored in coal. One teaspoonful of British coal contains sufficient energy to lift two modern locomotives to a height of one foot. A piece of coal the size of a man's fist has power enough to throw a weight of thirty pounds to a height of one-and-a-quarter miles. In our houses we use coal by the shovelful; but if the heat stored in the coal was efficiently utilized the coal-spoon would displace the shovel. To boil a gallon of water we require a large fire; yet the heat produced by one pound of coal is sufficient to raise to boiling point one hundred pounds or ten gallons of water.

Industrially we only utilize one-tenth of the power stored in coal; the balance (nine-tenths) is used up or wasted in the process of securing the one-tenth.

A National Conservancy is needed to protect the national store of solid fuel, and to obtain a better efficiency in the every-day use of coal. The industrial and maritime power and progress of our nation is founded on the enormous stores of first-grade coal and the large annual production.

Within the United Kingdom no less than two hundred millions of tons of coal are consumed annually, and the yearly export is well over sixty millions of tons. The important bearing of these figures on our national industries is quite obvious.

It is a national duty to win every ton of coal from the natural store in the most economical manner possible, and to obtain from the coal produced the highest possible value. These points are worth the attention of the nation's economists, and provide a wide field for profitable scientific investigation.

MYLES BROWN.

QUERIES AND ANSWERS.

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

QUESTIONS.

55. THE NEW ASTRONOMY.—I should be very grateful for any information as to the variability of double stars, and especially I should like to know of binaries that are doubly variable. If spectroscopists would look for lines of planetary nebulae about variable doubles, about the Cepheids, and about variables whose light curve ascends more quickly than it descends, they might supply useful information. I should also be glad to know if another variable could be found in the neighbourhood of variables with that kind of light curve when one exists alone. It would also be valuable to the theory to find if nebulosity at minimum exists in the case of any of the Cepheids. On page 80 in "The Birth of Worlds and Systems" (Harper's Library of Living Thought), I have given a table of variables that I picked out from Gore's list; nebulosity should be looked for between the constituents of each pair, or perhaps surrounding them if close. The lines of planetary nebulae should also be looked for about them. The old measures should be compared with the new ones, to see if the stars are still separating, or if they are in long ellipses. Their exact angle and distance should now be determined to make future comparisons. I should also be pleased if the position where novae have appeared were examined for nebulosity, for faint fluctuations of light, and for the lines of planetary nebulae. The Owl and Dumb-bell nebulae seem to me to be planetary nebulae. I should be glad to know if they show the characteristic lines; the singular bilateral symmetry suggests that each is a third body struck from grazing suns. In the case of the Owl the eyes may be the two original moderately rare bodies; it would be interesting to know if any changes of form or structure in these or other planetary nebulae have been observed, and it would also be desirable to know the several chemical elements of the sphere-in-sphere constituents of these nebulae.

Mr. McCarthy, in his encouraging letter, speaks of the exact comparison he finds to exist between the deduced properties of the third body and those observed in Nova Persei. Mr. Raffety is a careful spectroscopic student; I should like to know if he has compared the two, and to have his opinion as to temporary and variable stars being the result of partial impact and the third body.

A. W. Bickerton.

56. WATER SNAILS (*PLANORBIS CORNEUS*).—Would one of your readers describe the parasite of the Water Snails (*Planorbis Corneus*, and so on). It appears to eat into the shell and ultimately causes the death of the host.

J. M.

57. SOLAR SPECTRUM.—Why in photographs of the solar spectrum from diffused daylight (a bright sky) the lines are never sharp, as in the case from direct sunlight, though the slit has the same width?

C. A. S.

58. In a train of prisms for great dispersion, is there interference of light where the two beams of light cross? If not, why? And if there is, why is there no interference effect in the spectrum?

C. A. S.

ANSWERS.

51. THE GEOLOGY OF SOUTH DORSET.—Information asked can easily be obtained by turning up "Kelly's Directory of Hampshire, Wiltshire, Dorsetshire and the Channel Isles, 1907," where an outline of the Geology of Dorsetshire is ably described by W. Jerome Harrison, F.G.S., in which he not only gives a full account of the Strata, Minerals, and Fossils, but also of the names and writers of the numerous books treating on the Geology of the district. There is also a splendid collection of fossils in the Museum at Dorchester. The publications of the Government geological survey maps and reports, Map Sheet 16, Poole, Wareham and Swanage, take up the latest details; these can be obtained from Mr. Henry Ling, Bookseller, Dorchester, Dorsetshire.

A. M. W.

THE FACE OF THE SKY FOR JANUARY, 1912.

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

THE following table gives the Right Ascension and Declination of the Sun, Moon and Planets at intervals of 5 days, at Greenwich noon.

The following table gives for the Sun, Mars and Jupiter:— P the Position Angle of the Sun's or Planet's North Pole, measured from the North Point of the disc towards the East, B the Heliographical or Planetographical latitude of the centre of the disc, and L the Heliographical or Planetographical longitude of the centre of the disc, which in the case of the Sun or Jupiter is reckoned from an arbitrarily chosen zero meridian, in the case of Mars from the marking Fastigium Aryn (formerly called Dawes Forked Bay). That of Jupiter, system II, originally coincided with the great Red Spot. Two values are given for Jupiter: I corresponds to the equator, II to temperate zones. T the time of transit of the zero meridian is also given for each of the given dates. Here and elsewhere in these pages the time used is Greenwich Civil Time, day beginning at midnight, and the letters *m* (morning), *e* (evening) are used as abbreviations for a.m. and p.m. The quantities P, B, are also given for Saturn, and serve to indicate the position of the minor axis of the ring, and the amount of its opening. The additional quantities Q, q, given for Mars are the Position Angle (from North Point towards East) and the amount, in seconds of arc, of the greatest defect of illumination.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Ceres. R.A.	Ceres. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
	h. m.		h. m.		h. m.		h. m.		h. m.		h. m.		h. m.		h. m.		h. m.	
Jan. 1	[illegible]	S.[illegible]	[illegible]	N.[illegible]	17 30·3	S.20·2	15 7·0	S.16[illegible]	[illegible]	N.[illegible]	[illegible]	N.[illegible]	[illegible]	S.[illegible]	[illegible]	N.[illegible]	[illegible]	N.[illegible]
„ 6	19 4·4	[illegible]	[illegible]	N.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3 27·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
„ 11	19 26·2	[illegible]	11 22·1	S.[illegible]	[illegible]	[illegible]	[illegible]	19·4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
„ 16	19 47·[illegible]	[illegible]	[illegible]	27·4	[illegible]	[illegible]	[illegible]	20·4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
„ 21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17 16·4	21·2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
„ 26	[illegible]	[illegible]	[illegible]	N. 9·5	[illegible]	[illegible]	17 42·1	[illegible]	[illegible]	22·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
„ 31	[illegible]	S.17·7	[illegible]	N.[illegible]	[illegible]	S.[illegible]	[illegible]	S.22·[illegible]	[illegible]	N.22·1	[illegible]	N.[illegible]	[illegible]	S.[illegible]	[illegible]	N.13·[illegible]	[illegible]	N.[illegible]

TABLE 1.

THE SUN is nearest to the earth on Jan. 3, distance 91½ million miles: it is commencing its northward march, slowly at first, but with increasing speed. At Greenwich it rises at 8.8 on Jan. 1, sets at 3.58; it rises at 7.44 on Jan. 31, sets at 4.43. Its semi-diameter diminishes during the month from 16′ 18″ to 16′ 15″. The minimum of sunspot activity is expected in 1912 or 1913, but cannot as yet be predicted with mathematical accuracy.

THE MOON is Full, Jan. 4, 1^h 30^m *e.*; L.Q., Jan. 11, 7^h 43^m *m.*, New, Jan. 19, 11^h 10^m *m.*; F.Q., Jan. 27, 8^h 51^m *m.*; Perigee, Jan. 4, 2^h *e.*, distance 221,400 miles (an unusually close approach); Apogee, Jan. 18, 2^h *m.*, distance 264,600 miles.

The following gives the dates of the Moon's maximum librations: Dec. 29, 8° E.; Jan. 5, 6° S.; Jan. 10, 8° W.; Jan. 19, 7° N.; Jan. 26, 7° E.; Feb. 1, 7° S. The letters E. W. indicate that the region brought into view is on the East (Mare Humorum side), or West (Mare Crisium side) respectively. The letters N. S. indicate that the regions brought into view are at the Moon's N. or S. Poles. Observers will do well to watch their libration opportunities to improve our knowledge of the regions near the limb.

The occultations visible at Greenwich are given on page 475.

MERCURY is a morning star. It reaches W. elongation

Date.	Sun. P	Sun. B	Sun. L	Mars. P	Mars. B	Mars. L	Mars. Q	Mars. q	Mars. T	Jupiter. P	Jupiter. B	Jupiter. L_I	Jupiter. L_{II}	Jupiter. T_I	Jupiter. T_{II}	Saturn. P	Saturn. B
	°	°	°	°	°	°	°	″	h m	°	°	°	°	h m	h m	°	°
Jan. 1	[illegible]	S.[illegible]	[illegible]	[illegible]	S.14·[illegible]	[illegible]	[illegible]	[illegible]	[illegible] *m*	[illegible]	S.[illegible]	[illegible]	[illegible]	[illegible] *e*	[illegible]	[illegible]	S.[illegible]
„ 6	[illegible]	[illegible]	[illegible]	[illegible]	14·[illegible]	[illegible]	[illegible]	[illegible]	[illegible] *m*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] *e*	[illegible] *e*	[illegible]	[illegible]
„ 11	[illegible]	[illegible]	[illegible]	[illegible]	14·5	[illegible]	[illegible]	[illegible]	[illegible] *e*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] *e*	[illegible] *e*	[illegible]	[illegible]
„ 16	[illegible]	4·7	[illegible]	[illegible]	14·1	[illegible]	[illegible]	[illegible]	[illegible] *e*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] *e*	[illegible] *e*	[illegible]	[illegible]
„ 21	[illegible]	[illegible]	[illegible]	[illegible]	13·7	223·6	77·7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] *e*	[illegible]	[illegible]
„ 26	350·6	[illegible]	[illegible]	[illegible]	[illegible]	170·7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] *e*	[illegible]	[illegible]
„ 31	[illegible]	S.[illegible]	[illegible]	[illegible]	S.12·6	[illegible]	[illegible]	[illegible]	[illegible] *m*	[illegible]	S.2·0	[illegible]	[illegible]	[illegible] *e*	[illegible] *e*	[illegible]	S.[illegible]

TABLE 2.

The values of T_I T_{II} for Jupiter on intermediate days may be found by applying multiples of 9^h $50\frac{1}{2}^m$, 9^h $55\frac{1}{4}^m$ respectively.

It should be mentioned that L is reckoned in the opposite direction on the Sun from that used on Mars and Jupiter. This difference is unfortunate, but it has become established and cannot now be altered.

The two systems may be best explained thus: in that used for the Sun the longitudes of Bombay and New York from Greenwich would be 73°, 286° respectively; in that used for Mars and Jupiter the same two longitudes would be Bombay 287°, New York 74°.

(24° from Sun), Jan. 15. It is 6° N. of Moon, Jan. 17, 6^h *m.* Its diameter diminishes during month from 9″ to 5″; the illuminated part of disc increases from [illegible] to [illegible].

VENUS is a morning star, pretty well placed for observation. It is 6° N. of Moon, Jan. 15, 5^h *e.* Its diameter diminishes from 18″ to 15″; the illuminated part of disc increases from [illegible] to [illegible].

MARS has passed opposition, but is still well placed for observation. The vernal equinox of the Northern Hemisphere occurs on Jan. 14. His diameter diminishes from 13½" to 10". Veiling of surface details by mist or cloud in the Martian atmosphere seems to have occurred in several regions of the planet in October, according to MM. Antoniadi, Jarry-Desloges, and others.

Ceres, the largest of the asteroids, is in a very favourable opposition in January, being in high north declination, and also near perihelion. Its diameter is 430 miles, just ⅕ of the Moon's, and it will be of the 7th magnitude, and thus easily visible in the smallest telescope or binocular; a map of surrounding stars is given, which should make it easy to pick the object up and follow its motion from day to day. The brightest stars in the map are of mag. 5½, the faintest of mag. 9½. Faint stars are only shown when fairly near the planet's track.

Jupiter is a morning star, and just beginning to become observable after conjunction with the Sun. Its Equatorial Diameter increases from 32" to 34"; the Polar is 2" less. The defect of illumination on the West limb is ¼". The configurations of the satellites as seen with an inverting telescope at 6^h *m* are:—

Day.	West.		East.		Day.	West.		East.	
Jan. 1	2/4		13		Jan. 17	34		12	
.. 2	41	⊙	2		.. 18	12			
.. 3	43		12		.. 19	432		1	
.. 4	43 1/2				.. 20	41		32	
.. 5	4 3/2		1		.. 21	4		123	
.. 6	41		32		.. 22	421		3	
.. 7	4		1/2 3		.. 23	42		13	
.. 8	2⁴		3	1 ●	.. 24	43		2	1 ●
.. 9	1		34	2 ●	.. 25	31	⊙	4	
.. 10	3		124		.. 26	32		14	
.. 11	312		4		.. 27	13		24	
.. 12	32		14		.. 28			1234	
.. 13	1		324		.. 29	21		34	
.. 14			1234		.. 30	2		134	
.. 15	21		3/4		.. 31	3		24	1 ●
.. 16	2	⊙	3/4						

The following phenomena are visible at Greenwich:—1^d 5^h 40^m *m*. I. Oc. R.; 2^d 6^h 14^m *m*. III. Tr. E.; 7^d 7^h 24^m *m*. I. Sh. I.; 8^d 7^h 40^m *m*. I. Oc. R.; 9^d 5^h 23^m *m*. III. Sh. I.; 7^h 1^m *m*. II. Oc. R.; 7^h 12^m *m*. III. Sh. E.; 15^d 6^h 34^m 32^s *m*. I. Ec. D.; 16^d 4^h 40^m *m*. I. Tr. I.; 5^h 21^m 19^s *m*. II. Ec. D.; 5^h 58^m *m*. I. Sh. E.; 6^h 53^m *m*. I. Tr. E.; 18^d 4^h 37^m *m* II. Tr. E.; 20^d 5^h 14^m *m*. III. Oc. R.; 23^d 5^h 38^m *m*. I. Sh. I.; 6^h 38^m I. Tr. I.; 7^h 51^m *m*. I. Sh. E.; 24^d 6^h 8^m *m*. I. Oc. R.; 25^d 4^h 44^m *m*. II. Tr. I.; 5^h 18^m *m*. II. Sh. E.; 7^h 23^m *m*. II. Tr. E.; 27^d 5^h 8^m 5^s *m*. III. Ec. R.; 7^h 35^m *m*. III. Oc. D.; 30^d 7^h 31^m *m*. I. Sh. I.; 31^d 4^h 50^m 17^s *m*. I. Ec. D. The eclipses take place high left of the disc in an inverting telescope, considering the direction of the belts as horizontal.

Saturn is still well placed for observation. Its equatorial diameter is 19", major axis of ring 44", minor axis 15". The shadow of the ball on the ring is visible on the East side. The satellites except the outer ones, Iapetus and Phoebe, are in almost the same plane as the ring, so their apparent orbits are widely open ellipses. The times of some Eastern Elongations are given; intermediate ones are found by applying multiples of 1^d 21^h for Tethys, 2^d 18^h for Dione, 4^d $12\frac{1}{2}^h$ for Rhea.

Tethys, 2^d 6^h *e*; 8^d 10^h *m*; 14^d 2^h *m*; 19^d 6^h *e*; 25^d 10^h *m*; 31^d 2^h *m*. Dione 2^d 3^h *e*; 8^d 2^h *m*; 13^d 2^h *e*; 19^d 1^h *m*; 24^d *noon*; 29^d 11^h *e*. Rhea 5^d 10^h *m*; 14^d 11^h *m*; 23^d *noon*; Feb. 1^d *noon*. For Titan and Iapetus, E.W. stand for E. and W. elongations, I.S. for inferior and superior conjunctions. Titan 5^d 6^h *m* W. 9^d 4^h *m* S. 13^d 8^h *m* E. 17^d 9^h *m* I.. 21^d 5^h *m* W. 25^d 3^h *m* S. 29^d 7^h *m* E. Iapetus, Jan. 16^d 9^h *e* I. Feb. 5^d 8^h *m* W. This satellite is much easier to see W. than E. of the planet: it is presumed to rotate in the same time as its revolution.

Uranus is invisible, being in conjunction with the Sun on January 20th.

Neptune is very favourably placed, being in opposition on January 13th. It is of the 8th magnitude, 2¼" in diameter. A map is given of the stars near its path. Their magnitude ranges from 6½ to 9½. With its aid a powerful binocular or a 1½-in. telescope should find the planet. In December, it is 7½° south of Pollux. Its satellite, Triton, is too faint to justify the inclusion of an ephemeris here.

Comets.—The numerous comets visible in England in the autumn have now passed to the south, and become much fainter. Ephemerides are given for the use of southern observers; that of Brooks's comet is due to Dr. Smart.

It is hoped that Quenisset's Comet will be observed as long as possible in the Southern Hemisphere, as its orbit resembles that of 1790 III, and its identity appears possible.

BROOKS' COMET.

Date.	R.A. h. m. s.	S. Dec.	Log. r.	Log. △
Jan. 3	14 41 0	44 13'	0·1738	0·2588
.. 7	14 47 8	45 33	0·1923	0·2660
.. 11	14 52 59	46 49	0·2099	0·2724
.. 15	14 58 12	48 1	0·2266	0·2781
.. 19	15 3 4	49 12	0·2424	0·2833
.. 23	15 7 12	50 19	0·2576	0·2878
.. 27	15 10 44	51 24	0·2722	0·2918
.. 31	15 13 44	52 27	0·2860	0·2953
Feb. 4	15 16 9	53 28	0·2993	0·2985
.. 8	15 17 49	54 27	0·3121	0·3011
.. 12	15 18 24	55 25	0·3245	0·3037
.. 16	15 18 24	56 19	0·3363	0·3062
.. 20	15 17 24	57 11	0·3478	0·3083
.. 24	15 15 32	58 1	0·3588	0·3102
.. 28	15 12 40	58 48	0·3695	0·3115

QUENISSET'S COMET.

Date.	R.A. h. m. s.	S. Dec.	Log. r.	Log. △
Dec. 31	15 49 37	29° 18'	0·0806	0·2567
Jan. 8	15 49 8	34 37	0·1171	0·2499
.. 16	15 47 7	40 11	0·1519	0·2406
.. 24	15 42 28	45 59	0·1838	0·2312
Feb. 1	15 33 35	52 1	0·2141	0·2220
.. 9	15 17 52	58 8	0·2421	0·2156
.. 17	14 50 1	64 5	0·2684	0·2124
.. 25	14 2 9	69 16	0·2920	0·2139

Borrelly's Periodic Comet will probably be an easy telescopic object in December and January in both hemispheres. The following ephemeris is by Dr. Smart, from M. Fayet's elements, taking 1911, December 18·01 Greenwich Mean Time as the date of perihelion.

(*Continued on page 176.*)

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. Pt. E.	Reappearance. Mean Time.	Reappearance. Angle from N. Pt. E.
			h m		h m	
Jan. 1 ...	32 Tauri ..	5·8	5.14 e	67°	6.17 e	243
.. 1 ...	BAC 1238	6·5	7.51 e	354		319
.. 2 ...	62 Tauri	6·1	5.39 m	35		
.. 2	BD + 26° 706	6·8	10.10 e	77	—	—
.. 3	BAC 2023 ...	6·7	9. 8 e	157		—
.. 4	BD + 27° 1104	6·9	4.40 m	90		
.. 4	BD + 27° 1104	7·7	6.32 m	83	—	—
.. 4	BAC 2383	6·5	5. 0 e	43	5.35 e	315
.. 5 ...	ε Geminorum ...	5·5	4.10 m	90	5. 6 m	304
.. 8	l Leonis	5·3	6.22 m	160	7.12 m	267
.. 10	η Virginis ...	4·0	0.31 m	182	1. 2 m	241
.. 16	43 Ophiuchi ...	5·4		—	7.12 m	248
.. 25 ..	73 Piscium	6·2	8.45 e	56	6.47 e	247
.. 26 ..	BAC 542 ...	7·0	5.21 e	31		
.. 26	54 Ceti ...	6·0	7.44 e	120	—	
.. 27 ...	BAC 609 ..	6·0	0.25 m	60	—	
.. 27	π Arietis ...	5·2	11.45 e	87	0.30 m*	238
.. 29	BAC 1180 ..	5·0	1.47 m	114	2.30 m	220
.. 29	Mars ...	—	2.34 m	74	3.24 m	206
.. 29	BD + 24° 674 ...	6·8	8.16 e	108	—	
.. 30	BAC 1754	5·7	4.43 e	166	5.38 e	228
.. 30	BD + 27° 880 ..	7·0	10.33 e	61	—	
.. 31	136 Tauri ...	4·6	0.20 m	45	1. 2 m	321
.. 31	BD + 27° 943	7·0	2.52 m	98	—	

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

The asterisk indicates the day following that given in the date column. 0^h is used instead of 12^h. The occultation of Mars is not very favourable for observation, the Moon setting as the planet re-appears.

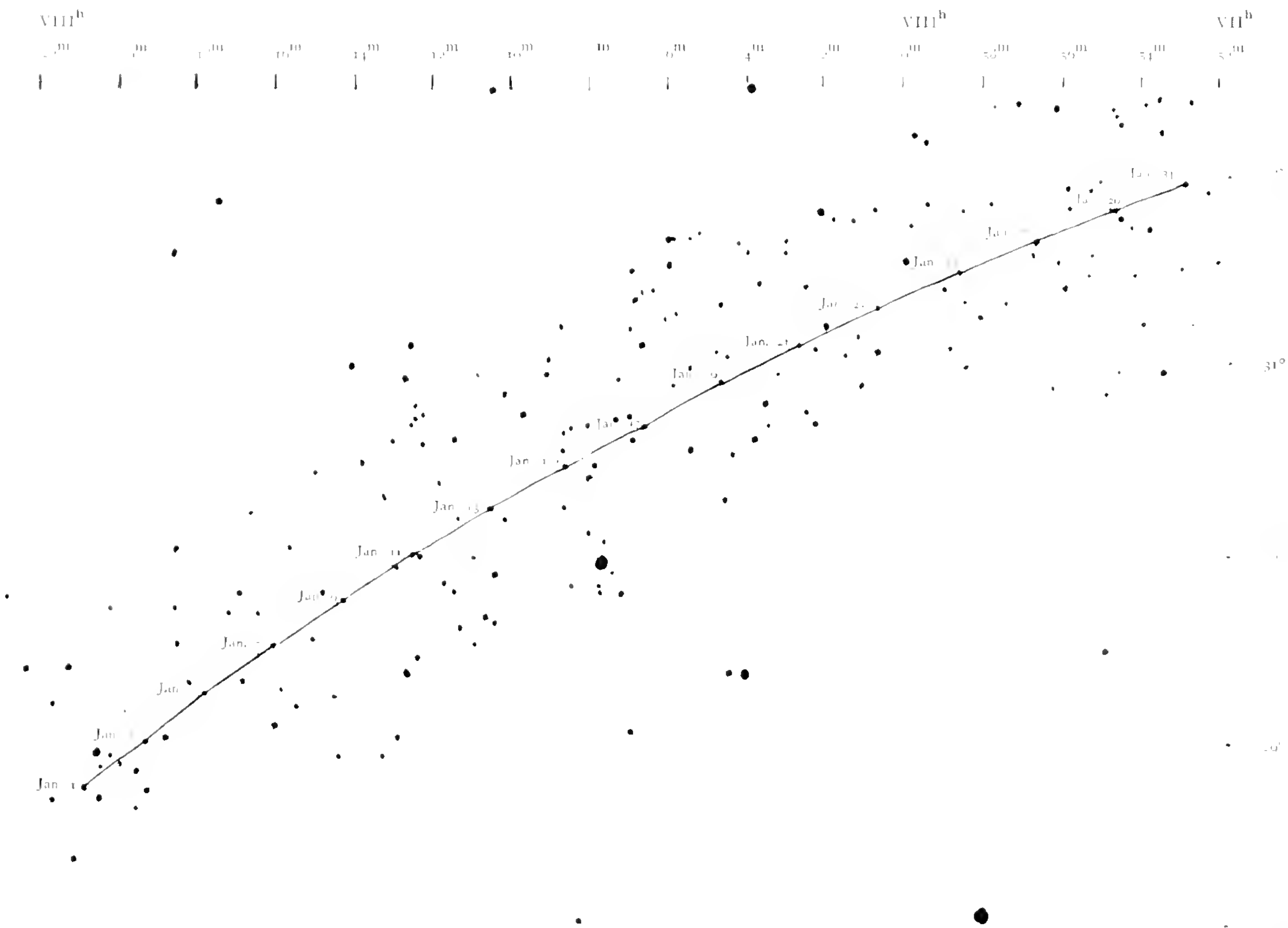


FIGURE 1. Stars near the path of Ceres, January, 1912.

BORRELLY'S COMET.

Date.	R. A.	Dec.	Log. r	Log. Δ
	h. m. s.			
Dec. 5	2 50 24	S. 8 38	0·1492	0·7065
" 13	2 48 0	N. 0 8	0·1472	0·7120
" 21	2 43 16	8 55	0·1471	0·7328
" 29	2 42 22	17 3	0·1488	0·7653
Jan. 6	2 45 52	24 12	0·1523	0·8052
" 14	2 52 44	30 17	0·1574	0·8491
" 22	3 3 29	35 15	0·1641	0·8931
" 30	3 17 28	N. 39 37	0·1720	0·9376

METEOR SHOWERS.—The following list of radiants for January is due to Mr. W. F. Denning.

Date.	Radiant. R.A.	Radiant. Dec.	Notes.
Jan. 2–3	230	N 53	Brilliant shower, swift, long-paths.
" 3 ...	150	N 41	Swift.
" 11–25	220	N 13	Swift, streaks.
" 17 ...	205	N 53	Slow, bright.
" 17–23 ...	159	N 27	Swift.
" 25	131	N 32	Swift.
" 29	213	N 52	Very swift.

VARIABLE STARS.—The following list gives every third minimum of Algol. Its magnitude ranges from 2·3 to 3·5. Period $2^d\ 20^h\ 49^m$. Jan. $6^d\ 9^h$e., $15^d\ 11^h$*m.*, $24^d\ 2^h$*m.*, Feb. $1^d\ 4^h$e.

β Lyrae ranges from 3·4 to 4·5.

Max.	Principal Min.	Max.	Secondary Min.
Jan. $3^d\ 9^h$*m.*	$6^d\ 1^h$.	$9^d\ 3^h$ e.	$12^d\ 12^h$ e.
" 16 7 *m.*	19 11 *m.*	22 1 e.	25 10 e.
" 29 5 *m.*			

DOUBLE STARS.—The period over which any double star can be observed is nearly always several months, and in some cases the whole year. But in order to make a distribution into months, I am adopting the principle of taking those which cross the meridian between 9^h and 11^h p.m. on the 20th of each month, *i.e.*, in January the limits of Right Ascension are 5^h to 7^h, in February 7^h to 9^h, and so on. Merely a brief selection of double stars, clusters and nebulae within these limits can be given.

The angle is measured from North towards East.

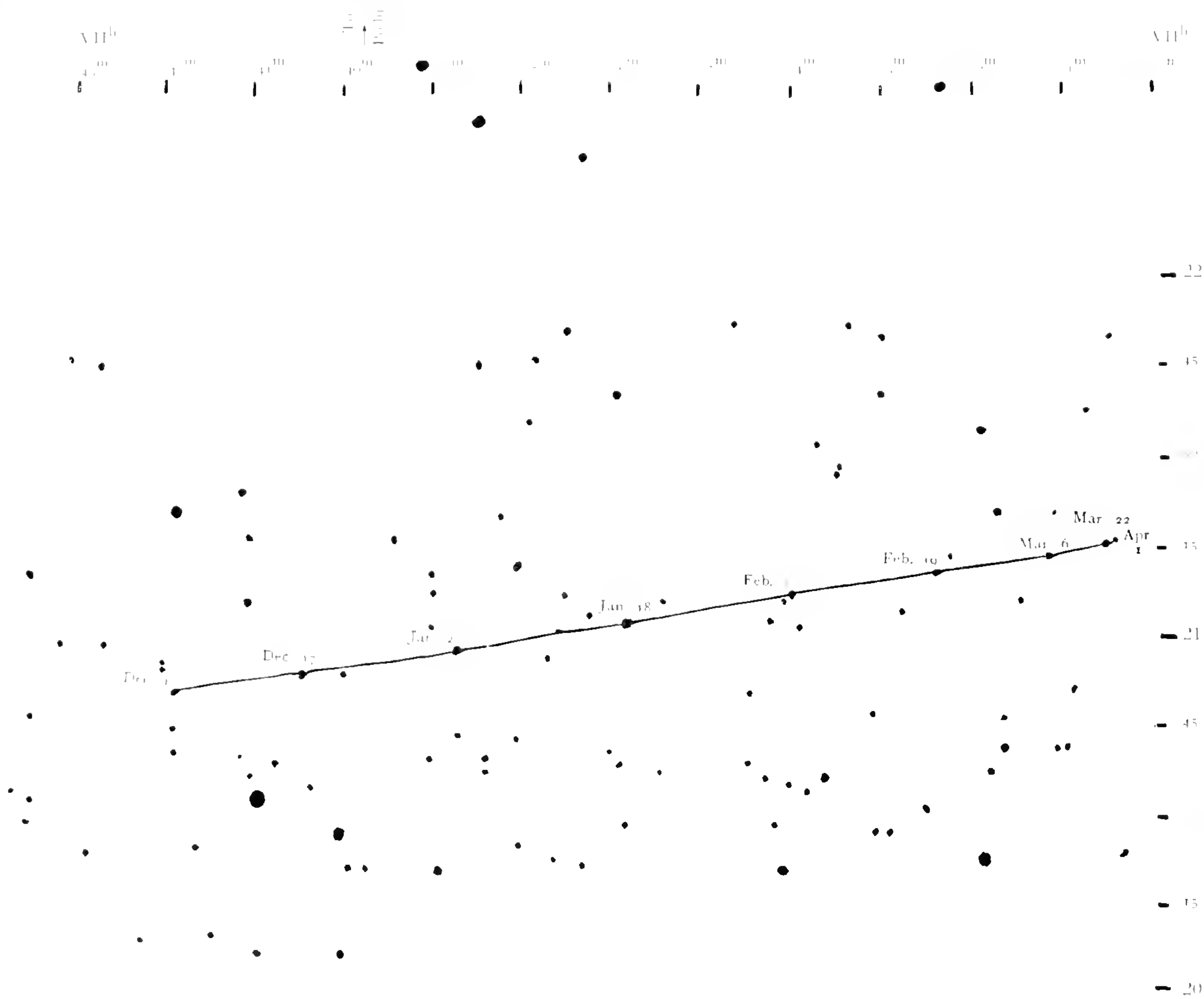


FIGURE 2. Stars near the path of Neptune, December, 1911, to April, 1912.

Star.	Right Ascension.	Declination.	Magnitudes.	Angle.	[illegible]	Colours.
	h. m. s.					
ρ Orionis ...	5 8 40	2 46′ N	5.8	63°	7	Yellow, blue.
ι Leporis	5 8 10	11 58 S	4.10	337	12	Bluish-white.
κ Leporis	5 9 10	13 3 S	5.8	358	3	Yellow, blue.
Rigel	5 10 17	8 18 S	1.8	202	10	Yellow, blue.
			The companion is an exceedingly close double.			
118 Tauri	5 23 44	25 4′ N	6.7	202	5	White, blue.
λ Orionis ...	5 30 12	9 52 N	4.6	43	5	Yellow, purple.
θ^1 Orionis	5 30 55	5 27 S	The Trapezium in the Great Nebula.			
σ^2 Orionis	5 34 30	2 30 S	A quadruple star, the principal being an exceedingly close pair, with more distant companions of 6 mag., 7 mag., 10 mag.			
ζ Orionis ...	5 36 10	2 0 S	2.5	156	2″	Yellow, blue.
4 Lyncis	6 14 0	59 25 N	6.8	103	1	White.
8 Monocerotis ...	6 19 2	4 30 N	4.7	24	13	Golden, lilac.
11 Monocerotis	6 24 30	0 58 S	5.5.6	132 / 106	7 / 3	Triple star.
12 Lyncis	6 38 24	59 31 N	5.6.7	119 / 306	1 / 8	Triple star.
Lal. F. 667	6 40 30	55 51 N	6.6	258	5	Yellow.
14 Lyncis ...	6 45 0	59 30 N	6.7	75	½	Orange, blue.
38 Geminorum	6 49 30	13 18 N	5.8	160	6	Yellow, blue.
μ Canis Majoris	6 52 3	13 56 S	5.8	338	3	Orange, red.
Piazzi VI 301 ...	6 58 35	52 53 N	6.7	155	3	White.

CLUSTERS AND NEBULAE.

	R.A.	Dec.	
M 38	5^h 22^m	35 49′ N.	Cruciform cluster
M 1	5 28	21 57 N.	The Crab Nebula; 1° N.W. of ζ Tauri.
M 42	5 30	5 27 S.	Great Nebula in Orion.
M 37	5 45	32 32 N.	Even in smaller instruments extremely beautiful (Webb).
M 35	6 2	24 21 N.	Very rich field.
H VII. 2	6 26	4 50 N.	Fine cluster, visible to naked eye.
M 41	6 43	20 38 S.	Visible to naked eye, 4° S. of Sirius.

EDITORIAL NOTE.

In accordance with the wishes of many of our readers Mr. Shackleton has, for the last few months, kindly made his notes on "The Face of the Sky" deal with the first week or so of the month following the date of issue of the Magazine, so that any delay in the receipt of the latter might not affect the usefulness of the column.

With this number, on account of the increasing pressure of other duties, Mr. Shackleton has given up the work which he has so well carried on for many years, and Dr. Crommelin, who has been so good as to undertake the duty, will prepare his notes a month ahead, so that "The Face of the Sky for January" is printed here. Our readers abroad will thus be in the same position as those at home.

NOTICES.

TRANSMISSION OF DISEASE BY MEANS OF BOOKS.—The undersigned is preparing a paper upon "Books as a Source of Disease," to be read before the next "International Congress of Hygiene," and in order to obtain data, respectfully requests the readers of this note to send him an account of any cases the source of which have been traced to books or papers, or where the evidence seemed to make books or papers the offender. He would also further request information where illness or even death has been caused by the poisons used in book-making.

All the information possible is wanted to present as complete a paper as possible. As in the case of insects which we now know to be "carriers of disease," it is first necessary to collect scattered evidence in order to show that there is real danger in books; and this will compel better care to be taken of libraries and books, and improve the health of mankind.—Wm. R. Reinick, 1709, Wallace Street, Philadelphia, Pa.

BOTANY IN THE "ENCYCLOPAEDIA BRITANNICA."—A careful perusal of the botanical articles in the eleventh edition of the "Encyclopaedia Britannica" shows that the revision of this section of the great work has been entrusted to reliable and experienced hands. The result is that, with a certain amount of addition in some directions and wholesale excision in others, this collection of articles would form an exceedingly good basis for a modern text book of Botany—certainly a much better one than any English work so far produced. Here and there the antiquity of the illustration blocks reminds one irresistibly of the fount whence the authors of "Wisdom While You Wait" drew so largely in writing their amusing skit, and it seems a pity that important articles on those departments of Botany in which so much recent literature is available have not been illustrated more adequately by new figures from that literature.

Most of the articles dealing with the great divisions of the vegetable kingdom—e.g. Algae, Fungi, Bryophyta, Pteridophyta, Gymnosperms—are models of lucidity, though in some cases interesting points have been omitted owing to the doubtless unavoidably small limits of space allotted to the compilers. In some cases this limitation has not permitted of the inclusion of speculative or controversial matter or of discussions regarding the relationships of the various groups. We get the facts, but very little of the "salt of morphological ideas," to use an expressive phrase of the late Sir Michael Foster's. However, there is in most cases a well-selected bibliography at the end of each of the longer articles, whence the reader may find guidance to the literature of the subject dealt with.

It is difficult to imagine what general principles, if any, underlie the selection of the biographies given in the list of botanical articles. Some of the naturalists whose lives are summarised can hardly be said to bulk largely in the history of Botany or to have advanced the science to such an extent as did many workers whose names are missing from the list. Among the omissions, one may mention such names as those of the two Gärtners (K. F. and J.), Hedwig, Ingenhousz, the Schimpers, Spruce and Unger.

NOTES.

ASTRONOMY.

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

WIRELESS TELEGRAPHY FOR TIME SIGNALS.—*L'Astronomie* for August gives an interesting account of the manner in which the Time Signals of the Paris Observatory are distributed by wireless telegraphy.

The standard clocks are kept in the "Catacombs," ninety feet under ground, where there is a practically constant temperature of 11°·8 C, the variations in several years being under 0·02. The sidereal and solar clocks can be compared at a distance, their beats being rendered audible by microphones.

Wireless telegraphy was first used for distributing time signals on 23rd May, 1910. It is probably only a question of time before these or similar signals are available to ships in any part of the world, which will completely solve the problem of longitude at sea, with an accuracy formerly undreamt of. This and the gyro-compass are two revolutionary improvements in navigational methods during the last fifteen months.

The mean solar clock is put right, as at Greenwich, by an electro-magnet that can either aid or oppose the action of gravity on the pendulum. Several warning signals are sent by hand in a pre-arranged manner to give notice of the actual signal, which is sent automatically by the clock, and goes through a relay to the Eiffel Tower, whence it proceeds by wireless telegraphy. A note in the *Observatory* recently stated that a clockmaker at Canterbury regulates his clocks by the Paris signals, which were recently changed to accord with Greenwich Time. Germany has also a system of signals despatched from Norddeich, and Rio de Janeiro is about to follow suit. The French propose to use the method for the accurate determination of the difference in longitude between Paris, Bizerta (Tunis), Athens and possibly Lake Tchad.

MR. BARTRUM'S THIRD QUERY.—In my solution given last month, the full value of the constant k″ should have been given, as this varies with *e* and so alters the result. Professor Adams showed that to get the numerical value of the acceleration correctly it was necessary to introduce the variation of *e* into the differential equations, and not merely put in its rate of variation at the end. He in this way brought down the numerical value to about half what had been found before. The publication of his result excited a lively discussion among mathematicians, and it was some time before Adams' result won universal acceptance.

STELLAR MOTION AND SPECTRAL TYPE.—The study of the systematic motions of the stars has engrossed much attention in recent years, Professor Kapteyn taking the lead with his announcement of the two general drifts which could be detected when the motions were analysed. This announcement was confirmed and extended by the work of Mr. Eddington, Professor Schwarzschild, and others. Last year Mr. Hough and Dr. Halm examined the radial motions of the stars, derived from spectroscopic observations, and found that these too showed anomalies such as the two-stream theory would lead us to expect. Dr. Halm has recently (*Month. Not. R.A.S.*, 1911, June) returned to the subject and arranged the evidence in a manner which makes the conclusions more evident. After eliminating the solar motion he finds preponderance of motion in the direction of the vertices of the two drifts. The average motion taken without regard to sign is twenty-six kilometres per second in these regions, and goes down to fifteen kilometres per second at intermediate points. Dr. Halm's paper also contains further confirmation of the result already announced by Kapteyn and others that a star's velocity increases as its spectral type grows more advanced. Thus the Orion type, which is supposed to consist of very large and heavy stars, in a very early stage of development, has a mean motion of six kilometres per second in the line of sight: the Sirian type has eleven kilometres, while for later types the mean motion goes up to eighteen kilometres. The advantage of the spectroscopic method is that it is independent of distance; it is particularly valuable in the case of the Orion stars, which are so remote that their transverse velocity is difficult to ascertain.

Mr. Eddington, in a paper read before the British Association, reprinted in the *Observatory* for October last, refers to the above result as "one of the most startling in modern astronomy." He proceeds:—"For the last forty years astrophysicists have been studying the spectra and forming their systems by which they arrange the stars in order of evolution. . . . If this result is right we have a totally different criterion by which the stars are arranged in the same order. If it is really true that the mean motion of a class of stars measures its progress along the path of evolution, we have a new and most powerful aid to the understanding of the steps of stellar development."

BROOKS' COMET.—This was a most conspicuous object in the morning sky at the beginning of November. The tail was plainly visible for 20° or more. Rev. T. E. R. Phillips noted that its type appeared to have altered from the earlier one of a bunch of straight rays diverging from the head, to a parabolic envelope enclosing the head. There are good reasons for supposing that this latter type arises for comets when their distance from the Sun is small.

BORRELLY'S PERIODIC COMET will be visible in small telescopes during December. An ephemeris is given in "The Face of the Sky for January."

MARS has been a very brilliant object in Taurus, far outshining Aldebaran, the lucida of that constellation. From the reports of MM. Antoniadi and Jarry-Desloges it would appear that veiling by mist or cloud of portions of the dusky regions has taken place to an unusual degree at this opposition.

BOTANY.

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

STRUCTURE OF FLOWER IN CRUCIFERAE.—Arising from the preceding note, there may be considered some points in the morphology of the flower in the Cruciferae. The peculiar structure of the Cruciferous flower has given rise to a good deal of discussion, and the question is still open. As is well known, the flower shows isobilateral symmetry. The calyx is in two whorls, each consisting of two sepals; the corolla in one whorl, alternating with the calyx as a whole, with the four petals placed diagonally in a cross. The stamens are also regarded as being in two whorls, an outer whorl of two short lateral stamens, and an inner of four stamens in two pairs placed back and front. The pistil is apparently composed of two carpels placed transversely (laterally); the ovary is divided into two chambers by a partition joining the two placentas, the latter being placed back and front—this partition arises as an outgrowth of the placentas, the two outgrowths meeting in the middle of the ovary cavity; the two stigmas are placed above the placentas—a somewhat unusual position (the stigmas usually alternate with the placentas) but found also in the Poppy family (Papaveraceae). On the bases of the stamens are nectaries, the honey being secreted into the bases of the sepals.

From comparison with the Papaveraceae, which have two sepals, and from the fact that in development the four inner stamens appear to arise in pairs by branching of an outgrowth at first simple in structure, it has been supposed that the

Cruciferous flower is fundamentally arranged in twos—that it is dimerous—and that the four petals and the four inner stamens are due to branching. This explanation has been widely accepted.

However, Klein (*Bot. Centralblatt*, Band 58, 1894) has urged that the Cruciferous flower is tetramerous—that is, primarily arranged in fours, not in twos. He bases this explanation chiefly on the position and course of the vascular bundles which supply the flower parts. Just below the flower itself, the flower-stalk shows eight bundles arranged in an ellipse. The first bundles to come off are at the ends of the long axis of the ellipse, and they go into the two transversely-placed sepals (though these are usually regarded as being the outer and first-formed sepals); the bundles for the two median (front and back) sepals come off higher up. Then, proceeding upwards, come four strands which proceed diagonally (answering to the position of the four petals); each of these strands soon branches into three veins, of which the median and thickest one enters a petal, while the slender lateral ones go into the neighbouring sepals—each sepal has, therefore, three basal veins (a thick middle vein and two slender lateral veins). The veins for the two short stamens come off next; then four more veins running in the diagonal direction and supplying the four long stamens.

From the arrangement of these veins, or vascular bundles, Klein concludes that the long inner stamens are diagonal in position, but have become approximated in pairs lying in the median (back and front) line, simply on account of the exigencies of space in the developing flower, due especially to the position of the nectaries. Klein, therefore, opposes the view that the four inner stamens have arisen by branching from two primordia situated in the median plane. Further up, there are two laterally placed veins, right and left, corresponding to the position of the two chambers of the ovary; and last of all come two veins lying in the median plane, which run up into the partition of the ovary. Klein regards these veins as belonging to two carpels which cannot develop owing to exigencies of space. Hence Klein considers that the flower parts are arranged in fours, with the theoretical formula K4, C4, A4 + 4, G (4). The outer whorl of stamens is incomplete on account of the development of nectaries in place of two of the stamens; the inner four stamens are arranged diagonally, being opposite the petals; and the two fully-developed carpels alternate with two abortive carpels.

In further support of Klein's view, it may be mentioned that in some Crucifers the four inner stamens are obviously diagonal, rather than arranged in two pairs (anterior and posterior); also that four carpels are present in genera like ***Holargidium*** and ***Tetrapoma***, also in forms of *Capsella*, and in various cultivated and wild varieties of other genera.

CHEMISTRY.

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

A STALAGMITIC GROWTH IN SEA WATER.—An interesting case of the formation of mineral growths of a stalagmitic nature is described by Mr. T. Walton, in the current issue of the ***Journ. Soc. Chem. Ind.*** (1911, XXX, 1198). These were produced in an iron tank through which sea water had been flowing for several months for the purpose of cooling ammonia heated by pressure in a refrigerator. At several points in the pipe there were minute leaks, and the passage of the ammonia through these caused precipitation of some of the lime and magnesia in the sea water, and from the nucleus thus deposited upon the surface of the coil small columns of white mineral matter had gradually risen to the surface of the water. These formations ranged in length from five to fourteen inches, and from a quarter of an inch to three inches in diameter. Examined under the microscope they were seen to have a cellular structure, which was due to the pressure of the escaping bubbles of ammonia gas. The dried material composing these "stalagmites" consisted of eighty-eight per cent. of magnesium hydroxide, eight per cent. of calcium carbonate, 0·9 per cent. of calcium sulphate, and 2·8 per cent. of sodium chloride.

ESTIMATION OF THE AGE OF BLOOD STAINS.—A method of estimating the approximate age of blood stains has been based by Dr. de Dominicis (*Boll. Chim. Farm.*, 1911, L, 273) upon the rate at which they may be dissolved. A small portion of the stained material is immersed in pure glycerine, and the tube given a [illegible] shake at intervals of a minute until solution occurs. The resulting solution is protected from the air and compared with solutions obtained in the same way from blood stains of known age, the relationship between the colour of which and the time required for the solution is also known. It was found that blood stains which dissolved within one minute were undoubtedly of recent origin, while the longer the solution period the older the stain. The presence of blood in the solution should, of course, be proved by means of the spectroscope.

GEOLOGY.

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

THE NEW GLASGOW MEMOIR.—In continuation of the admirable policy of publishing maps and memoirs illustrating the geology of large centres of population, the Geological Survey has just issued a memoir and map of the Glasgow district. These have been specially prepared, as we are told in the preface, for economic and educational purposes with Glasgow as the centre of interest. An official description of this district was long overdue, for the old map (Sheet 30, Scotland), published in 1878, was not accompanied by a memoir.

As a centre for extraordinarily interesting and varied geology, Glasgow is perhaps unrivalled in the British Islands. Standing in a basin of Coal Measures and Carboniferous Limestone which is highly fossiliferous and replete with stratigraphical problems, it is surrounded, at a distance of a few miles, by an almost continuous rim of high volcanic hills, built up of igneous material of great variety and petrographical interest. To the north, at a distance of twenty miles, are the Highlands—an area of mystery likely to provide Glasgow geologists with work for many years to come. To the west the Clyde lochs and islands, including Arran—that favoured isle of perennial petrological interest—are easy of access. Also within an easy distance is the comparatively untouched area of Ayrshire, full of new material awaiting the geologist's hammer.

Under these circumstances the new memoir is very welcome, as providing a most valuable guide and groundwork to the geology of the district. The stratigraphical groups present in the area described range from Lower Old Red Sandstone to the Upper Barren Red Measures overlying the Coal Measures of Lanarkshire. In Calciferous Sandstone times a great volcanic episode occurred, which gave rise to the fine terraced lava escarpments of the Campsie and Kilpatrick Hills, flanked by numerous isolated, conical, volcanic necks. Towards the end of the Carboniferous period an interesting suite of teschenites was intruded into the Coal Measures of the east of Glasgow. Other rare igneous types are described, notably a bekinkinite from Barshaw, near Paisley; and a beautiful porphyritic essexite (long ago described by Allport) from Lennoxtown, both carrying conspicuous nepheline. A good nepheline phonolite has also been found near Fintry. The district is "full of petrographical material of the first importance," says Mr. E. B. Bailey, who has written the petrographical chapter; and we concur with his further remark that "the petrographical interest is likely to quicken rather than flag as the igneous rocks of Ayrshire to the west come to be examined."

A meritorious feature is the long chapter on economic geology, giving information as to coals, ironstones, fireclays, limestones and cements, setts and road-metal, building stones, brick-making and water supply, a list which illustrates the extent to which geology is a practical and applied science.

The colour-printed map is not so satisfactory as the memoir. It is extremely complicated, and looks as if colour-printing were being made to sustain an elaboration of detail of which it is not capable.

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

The weather of the week ended October 21st, as set out in the Weekly Weather Report issued by the Meteorological Office, was at first fair and very warm, but became unsettled, with rains and thunderstorms. Temperature was very high in all districts, and the excess above normal amounted in places to over 8°·0, and at Birr Castle to as much as 9°·1. The highest readings reported were 68° at Guernsey, and 67° at Jersey and Margate. The minimum was below freezing point at only two stations, Balmoral 31°, and Nairn 30°. In the English Channel the temperature did not fall below 52°. On the grass readings of 26° at Crathes and at Glasgow were reported. Rainfall was below the average in most parts, but was in excess in Scotland W., Ireland and in England, S.E. At several places falls of upwards of an inch in twenty-four hours were reported, the greatest being 1·7 inches at Brighton on the 21st. Sunshine was less than average. The sunniest stations were Jersey 25·4 hours (34%), and Gordon Castle 25·3 hours (36%). In Sheffield the total duration for the week was only 1·2 hours (2%). The mean temperature of the sea water round the coasts ranged from 46·0 at Kirkwall to 58·1 at Newquay.

Aurora was seen at Fort William on the 17th.

The week ended October 28th, was unsettled throughout. There was much rain, some snow or sleet in Scotland and many reports of thunderstorms. Temperature was in defect in Scotland, but was not far from the average elsewhere. The highest maximum was 62° at Westminster, on the 22nd, while minima of 32° or below were reported in all districts except the English Channel, where the lowest reading was 45°. The lowest of the minima were 21° at Fort Augustus and Kilmarnock. On the grass temperature fell to 16° at Llangammarch, and to 17° at Newton Rigg. Rainfall was less than the average in Scotland, N. and W., but was in excess elsewhere, very greatly so in the Channel Islands. Sunshine was in defect except in Scotland N. and in Ireland, but except in the extreme N. and extreme S., the difference was not large. Falmouth reported the largest aggregate, 28·4 hours (41%), Tenby coming next with 7·2 hours (39%). The mean temperature of the sea water varied from 45·1 at Kirkwall to 57·3 at Newquay.

During the week ended November 4th, the weather remained unsettled with frequent heavy rain. Thunderstorms were reported in the North. Temperature differed but little from the normal; the highest reading was 61° at Shields on the 30th, the lowest 15° at Balmoral on the 29th. On the grass, however, the minima were as low as 8° at Llangammarch, and 13° at Balmoral. Rainfall was in excess in all districts, except England N.E. and the English Channel. In Scotland it was from two to three times as much as usual. At Fort Augustus the total for the week was 6·49 ins., as compared with an average of 1·80 ins. Sunshine was in excess in the Eastern districts, but in defect in the West. The aggregate ranged from 31·1 hours (46%) at Felixstowe to 2·9 hours (5%) at Baltasound and Fort Augustus. The temperature of the sea water ranged from 42° at Kirkwall to 58° at Salcombe.

The week ended November 11th was also very unsettled. There were frequent rains but also bright intervals. Thunderstorms were observed over a wide area. Temperature was below the average nearly everywhere, the difference from average reaching 4°·0 in Ireland. The highest maximum was 61° at Tottenham on the 5th, the lowest minimum being 21° at West Linton on the 10th. In the English Channel the temperature did not fall below 40°. On the grass the lowest reading was 11° at Llangammarch.

Rainfall was in excess of the average in all districts except England, N.E. In England, S.E., and the English Channel, the total was more than twice the average. Bright sunshine was above the normal in all districts, the greatest excesses being in England, N.E., and the Midland Counties. Sheffield reported the highest aggregate, 32·0 hours (51%). At Greenwich the amount was 26·3 hours (41%). The temperature of the sea water varied from 40° at Scarborough to 55° at Newquay and Salcombe.

KITES IN THE UPPER AIR.—On October 21st a kite flown at Pyrton Hill, Oxon, from 10 a.m. to 10.30 a.m., reached a height of 1,600 feet, and experienced a very strong and gusty wind, during which the pull on the wire ranged from 10-lbs. to 180-lbs.

GEOPHYSICAL JOURNAL.—The Meteorological Office has commenced the issue of the *Geophysical Journal*, which comprises not only Meteorological Observations but also the daily record of observations of Solar Radiation, Seismology, Atmospheric Electricity and Terrestrial Magnetism. The contributing observatories are three in number, namely Valencia, Co. Kerry; Kew, and Eskdalemuir, Dumfriesshire. A feature of the publication is the introduction of the Centimetre-Gramme-Second System of Units for all the data. Thus the barometer readings are given in "bars," *i.e.* megadynes per square centimetre, where one "bar" is approximately equal to the pressure of 750 mm. of mercury; temperatures are given in units on the Kelvin Absolute Scale, *i.e.*, in Centigrade degrees measured from a zero 273° below the freezing point of water; vapour pressure in "Millibars," and wind velocity in metres per second.

The *Seismological* data is for Eskdalemuir only, and is based upon the records of a Galitzin Seismograph, giving both period and amplitude of the microseisms. The Electrical data provided for include the potential gradient, the number of ions per c.c. and their velocity, the conductivity and the strength of the air-earth current. The Magnetic data are very full, and are based principally upon continuous automatic records.

It is believed that this is the first publication of its kind to be issued in any country.

MICROSCOPY.

By A. W. Sheppard, F.R.M.S.,

with the assistance of the following microscopists:—

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

THE INFUSORIAN MICRONUCLEUS IN REGENERATION.—The behaviour of the infusorian micronucleus in regeneration was dealt with by K. R. Lewin, B.A., in a paper read before the Royal Society, on November 2nd.

The variety of *Stylonychia mytilus* used was that possessing two micronuclei, and when a specimen is cut in two so that each merozoön receives one member of the meganucleus and one micronucleus, both fragments exhibit in favourable circumstances complete regeneration. This involves segmentation of the meganuclear member, and division of the micronucleus.

If a portion of the cytoplasm be removed from the hind end of the animal without disturbing the nuclei, there may occur during regeneration a division of one, usually the posterior, micronucleus. The result is to furnish the regenerated infusorian with three micronuclei instead of two, *i.e.*, the division does not restore but actually disturbs the nuclear relations characteristic of the race. When the regenerated individual proceeds to fission, all three micronuclei divide. That an extra division can be introduced into the normal cycle of mitoses shows that the organella is in a fit state to divide before the whole animal is ready for spontaneous fission; that the supernumerary mitosis occurs during regeneration suggests that the stimulus causing the micronucleus to divide may be the condition of the surrounding cytoplasm which obtains during the constructive activities of regeneration.

The cases in which regeneration occurs without either of the micronuclei dividing can be supposed to be those in which either the micronuclei were not ripe for mitosis, or the stimulus was not sufficiently intense to evoke a division.

During normal fission when all the micronuclei present divide, there is a general formation of new parts, quite comparable with the localised activity in regeneration and accompanied, it is natural to suppose, with much the same condition of the cytoplasm. The mitoses occurring normally and those taking place during regeneration, can thus be brought under one point of view.

EUGLENA EHR.—Although such a "common object" as sometimes to be quite an inconvenience to the microscopist, *Euglena viridis* (Figure 1) has many points of interest which will repay rather more attention than is usually accorded to them. As with not a few other micro-organisms, in the past there has been much discussion as to whether it should be classed as an animal or as a plant. The modern view is that it partakes of the nature of both and may best be described as a plant-animal. Its possession of a mouth, and the ingestion of solid food, and its general activity entitle it to be looked upon as an animal; while its green colour, which is undoubtedly due to the presence of chlorophyll of the same character with that of plants, and the fact that it appears possible for it to exist without taking in food by the mouth, endorse its claims to be considered as belonging to the vegetable kingdom. Recently a small book under the name of "Plant-animals, a study in symbiosis" was published, describing two small worms (Convoluta) which display the same characteristics in a marked degree. The facts ascertained respecting these and the exhaustive experiments made on them prove conclusively that there are aquatic organisms, which, though unquestionably animals, yet owing to the inclusion of chlorophyll within them are able to, and actually do, obtain the carbon elements of their food, at least during a portion of their life, from the carbon dioxide dissolved in the water. The extent to which this capacity is possessed and exercised differs in various cases, but *Euglena viridis* certainly takes advantage of its endowment in this respect and so may be looked upon as a plant-animal. It has been suggested that the creature takes in nourishment during daylight as a plant by means of its chlorophyll, during the darkness feeding as an animal, but perhaps this idea rather exaggerates its voracity. It is not possible to make out the mouth and flagellum while the animal is swimming, but the careful application of a little iodine will kill it and bring them into view. The mouth is a funnel-shaped depression in the forward end—only capable of receiving very small particles—and from it springs the long, and during active life, swiftly moving flagellum (Figure 2a). The body is covered with a delicate cuticle, not sufficiently firm to prevent it readily changing shape; that represented at Figure 2b, is frequently assumed. The protoplasm is granular and the chlorophyll seems to be diffused in it, not collected into definite "chloroplasts." Many partially transparent bodies of considerable size are usually present; they resemble starch grains, but the substance composing them is known as *paramylum*, and though having the same chemical composition as starch, is not coloured blue by iodine. A nucleus is present and near the usually distinct red "eye spot" a contractile vacuole. For the purpose of multiplication, towards autumn, or at any time on the occurrence of unfavourable conditions, *Euglena* may assume the encysted state. The body becomes spherical and a wall of cellulose (Jeffery Parker) is secreted round it. If the animals are present in great numbers—as is frequently the case—they adhere and form a kind of pellicle on the surface of the water. Blown by the wind, or moved by any object, this does not readily break up, but will crease and fold, just as the skin on boiling milk does. Later the animals may resume their active state, and the cells which contained them (at first circular, but afterwards, owing to pressure and movement, [illegible] and mis-shapen) are left adhering together, and have the appearance of a cellular membrane (Figure 1). This persists for some time, and various floating aquatic organisms make it their home. It has been mistaken for, and described as, some kind of alga. During the past summer this object has often been noticeable on the surface of ponds as a brownish delicate film. While resting encysted the individuals may undergo division into two or four smaller specimens, but of the same shape as the adults, so that on emergence their numbers are greatly increased. Figure 2c, "An interesting local variety of *Euglena viridis*, has been described by Mr. M. H. Robson, of Newcastle-on-Tyne, in *Science Gossip*, October, 1879, in which the distal extremity of the flagellum presents an inflated knob-like aspect." Figure 2d: The same singular variety has recently been recognised in some ponds near London.

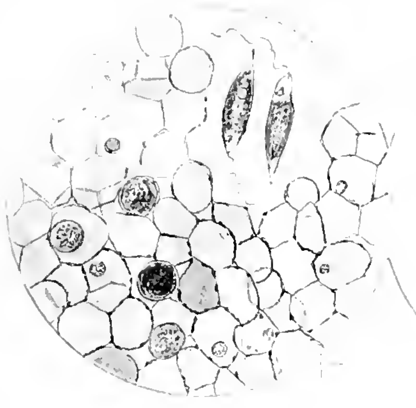


FIGURE 1.

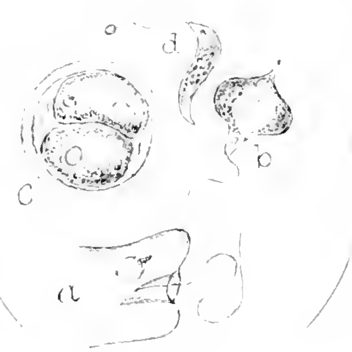


FIGURE 2.

Figure 1 is from a specimen which lasted several weeks in a saucer of water after being brought from a pond. The membrane is represented on the same scale as the two animals above. Figure 2 is from Saville Kent's Infusoria, a and c highly magnified.

J. BURTON.

AMPHIDINIUM OPERCULATUM CLAP. AND LACH.—In the Journal of the Linnean Society, vol. XXXII, pages 71–75, Professor W. A. Herdman, F.R.S., describes the occurrence of this little peridinian in vast quantities in Port Erin Bay (Isle of Man). The hollows of the ripple-marks and other slight depressions formed by the water draining off the beach were occupied and outlined by a greenish-brown deposit which in places extended on to the level, so as to discolour patches of the sand. Here the deposit remained more or less for a month, waxing and waning, sometimes increasing in the tide, say, roughly ten-fold, and at other times apparently disappearing for a day or two and then reappearing either on the same part of the beach, or it might be a few hundred yards away. At one time it coloured a continuous stretch of sand about fifty yards long by five yards in breadth just below high-water mark, and was noticeable for some distance away. On examination the deposit was found to consist of vast numbers of *A. operculatum*. This peridinian was first described by Claparède and Lachmann, in 1858, from specimens obtained in some few places in Norway, and according to a recent authority is found occurring in brackish water on the North Coast of Europe, but has not been previously recorded for the British area. It was first observed at Port Erin early in the year, but later brown patches of similar appearance were again observed on the sand; on examination these were found to consist of vast numbers of a golden-yellow naviculoid Diatom. The Amphidinium had disappeared, but re-appeared in abundance by September.

Under observation *A. operculatum* swims about freely, but soon comes to rest by attaching itself to a sand-grain. It is positively heliotropic and collects in quantity on that side of the dish which is turned towards the light. Multiplication by fission was frequently observed. Its greatest diameter is 0·05 millimetres.

QUEKETT MICROSCOPICAL CLUB. October 24th.—Professsor E. A. Minchin, M.A., F.R.S., President, in the chair. An old microscope, sent by Mr. Hugh Paterson, of Sydney, N.S.W., was exhibited. It had been presented, about 1850, to his father, by J. T. Quekett, F.R.S. (1815-61), the distinguished microscopist, after whom the club is named.

E. M. Nelson, F.R.M.S.—"An improved compound microscope, by James Mann, 1751," was read by the Hon. Sec. The instrument is, in the main, obviously a copy of J. Cuff's (1744), the improvements consisting in the mirror and its attachment, and in making the instrument portable. The first portable compound microscope was made by George Adams, in 1746, and the one now described showed Mann's device for adapting Adams's idea of portability to Cuff's microscope. Very probably this was the second portable microscope.

J. W. Shoebotham, N.D.A.—"A general account of the Spring-tails (Collembola)." They were described as belonging, with the orders Protura and Thysanura, to the sub-class Apterygota, of the class Insecta. The anatomy of the Collembola was described fully, accounts being given of the eyes, post-antennal organ, pseudocelli, antennal organs, body, legs, and those very typical and curious organs, the ventral tube and the spring. A tracheal system is usually absent and in the few species possessing one it is very poorly developed. Although they have generally been regarded merely as scavengers, there is now evidence to show that they may do considerable damage to growing crops. Between four hundred and five hundred species are at present known, of which one-hundred-and-seven have been recorded from Britain.

Messrs. Watson & Sons exhibited under microscopes an interesting series of preparations of embryos of Decapods.

THE ROYAL MICROSCOPICAL SOCIETY. October 18th.—H. G. Plimmer, F.R.S., President, in the chair.—T. W. Butcher: Structural details of *Coscinodiscus asteromphalus*. A paper describing the primary areolations with the secondary and tertiary markings, illustrated by a series of lantern slides made from photomicrographs obtained at a magnification of one thousand one hundred. In addition slides were shown demonstrating a fine siliceous network or veil lying upon the outer surface of the valve, and others in series, from photomicrographs taken, at five or six consecutive foci, of the hexagonal cell layer with its "ringed" openings of Morland, to prove that these openings are clear and not obstructed by the finely perforated membrane recently reported by Mr. Nelson (*Journ. R.M.S.*, October 1910). The membrane being non-existent, its value as a test for a high-power lens is *nil*.—Rev. Hilderic Friend: New British Enchytraeids. *Enchytraeus minimus* Bret. was described in the *Rev. Suisse de Zoologie* in 1899. Michaelsen, in *Das Tierreich*, 1900, suggested that it might be one with *E. argenteus* Mich. (= *E. parvulus* Friend). Bretscher examined the subject again in 1902, and decided that the two were distinct. The author, who had already described *E. argenteus*, has found *E. minimus* at Buxton, and holds with Bretscher. *Fridericia peruviana* n. sp. was received in earth from Peru and submitted to the author by the authorities at Kew. It is 5–6 mm. in length, has 2·5 setae which are somewhat larger behind than before. Brain slightly concave posteriorly; oesophagus sharply marked off from intestine; dorsal vessel postclitellian in origin with dilatations in segs. 7-9. Salivary glands not branched; long.—Walter Bagshaw: Instantaneous exposure in photomicrography.—Flashlight illumination has been put to a novel use by Mr. Walter Bagshaw, F.R.M.S., for the photography through the microscope of objects in motion. A good negative of freshwater polyzoa, (*Lophopus crystallinus*) expanding its tentacles, was secured by a charge of "Agfa Flashlight Powder" in one-thirtieth of a second. Gatherings of Pond-life, such as diatoms, larvae, water fleas, also yielded successful results. Provision was made for replacing the ordinary lamp by flash powder put in the position previously occupied by the centre of flame, and ignition made with a red-hot wire.

ORNITHOLOGY.

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

BLACK REDSTART REPORTED NESTING IN ENGLAND.—It is stated that the Black Redstart (*Ruticilla titys*) has been identified as nesting in the Keswick district this season (1911). Very conclusive and convincing evidence is, however, necessary before this species can be admitted to the list of British nesting birds. In past years supposed eggs have been obtained or observations made in different localities (Sherwood Forest, in 1854 and 1856; Dumfriesshire in 1858 and 1889, and Hertfordshire in 1876), but in no case has the identification as to nesting been accepted as satisfactory. The bird's habitat is central and southern Europe, and the seasons of its annual occurrence in England are autumn and winter, although in a very few instances it has been found at other times. This distribution is rather curious, as it is only a summer visitor in central Europe, and has not so high a northern range as the Common Redstart (*R. phoenicurus*), which appears throughout all Europe in summer, and is not known in the British Isles at any other season of the year. The point is, that the summer Redstart in Britain is the more northern species, but the visitant Redstart seen in autumn and winter is the southern form (*R. titys*).

THE STARLING AS A MIMIC.—A correspondent, Mr. Basil T. Rowsfell, writing from St. Martin's, Guernsey, says that on 22nd September last he was astonished to hear what was apparently a Wryneck's call from a tree in his garden there, clear and distinct, as it may be heard in spring and early summer. This was repeated for some days up to 6th October, and, by carefully watching, Mr. Rowsfell made out that the calls came from a Starling (*Sturnus vulgaris*). He suggests that this particular bird may have been reared in the immediate vicinity of a Wryneck's nest, and caught the note from the parent Wrynecks.

Starlings are, of course, well known as mimics. The wailing whistle of the Common Curlew (the Whaup of northern districts) is associated with wild and lonely places, but we have known a Starling to give a very passable imitation of this call from the house-tops of a great city. This individual bird, or another which had also picked up the trick, returned to the same place a second winter and brought moorland echoes with it, amongst thronging people and crowded houses.

THE NATIONAL COLLECTION AT SOUTH KENSINGTON.—According to the "Return" presented to Parliament of the British Museum for the year 1910, the additions made to the great bird collections at the Natural History Museum amounted to 9377 specimens in the year named. These came mostly from Asia, Africa and South America, and several of the collections consist of some hundreds of items. The most extensive is 1346 birds, nests and eggs from Angola, Portuguese Guinea, and the Cape Verde Islands, obtained by Dr. W. J. Ansorge.

PHOTOGRAPHY.

By Edgar Senior.

The article in "Notes" of last issue contained a description of the use of a pin-hole in place of a lens, and was illustrated by an excellent photograph taken by its means. It may, therefore, be of interest in connection with this subject, to just consider "on theoretical grounds," the conditions which govern the use of plain apertures, in order to obtain the best results with them in practice. It is well known that photographs taken by means of a plain aperture in place of a lens, possess advantages over those taken with the lens, in so far as distortion is entirely absent, and the artistic effect obtained is extremely pleasing. It is also well known that for a given aperture an image will be obtained at whatever be the distance from it to the plate; but it was proved many years ago by Lord Rayleigh, as a consequence of the Wave Theory of Light, that the best definition is obtained when the diameter D of the aperture is related to the distance L from it to the plate, as given by the equation

$$D = 2\sqrt{\lambda L}$$

where λ is the wave length of the light employed.

Taking into account the wave length of light of maximum photographic activity, Sir William Abney gives the formulae

$$D = \frac{1\sqrt{L}}{120}$$

where D and L are measured in inches. It was proved by Lord Rayleigh that when the conditions specified by his formulae are complied with, no further improvement could be obtained. We have before us as we write a photograph taken by means of a plain aperture, in which the conditions set forth above were fulfilled. The distance of the plate was nine inches, and from our formulae $D = \frac{\sqrt{9}}{120}$ we obtain $\frac{1}{40}$ inch as the diameter of the aperture that would give the best definition with the plate placed at nine inches from it.

COLOUR PHOTOGRAPHY UPON PAPER.—However beautiful may be the colour photographs in the form of transparencies upon glass, there is still the feeling among a large number of persons that the only really satisfactory solution of the problem of photography in colours will be found in a process which is applicable to paper. Quite recently the attention of photographers has been drawn to a new paper which has been placed upon the market for the purpose; prepared by Dr. J. H. Smith. The general principle upon which several experimentalists appear to be working is that suggested by Wiener, who considered that the chromosensitive surface should be black, and composed of, at least, three physical elements. The writer experimented in this direction some few years ago, employing paper coated with red, yellow and blue dyes. The dyes being fugitive, the prepared paper was found, after exposure under a coloured transparency, to give a fairly good rendering of the object, although in every case the time necessary to obtain the results was very prolonged, amounting to days in the strongest light. To what extent this and other difficulties may have been removed we are unable to say, as we have not had an opportunity of trying any of the recently prepared papers.

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

POSITIVE IONS FROM HOT SUBSTANCES.—These have been the subject of numerous investigations recently. Professor Sir Joseph Thomson found that aluminium phosphate gave off a large number of positively-charged particles when deposited on a platinum strip which was heated to about 1000 C. Garrett and also Horton have investigated the effect and have shown that the production of these positively charged ions is intimately associated with the production of small quantities of carbon monoxide—a very commonly occurring substance in vacuum tubes submitted to the electric discharge.

Professor Richardson has investigated the carriers of positive electricity from strips of platinum coated with alkalis and alkaline earth metals. He finds evidence to show that these carriers are atoms of the metal carrying a single charge. Even the divalent metals carry only a single positive charge, which is contrary to what might be expected, since these metals are chemically equivalent to two atoms of hydrogen. The heated platinum itself gives off a certain number of charged ions and Professor Richardson has investigated this thoroughly. He suggests that the considerable discharge of positive particles from aluminium phosphate is due to the impurity of alkali metals it contains. These positive ion discharges are not nearly so marked in effect as the negatively charged particles emitted by the alkaline earth oxides. If a small piece of sealing wax be allowed to coat a platinum strip mounted in a vacuum tube so that an electric current can be passed through it, and if there is a difference of potential of 100 volts or thereabouts between the strip and another electrode in the tube, then on heating the wax, only lime and barium oxide is left which gives a copious discharge of negative corpuscles. Professor Thomson has utilised these discharges to obtain steady [illegible] in a vacuum tube and by investigating the behaviour of a cathode ray beam from a side tube as it passes transversely through the electric field in various portions of the striated discharge, he has been able to find the magnitude of this electric field, and hence show that the striations are due to the [illegible] up of corpuscles. The collisions of these with the [illegible] of the gas cause the latter to radiate light. From [illegible] of collision corpuscles acquiring great velocity are shot off in the direction of the positive electrode and until, by collision with the gas molecules in the tube, their velocity is reduced to such an extent that they can no longer keep on in a straight path, there exists a dark space. Thus a striated discharge comes about: the number of striations depending on the pressure of the gas in the vacuum tube.

When an electric discharge is passed through a gas at low pressure, it has long been questioned whether the gas is electrolysed: that is, suppose one passed an electric discharge through hydrochloric acid gas, would hydrogen be found in greater concentration at the cathode and chlorine at the anode, as in the electrolysis of the aqueous acid. Professor Thomson many years ago succeeded in obtaining the hydrogen spectrum at the cathode and the chlorine at the anode and on reversing the current the hydrogen and chlorine changed places, the hydrogen still being found at the cathode. However Kayser, the illustrious author of the "Handbuch der Spectroskopie," has asserted that these effects are due to thermal effects, the cathode being always hotter than the anode. Recent experiments at the Cavendish laboratory have apparently shown without doubt that a separation of an electrolytic nature does occur, but that the effect is upset by the mobility of the gaseous ions and consequently thermal effects come in to a great extent. Many organic halogen compounds have been investigated, and the chlorine is sometimes found at the anode and sometimes at the cathode, but as a rule exactly in accordance with its chemical behaviour, either as an anion or cation. In a compound such as methyl sulphide, sulphur would be found at the anode and the carbon monoxide spectrum at the cathode. These results have been obtained by Mr. G. Stead.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

ASSOCIATION OF CRAB AND HYDROID.—Everyone knows that many animals grow upon others in an accidental sort of way, because the young stages landed there. This is a fortuitous epizoic association. Sometimes, however, the association, though remaining entirely external, is by no means fortuitous; thus many spider-crabs pluck hydroids along with sea-weeds from their surroundings, and plant them on their shells, with the result that they are "masked." Different from this again is a case like the following, recently described by Dr. W. T. Calman, whose delightful introduction to Crustaceans ("The Life of Crustacea," Methuen, 1911) should be read by all interested in Natural History. A crab from Christmas Island showed a hydroid polyp, allied to Stylactis, attached like a tassel at the "knee" of each of its legs. This is interesting in several ways. All but two of the polyps were symmetrically disposed; the type specimens of the species (*Medaeus haswelli*) to which the crab belongs, although coming from a distant locality, were found to bear a similar or identical hydroids; the crab is a Xanthid, not one of the spider-crabs in which masking is common; even the rootwork or hydrorhiza was very precise in its occurrence, following the inter-regional grooves on the carapace.

A PRIMITIVE ANT SOCIETY.—There is a Mediterranean ant, *Aphaenogaster sardoa* by name, not uncommon in Sardinia, which illustrates a simple type of societary form,—simple, at least, as ant-societies go. It has been recently studied by Dr. Krause-Heldrungen, who describes the way in which the ants huddle together in living balls, interlocked with mandibles and tarsi, and holding the eggs, larvae, and pupae in the centre. An average society consists of three hundred to a thousand individuals; the males have not been found; and the observer found only one queen. Architectural construction is at a minimum; they use holes in the ground. They do not store and they have no guests. Huddling together in a ball is their form of sociality. In winter the ball is very stiff and is slow to relax when it is unearthed. In summer, naturally, it is more plastic, being made and unmade several times a day.

BLOOD-SUCKING MAGGOTS.—There is a fly called *Auchmeromyia luteola* (Fabr.), whose larvae have the remarkable habit of piercing the human skin and sucking blood. This has been hitherto a quite unique thing, but E. Roubaud has found its parallel in a related African form, for which he establishes a new genus *Choeromyia*. One species lives in the burrows of the Cape Ant-Eater and another along with the Wart-hog. The flies eat dung and like darkness. The larvae live in the damp ground; they are able to fast for a long time; they are attracted to the warmth of their hosts; they fix themselves on the skin, pierce it, and suck blood. They can ingest three times their weight of blood. Roubaud reared one on himself.

BEETLES IN NESTS.—Heinrich Bickhardt has collected the available information in regard to what he calls "nidicolous" beetles—those which live in the nests of birds and mammals. There are no fewer than twenty-eight which are found exclusively in nests. A much longer list is given of those that usually occur in nests, but also in other suitable places. Besides these there are casual visitors. Of the exclusively nidicolous beetles, eighteen are confined to the homes of Mammals, such as mole, hamster, mouse and rabbit; seven are confined to the nests of birds, such as dove, sand-martin, owl, and woodpecker; three are found associated with both birds and mammals.

INNERVATION OF WINGS IN LEPIDOPTERA.—R. Vogel has made a study of the rich innervation of the wings in butterflies and moths, and shows how rich the wings are in sensory structures. There are tactile scales and (probably) tactile spines. There are peculiar papillae, which may have to do with orientation in flight, and "chordotonal organs" like those which distinguish notes in various Orthoptera. Altogether the wing is an exquisitely sensitive structure.

SOLAR DISTURBANCES DURING OCTOBER, 1911.

By FRANK C. DENNETT.

THE falling off in solar disturbance shown last month was equally noticeable during October. Observations were made on twenty-nine days, the omissions being on the 16th and 27th. On fourteen days the disc presented an even brilliance, save for the delicate granulation, these being October the 9th, 10th, 13th until 15th, 17th until 21st, 24th, 26th, and 28th until 31st. On the 1st and all other dates after the 10th only faculic disturbances were seen. The central meridian on October 1st was 289° 42′.

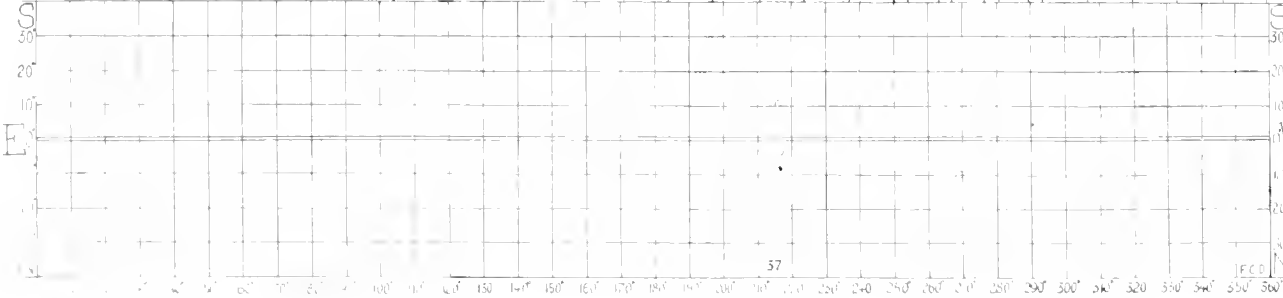
No. 37.—Two brilliant curved ridges of faculic matter formed a striking object a little within the eastern limb of the Sun on October 1st, like the borders of an elliptical disturbance. On the 2nd in place of the western ridge a dark spot having two umbrae had developed, whilst three pores were embedded in the eastern ridge. Next morning the spot had become 10,000 miles in diameter, and the number of pores had reached seven, the group being 30,000 miles in length. Only two of the pores were seen following the leader on the 4th. By the 6th the leader enclosed two umbrae, whilst one pore showed 10,000 miles behind and a second nearly two degrees south of the leader. On the 8th the leader, reduced to a pair of umbrae, was alone, and had quite disappeared before next morning. The spectroscope showed a considerable amount of activity around this group indicated by dark hydrogen flocculi extending for a long distance. On the 6th there was a considerable prominence visible, projected on the bright surface, a little south east of the spot, whilst the whole region showed traces of helium by the presence of the dark line known as D_3.

The dotted areas indicate the positions of faculic disturbances. On October 2nd a small bright knot was visible near longitude 353°, S. latitude 17°. On the 8th there was a small knot at 269°, N. latitude 5°. On the 11th and 12th two separate faculic disturbances were visible near the western limb, one double group closely ahead of the place where the spot group, No. 37, had disappeared, whilst the other was on the other side of the equator. On the 22nd and 23rd there was a faculic district about longitude 10°, and 10° N. latitude. On the 25th there was a group of greyish pores in a disturbed area near longitude 280°, but careful measures were not possible.

The Prominences are much fewer in number than was the case only a few months since. The most remarkable one appears to be a very tall spindle at 20° South-east, seen on October 21st.

Our chart is constructed from the combined observations of Messrs. John McHarg, A. A. Buss, E. E. Peacock and F. C. Dennett.

DAY OF OCTOBER, 1911.



REVIEWS.

EVOLUTION.

Convergence in Evolution.—By Dr. Arthur Willey, D.Sc., F.R.S. 177 pages. 12 illustrations. 8¾-in. × 5½-in.

(John Murray. Price 7/6 net.)

Dr. Willey writes, he says, so as to be intelligible to those who have an inkling of biological knowledge, but it is probable that his argument as a whole will hardly be appreciated save by trained zoölogists. Nevertheless, there is an abundance of facts recorded, many of them new and all interesting, that should appeal to every naturalist however much of an amateur he may be; and it is safe to say that even a professional zoölogist will learn much to his advantage. The author sets out by reviewing certain points in the growth of the science of morphology and its kindred branches which have rendered them valuable both as intellectual recreations and as of direct practical use to mankind. He goes on to suggest that we may look to other properties of animals besides those of structure to gain a comprehensive survey of the animal kingdom. Without going so far as to compare the value of classification based on structure with that based on similarity of function, he asserts that too little attention has been paid to what may be called physiological systems of classification. Air breathers, and water breathers, fixed forms (statozoa) and free forms (eleutherozoa), light avoiding habits (cryptotaxis), and light seeking habits (phanerotaxis), and so on, are compared together, with a host of interesting and illustrative facts of natural history, many of them personally observed by the author. Similar habits and environment have brought about similar structure; in other words, convergence and parallelism have been far more potent factors in evolution than is generally believed, and the same structure in homogenous animals has nevertheless often been independently acquired. Especially applicable are his ideas of convergence, divergence and parallelism to the parallel series of marsupials and placentals; perhaps the most convincing argument in the book. According to Dr. Willey, convergence may be traced in the anatomy, bionomy, physiology and histology of animals closely related and widely dissimilar, e.g., the pectoral fins of flying fishes, and the solenocytes of Amphioxus and the Polychaetes, to take but two examples. He might also have added psychology as well. Nothing is clearer from the results of anthropological research, than that the different races of men, separated by the whole length of the globe, have evolved almost, if not quite, the same myths and folk-lore, independently of one another.

Nevertheless it must be confessed that the ordinary zoölogist will not feel that his cherished beliefs and traditions have been seriously undermined by Dr. Willey's book. The true test of relationship of animals must be based on the structure of modern and extinct forms, and this fact Dr. Willey would himself probably be unwilling to challenge; and although such eminent writers as Dr. Gaskell, whose theories as to vertebrate origin the author extensively quotes to refute, may be led into situations where the finding of homologies based on structural resemblance takes on an almost terrifying aspect, yet the main principle holds good.

Here and there, e.g., on page 10, it is not easy quite to understand what is meant, but, as a whole, the book is clearly and brightly written.

M. D. H.

Neglected Factors in Evolution.—By H. M. Bernard. 489 pages. 47 illustrations. 8¾-in. × 5½-in.

(G. Putnam's Sons. Price 12/6 net.)

It not infrequently happens, and this book is a case in point, that a biologist after years of work in some more or less restricted branch of his subject, it hardly matters what, proceeds to the most far-reaching generalisations. We are far from deploring this t[illegible] [illegible] at times it is accompanied by a want of [illegible] portion, patent to all save the author himself. For it [illegible] undoubted fact that careful observations even of a li[illegible]pe coupled with sound reasoning and a sufficient d[illegible]agination, have in the past, as they will in the future, [illegible] biological science. We leave our readers to d[illegible] themselves if this is true of Mr. Bernard's work. [illegible] author is chiefly known for his researches on the histology [illegible] retina, and on the morphology of the apodidae and of other [illegible]pods.

The book is divided into two parts. The first, however much we may disagree with the conclusions therein arrived at, is a valuable contribution to cytology. It is clearly written throughout, and Mr. Bernard never forgets the point of view which most biologists hold on the Cell Theory. That the facts observed necessarily prove the theory does not follow, though there is much to be said in support of it, yet the author's careful summary of the facts in itself is a valuable piece of work. A long study of the minute structure of the human retina convinced him that the views commonly held as to the fundamental nature of tissues in general are untenable. In common with Whitman, Sedgwick, and others, he refuses to look on cells as the lowest units of life. The structure of bacteria and of some protozoa, and the histology of the metazoa prove, he thinks, that organisms are not made up of cells but of smaller units, which he calls chromidia. A cell is simply a complicated tangle of chromidia, and cell-boundaries are always indefinite and of little importance. In fact protoplasm is made up of a network of living threads, visible only when they are coated with some stain-receiving matter, on which are threaded lumps of chromatin. This latter substance he believes to be chiefly made of complex chemical bodies necessary for the life of the filaments. A simple chromidium consists of a small lump of chromatin provided with a number of radiating threads along which it can creep backwards and forwards, bathed in a nutritive albuminous matrix. He points out that such a view of cell structure brings into harmony the well-known views of Butschli and Altmann as to the structure of protoplasm; with great ingenuity he applies this conception to explain not only the structure of a typical cell, but of cilia, flagella, ecto- and endo-plastic skeletons, and even the phenomena of mitosis. Though in justice to the author it should be remarked that few difficulties are shelved, yet more attention should have been paid to the discoveries of the "Entwickelungsmechaniker." The fact that isolated blastomeres of developing eggs can produce a perfect though much reduced larvae hardly squares with his theory. Mr. Bernard believes that the cell theory in its present shape stands in the path of further progress in cytology, while his theory of a primitive network, protomitome, pervading the whole organism, certainly does away with some of the difficulties attending a comprehensive understanding of tissue formation. Furthermore, we are shewn the way in which the metazoa might have been evolved from an unicellular ancestor. All this is very interesting, and, if not convincing, is at all events well worth reading.

Part 2 contains far more theory and less fact. Postulating a kind of rhythm in evolution, the author suggests that the factors according to Darwin are insufficient to explain the gradual development of a highly differentiated organism such as Man. He believes that evolution has been marked by periods at the end of each of which an outburst of activity has taken place resulting in colony formation. A colony of chromidial units becomes a cell, a colony of cell units becomes a gastrael unit, a colony of gastrael units forms an annelidan unit. Some such creature as an annelid gave rise in the process of evolution to vertebrates, culminating in Man himself. The fifth evolutionary colony formation has Man as its unit, the colony itself being human societies. Just as the physical bodies of all the five units consist of a work, so are the units of human societies joined together by a psychical network, invisible perhaps, but connecting man to man. The physical network that exists between a mother and her unborn child is broken at birth, but a psychical network connects them both until death, and perhaps hereafter. Thought transference is taken for granted as an established fact; and it is hinted that in another stage of existence, or possibly in this, more and greater bursts of evolutionary activity may be in store for the human race.

In conclusion, we may cordially recommend Part 1 to the notice of biologists, even if they do not agree with Mr. Bernard's views. As to Part 2 it is harder to speak. We ourselves believe that the time is not yet ripe for such speculations, and although most biologists will pause to think from time to time over such matters as the connection of the physical with the psychical, materialism and vitalism, and kindred speculations, which the study of living matter arouses, it does not necessarily follow that much will be gained by giving them to the world at large.

M. D. H.

The Evolution of Painting: A History of Painting in Italy.—By J. A. Crowe and G. B. Cavalcaselle. Vol. IV. 379 pages. 54 illustrations. 9-in. × 6-in.

(John Murray. Price 21/- net.)

It is with the greatest satisfaction that every student of painting, as well as those who are interested in art for its own sake, will receive the intimation from Mr. John Murray that the re-issue of Crowe and Cavalcaselle's great work is now on its way to a satisfactory completion. When Mr. Crowe and Signor Cavalcaselle wrote their volumes, the study of Italian painting was the privilege of a few, and the occupation of a yet more limited band of enthusiasts; the photograph and the cheap trip were alike remote. But the genius, the industry, and the visual memory of these two men were capable of producing a treatise on the subject such as remains an unassailable masterpiece; and though the books on Italian Masters are almost as numerous as the picture post cards which the twentieth century tourist in Italy brings or sends home as mementoes of the paintings he has seen, none of them has the unique authority and comprehensiveness which this work attained. Nevertheless, the demand for information must evoke a supply, even of pictures and the whereabouts of pictures. One might almost go so far as to say that the demand for new knowledge must sometimes confound the old, so that an attribution which seemed perfectly reasonable when Crowe and Cavalcaselle wrote is rightly subject to revision as other pictures come to light; and it is certain, that human taste being not infrequently only the essence of generally received opinions, the artistic values set on Old Masters, especially on minor Old Masters, must be subject to alteration. A new edition of the volumes must therefore be a work much larger than the old, much more valuable than the old, much better illustrated than the old; and the chief difficulty of the publisher must be to find editors sufficiently catholic to admit the new material, sufficiently eclectic to prevent a lowering of the standard.

In the fourth of the six volumes in which the work is to be completed, and which deals with Florentine Masters of the Fifteenth Century, these requirements are as faithfully fulfilled under the editorship of Mr. Langton Douglas assisted by Mr. G. de Nicola, as they were in the earlier volumes, when Mr. Douglas had the collaboration of Mr. Arthur Strong. It is in many ways the fullest of the volumes hitherto issued; and the new notes and references are on a scale which almost adds an additional volume to the original work. The remaining two volumes are promised during the next year, and the only satisfactory and complete handbook on the development of Italian painting will be within the reach of persons of moderate means.

E. S. G.

Photography for Bird Lovers.—By Bentley Beetham, F.Z.S. 126 Pages. 18 illustrations. $8\frac{1}{2}$-in. × 6-in.

(Witherby & Co. Price 5/- net.)

The accompanying illustration, which we reproduce by the courtesy of Messrs. Witherby & Company, shows how carefully Mr. Bentley Beetham has studied his subject, and how much he is able to put into his pictures, for the photograph which has been reproduced not only shows the nest and eggs of the Oyster Catcher, but also indicates in no small degree the kind of site which the bird selects. The book consists chiefly of instructions telling the would-be bird-photographer how to proceed. After apparatus has been dealt with, the photographing of nests and young birds, the use of stalking and concealment methods, not to mention rope work on the cliff faces, the taking of birds in flight, in colour, and by means of the cinematograph are considered. It is truly surprising how much information and how many beautiful photographs have been included in this small volume.

From "Photography for Bird Lovers" by Bentley Beetham.

An Oyster Catcher's Nest. A suggestion of the Bird's Habitat.

PSYCHOLOGY.

Body and Mind: A history and a defence of Animism.—By William McDougall, M.B. 384 pages. 13 illustrations. 9-in. × $5\frac{3}{4}$-in.

(Methuen & Co. Price 10/6 net.)

This book, as we are informed in its preface, contains "a critical survey of modern opinion and discussion upon the psycho-physical problem, the problem of the relation between body and mind." Its author has clearly done his utmost to present his material "in a manner not too dry and technical for the general reader who is prepared to grapple with a difficult subject," and truly the subject is a difficult one. Nevertheless, the writer must be warmly congratulated on his bold attempt to make clear that which is to most so obscure, for the definite line of argument which pervades the whole book will make it difficult for any reader who systematically studies it to miss the author's meaning on any one of its closely covered pages. The book is a book for students, amateur and professional, and may be described as a scientific defence of Animism, the theory of the existence of the soul. The author clearly shows that there is no alternative between Animism and the most absolute Materialism, and boldly stands for the former; indeed the present volume is perhaps the first really scientific attempt to justify the soul theory. But it is much more than this, for the first half at least is occupied with a "survey of modern theories of the psycho-physical relation," and without this the reasoning of the later chapters is almost impossible to follow.

The book is clear and concise and excellently written, and though wholly unsuited to the casual reader is most emphatically to be recommended to anyone of average intelligence, who has made up his mind to systematically grapple with this difficult but interesting subject.

PHYSICS.

Treatise on Practical Light.—By REGINALD S. CLAY. 519 pages. 408 illustrations. 8-in. × $5\frac{1}{2}$-in.

(Macmillan & Co. Price 10/6 net.)

Dr. Clay's treatise which is an enlargement of his well-known "Practical Exercises in Light," is a book which will be welcome to many. There are many books which deal with optics from a theoretical point of view, from a geometrical standpoint or as an entertaining subject for the lecturer. There has long been required a book which collects together the various methods of optical measurement. Works on Practical Physics contain sundry optical measurements, but seldom can one find just that process of measurement that one requires. Dr. Clay in his introduction says, "There can be no doubt that it is to the advantage of the optical industry both that the difficulties manufacturers find should be known to those whose scientific training may assist in their solution, and also that the experimental methods which have been adopted by individual manufacturers should be known to each other, as well as to those whose interest may be chiefly theoretical. The chapters on aberration of lenses and mirrors and on the compound lens illustrate the above statement, and show that the author has written a book which comes up to these excellent ideals.

The book commences with a chapter on simple pin experiments—some most useful, such as the determination of the angle of the surfaces of a piece of nearly parallel glass, and all very instructive to the beginner. This leads up to a chapter on the position and nature of images formed by mirrors and lenses, dealt with in a simple manner; and then more completely in a chapter on the focal length of lenses and mirrors which contains many valuable methods and even means of obtaining the radius of curvature of very small lenses as used for microscope objectives. Chapters follow on optical instruments, deviation and dispersion of light, the velocity of light, and focal lines. The adjustments of the spectrometer are well described; it is such descriptions that make a practical treatise of good value, and it would have been pleasing to have found a rather fuller account of the method of working refractometers, spectrophotometers, and other refined optical appliances. The author's admirable love of simplicity causes him to omit fuller descriptions of instruments such as the echelon grating spectrometer, and various interferometers and refractometers, and perhaps this is to be regretted, since the research chemist has sometimes to use such instruments and is often rather ignorant of the correct method of manipulation, [illegible] some handbook to guide him. However, the chapters on interferometers, diffraction, colours of thin and thick plates and polarised light will be most useful to the student of optics, who has hitherto had to search in many different volumes to find the many different instructive experiments the author has collected in these chapters. The chapters on [illegible] colour measurement, resolving power, the compound lens, and the microscope are thoroughly up to date, and contain a great deal of very useful information, useful both to the student and to the technician.

It remains to say that the printing, [illegible] and general arrangement of the book are excellent.

A. C. G. E.

Principles of Physics.—By WILLIAM F. MAGIE, Ph.D. 570 pages. 281 illustrations. 9-in. × $5\frac{1}{2}$-in.

(G. Bell & Sons. Price 7/6 net.)

The author mentions in the preface that Physics is the one science of all others in which scientific reasoning is illustrated by the simplest and most varied examples. The peculiar advantages of the science as a means of intellectual training are not given sufficient attention, as physics is now commonly taught; and the author has endeavoured to present the subject in such a way as to direct attention particularly to the development of its various branches and thus to exemplify the processes of thought which are employed in the examination of a group of physical phenomena and the establishment of a physical law or theory. The book is consequently constructed upon the historical outline.

The result is an interesting survey of the science of physics, cramped in certain sections of the book a little too much, e.g., electricity, but nevertheless a book useful both to the elementary student and especially to the man who requires a general outlook on Natural Philosophy without having to call to his aid his mathematical facilities, or to bother his memory with a host of details which must be included in any book on Physics which includes the numerous practical applications of the Principles of Physics. The author avoids complication by rigorously keeping only the main principles of the science, and by excluding many side issues, e.g., dynamo-electric machinery, steam engines, and so on.

A. C. G. E.

An Experimental Course of Physical Chemistry.—Part I.: Statical Experiments.—By JAMES F. SPENCER, D.Sc., Ph.D. 228 pages. 65 illustrations. $7\frac{1}{2}$-in. × $4\frac{3}{4}$-in.

(G. Bell & Sons. Price 3/6.)

This work, says the author, has been written to provide the student of Physical Chemistry with a guide which shall enable him to carry out for himself the simple physiochemical operations. Dr. Spencer commences well with a chapter on errors and interpretation of results, and continues with a valuable chapter on the calibration of instruments, weights, measuring vessels, and thermometers, another on constant temperature baths, and on the manipulation of gases. These chapters are the most important part of the book, for knowledge of how to work accurately, and consequently of how to calibrate one's instruments, is all important to the physical chemist. When once apparatus is properly set up and its errors determined, accurate measurements are not difficult. Some account of the setting up of cathetometers, and reading microscopes and the calibration of fine capillary tubes might, with advantage, have been included.

The rest of the book deals with the determinations of various physical constants, and the descriptions are very clear and concise. Density, atomicity, molecular weights, solubility, viscosity, surface tension, polarimetry, spectroscopy, refractivity, and thermal measurements are dealt with in succession. A useful collection of tables is to be found at the end of this well got up and useful book. The student of physical chemistry will find most of what he wants in this small book and can always refer for greater detail to Ostwald and Luther's "Physiko-chemische Messungen": the one is a laboratory working guide, the other a reference book. Another volume of dynamical experiments is to follow this volume shortly.

A. C. G. E.

General Physics for Students. By Edwin Edser. 632 pages. 285 illustrations. 7-in. × 4½-in.

(Macmillan & Co. Price 7/6.)

Mr. Edser's physical books, those on light and heat, are already very well known and much admired for their clearness and arrangement. The book on the Fundamental Properties of Matter now under review is part of the same series of books and is even of higher standard than the other two text books. It is a new book—that is to say, it contains material which was not to be found in any other book. Mr. Edser has collected together a great number of physical facts and principles into a small volume of six hundred pages, and arranged them so adroitly that there is neither cramping nor loss of clearness. A good book for the advanced student and research student on the properties of matter has long been required; the former working for examination had no time to consult the larger treatises, such as Chwolson's Treatise, and it was often not worth the research student's while to wade through a large mass of literature after a small matter. Mr. Edser's excellent book supplies the need. The chapters on the spinning top, on gravitation, on surface tension, and on the molecular structure of gases will be of great interest to all students of physics.

"The student who possesses a sound knowledge of the elements of algebra, geometry, and trigonometry will find his acquirements are sufficient to enable him to read the book without referring to mathematical treatises": this sentence is taken from the preface, and the author has been led thereby to work all proofs from first principles and to avoid the calculus as far as possible; this is a pity, perhaps, because the calculus simplifies many arguments, and most students of physics have at some time or other to get familiar with it; and it is somewhat irksome for the more advanced student to work through a proof from first principles each time. To some it is more pleasant to be led up to a subject from the mathematical standpoint and then to compare the experimental with the inductive results; others care to do the experiment, form a mechanical picture of what is happening and then to apply mathematics to get that picture into a more exact representation of what is occurring. Mr. Edser seems to prefer along with many other physicists, the former plan; the latter would appear the more natural to the elementary student. Only in a few places in this book does this tendency become apparent, and on the whole it is exceedingly clearly written and arranged.

The printing and diagrams are very good; there are very few misprints (on page 14 "melting" occurs instead of resulting).

The book is bound to please everyone in whose hands it finds itself, and is a valuable asset and help to those studying natural phenomena.

A. C. G. E.

Illumination: Its Distribution and Measurement.—By Alexander P. Trotter. 292 pages. 209 illustrations. 9-in. × 5¾-in.

(Macmillan & Co. Price 8/6.)

This book does not deal with the many illuminants of the present day, but rather with the methods by which they may be used to the best advantage, an equally important study. In order to be able to determine quantitatively the effect of an illuminant at any particular position it is necessary to be able to measure the intensity of the light at that place. Mr. Trotter has himself devised many useful forms of apparatus to attain this end and describes in addition all the other forms of apparatus in use. The book is a mine of information for the user of the Photometer. The author has worked up the history of this most important class of instrument and has presented a very complete account of its various forms. The three chapters on the distribution of illumination contain a great deal of useful original work which will be of great value to the engineer engaged in the proper lighting of buildings and streets.

The book is splendidly illustrated and is printed in very clear type; while it contains a valuable bibliography at the end. It will be indispensable to the user of photometers and to the illuminating engineer.

A. C. G. E.

NOTICES.

CHRISTMAS GIFTS.—In view of the approach of the Yule-tide gift season we would direct the attention of our readers to the fact that most scientific and optical instruments, including cameras, lend themselves admirably to the material expression of goodwill among relatives and friends, and that such, chosen with regard to the particular interests of the recipients, would be sure to find a warm welcome with them.

PHYSICAL TRAINING AT BIRMINGHAM.—We recently had the pleasure of seeing the work which is carried on at the Anstey Physical Training College, near Birmingham, and we hope soon to public an article dealing with the scientific side of Swedish Physical Exercises, by Miss Anstey, the Principal and Founder of the College. There is no quicker way to Birmingham than by the two-hour expresses of the London and North-Western Railway. No less than forty trains run daily between Euston and Broad Street and New Street—a most frequent service.

WELLCOME TROPICAL RESEARCH LABORATORIES.—Messrs. Baillière, Tindall and Cox, the well-known medical publishers, announce that they have been authorised by the Department of Education of Sudan Government, to publish immediately the Fourth Report of the Wellcome Tropical Research Laboratories, Khartoum. The Third Report was issued in 1908, since when a great amount of important research work has been accomplished, and the announcement that a further instalment is to be expected should arouse the keenest interest among students of Tropical Medicine.

The thorough examination of the conditions of tropical life, as they present themselves in men, animals, and plants, is the task to which this great institution is devoted, and the Fourth Report, which is in three volumes, contains facts, observations, and discoveries recently brought to light. It is the actual record, at first hand, of new contributions to the solution of problems of deep and world-wide importance.

The edition is, however, limited, and in order to ensure delivery of copies immediately upon publication, it is essential that orders should without delay be forwarded to the publishers.

TREASURE TROVE.—The Committee of the South Eastern Union of Scientific Societies on Means of the Preservation of Treasure Trove and other Relics, has issued a second edition of its pamphlet upon the law of Treasure Trove together with a sheet of illustrations showing in an attractive manner the sort of articles which may be found and ought to be preserved. Mr. H. Norman Gray, the honorary secretary, is sending copies to various county museums and other institutions for exhibition and reference, and although the Committee is inclined to the opinion that public museums should be the homes of all finds of interest, it is only concerned with the preservation of the finds, and therefore private collectors need have no fear from any action from this Committee. The printing and circulating of the literature entails a considerable amount of expense and the Committee invite contributions to aid it in its useful work.

SCIENTIFIC BOOKS.—We have received from Messrs. W. & G. Foyle their catalogue of technical and scientific books. The great feature of it is the way in which the various items are carefully listed under alphabetical headings. The index contains over two hundred different subjects, so that it is easy to find any one required without the trouble that usually has to be expended in looking through catalogues of books.

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