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Knowledge.

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

A Monthly Record of Science.

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

NOVEMBER, 1910.

NOTES ON BRITISH FORAMINIFERA.

IV.—HAPLOPHRAGMIUM AGGLUTINANS D'ORBIGNY, SP. *HAPLOPHRAGMIUM CANARIENSE* D'ORBIGNY, SP.

By EDWARD HERON-ALLEN, F.L.S., F.R.M.S., AND ARTHUR EARLAND.

HAVING now described a species representative of each of the principal groups of the Foraminifera, viz., the Imperforate or Porcellanous (*Massilina secans* d'Orb. sp.) and the Perforate or Hyaline (*Polystomella crispa* Linné sp.), we now propose to deal with two species of a genus representing the Arenaceous Foraminifera, *i.e.*, the group in which the animal, instead of secreting a shell of carbonate of lime derived from the seawater, builds itself a composite house of adventitious fragments of material obtained from its environment, such fragments being cemented together in a more or less orderly arrangement by means of special cements secreted by the animal.

From a photograph *by A. E. Smith.*

FIGURE 1.

Haplophragmium agglutinans, d'Orbigny, sp. Specimens from the Mixon Beacon, Selsey, Sussex, utilising garnet glauconite and coal dust for the construction of the shells. × 65.

Taken as a whole the Arenaceous Foraminifera are inhabitants of more or less deep water, some being known only as deep sea forms. They are consequently but little known to the student whose observations are confined to such material as can be gathered between tide marks, and although a few species, such as those now under consideration, can usually be found in any extensive gathering made on our coasts, we should perhaps have omitted them from our sketches of the commoner British Foraminifera but for the extraordinary interest which the group possesses owing to the marvellous ingenuity which is sometimes displayed by the animals in the construction of their shells.

The exact zoölogical value of the Arenaceous group is somewhat difficult to estimate, for although it would be very convenient for purposes of classification to separate all the Foraminifera with agglutinated shells from those secreting an external shell wall of carbonate of lime, such a division would be entirely artificial. There are some species proper to both the Porcellanous and th[illegible]ne groups which habitually mask the [illegible] characteristics of their shells by the [illegible]ation of an external coating of sand-grains or [illegible]d. These species are to all external purposes Arenaceous Foraminifera, but their true position in the Order is immediately recognisable if a thin section of the shell is made, as the characteristic shell wall can always be detected under the external coating. It is not surprising therefore that among the many schemes of classification which have at various times been proposed for the Foraminifera, there are several in which no essential value has been attributed to the agglutinated shell, such species being allotted indifferently to either the Imperforate or the Perforate group, according to their external resemblance to recognised types, or the caprice of the author where no superficial resemblance existed. Such schemes of classification, so far from solving the question of the zoölogical value of the group, appear to increase its difficulty, for while there are some truly Arenaceous Foraminifera which bear a close external resemblance to Imperforate species, and a great many more which are isomorphous with Perforate types, there are a still greater number which have no particular resemblance to generic types in either group.

In Brady's system of classification, which is more or less generally accepted as the most convenient in our present state of knowledge of the Order, the external investment of the animal is abandoned as an exclusive basis for a primary division; that is to say, such species as possess an internal shell, masked by an agglutinated test, are allotted to the Imperforate or Perforate group, according to the nature of the internal shell. The truly Arenaceous Foraminifera, that is to say, those in which the shell consists entirely of adventitious material fastened together with either a chitinous or ferruginous cement, are separated into two distinct families, (i) the Astrorhizidae, nearly all of which are deep-sea forms, characterised by large irregular and usually monothalamous shells, sometimes branching or radiate, and segmented by constrictions of the wall, but never truly septate or symmetrical; and (ii) the Lituolidae in which the chambers are usually regular. Many of the Lituolidae are isomorphous with porcellanous and hyaline types. The species treated in this paper are Lituolids.

The origin of the Arenaceous Foraminifera is very uncertain. Neumayr, Lister and others suppose that they represent more primitive types than the Imperforate and Perforate groups. But the evidence in either direction is very fragmentary and to our ideas it seems more probable that they are of later evolution than the shell-secreting forms. The facts on which we base our belief are as follows:—

(1) The power of secreting carbonate of lime is generally present in animal organisms and does not mark an advance on the selection of foreign material but rather the contrary.

(2) The geological record does not show that Arenaceous Foraminifera preceded the other groups. So far from this being the case, the earliest known Foraminifera deposits contain Perforate types only.

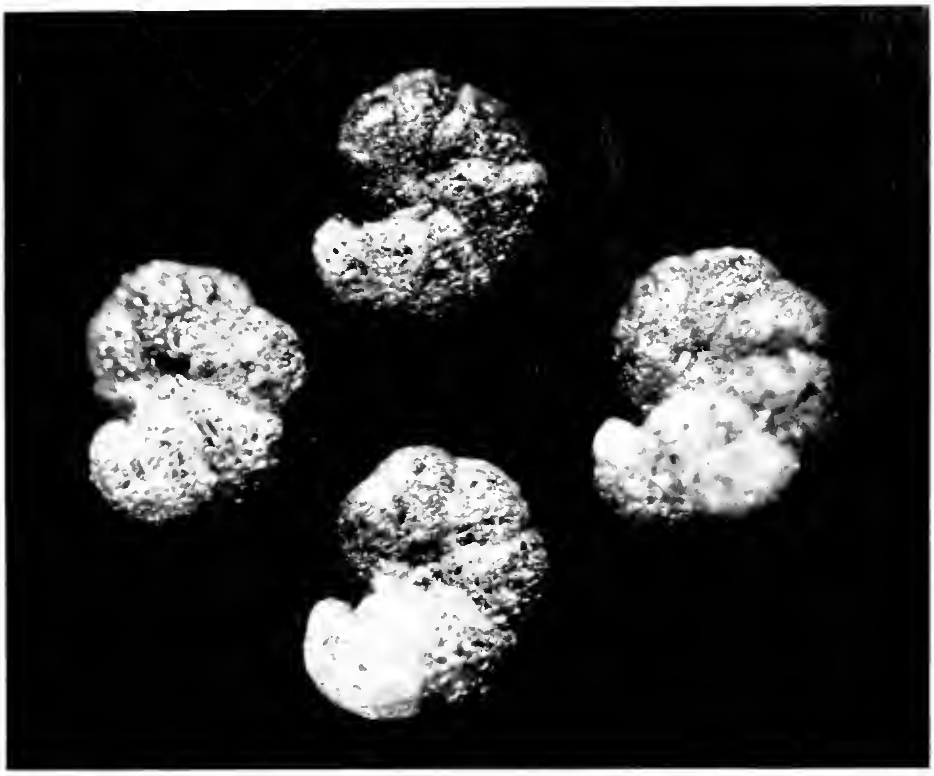
(3) The "selective power" exercised by many of the Arenaceous Foraminifera in the construction of their shells is, in our opinion, evidence that the animals possess functions and powers greatly in advance of their relatives of the shell-secreting types.

The possession of "selective power" by certain species has long been known, but the subject appears to have been avoided by most rhizopodists, probably owing to the difficulty of explaining a process which seems to require the possession of "intelligence" by organisms which, as we know, are merely particles of nucleated protoplasm possessing no differentiated organs of any kind. We are not ourselves prepared to furnish any explanation of the phenomena, nor do we expect any explanation to be forthcoming in our present state of ignorance as to the life-history of these organisms, but we have in another paper* attempted a short study of this most suggestive subject. Space will not permit of any detailed reference to the facts which we have there set forth, but the student interested in the subject will find in that paper ample evidence that these little organisms (Protozoa) are endowed with a power of selection and adaptation of adventitious material, both for purposes of construction and defence, equal to anything which exists among the higher forms of life (Metazoa).

To return to the immediate subject of our paper, the first species, *Haplophragmium agglutinans*, cannot be described as a common British species, for the records of its occurrence appear to be limited to the Isle of Wight (Millett) and the East Solent (Brady) and two dredgings in the Irish Sea (Balkwill and Wright). We believe, however, from our observations that this rarity is possibly due to the fact that the cement with which the shell is built up, is when dried, extremely friable, so that the shells break up in the process of cleaning the material. It is, moreover, as we have remarked in the paper already referred to, a species which, occasionally at any rate, exercises a fantastic taste in the selection of its building material, selecting grains of marked contrast in colour for the construction of its shell, in preference to the quartz sand among which it lives.

Haplophragmium agglutinans, as will be seen from our Figure 1, commences life with a series of chambers arranged in a spiral coil; then departing

* Edward Heron-Allen and Arthur Earland "On a new species of *Technitella* from the North Sea, with some observations upon selective power as exercised by certain species of Arenaceous Foraminifera." *Journal Quekett Microscopical Club*, 1909, pp. 403–412. Plates 31–35.



From a photograph by A. E. Smith.

Figure 2.

Haplophragmium canariense d'Orbigny, sp. Typical shallow water British variety from Selsey, Sussex. × 85.

from the spiral it adds a series in a straight line, so that the entire shell is crosier shaped. In our small British specimens this shape is not very noticeable, but in large deep water specimens the elegant crosier shape is very marked. It is a species of world-wide distribution, but very rarely recorded except from deep water in which it has been found down to a depth of 3,125 fathoms. Its geological record according to Brady extends back to the Carboniferous period, so that it is one of the oldest of the recorded Arenaceous types.

As we have said above, *Haplophragmium agglutinans* is not a prominent or common object in dried, floated and sifted shore gatherings. It seems clearly established by our observations that the cement which agglutinates the sand-fragments of which this Rhizopod builds its shell "perishes" under the influence of drying by heat, and that in the subsequent processes of floating, drying and sifting, the shell is disintegrated and disappears. In April and June of this year (1910) we made careful washings of large quantities of sea-weeds from the rocks which are exposed at low tides round the base of the Mixon Beacon at Selsey Bill, Sussex. The mud and sand containing living Foraminifera thus obtained, were preserved and cultivated by us in a series of small observation tanks such as we described in the first paper of this series, and it must be noted that this material was never exposed to the elutriating action of the waves as they reach the shore. Among the first Foraminifera to emerge from the mud at the bottom of the tanks were a large number of exceptionally fine specimens of this

From a photograph by A. E. Smith.

Figure 3.

Haplophragmium canariense d'Orbigny, sp. Specimens of the large North Sea or Arctic type (=*H. crassimargo* Norman. Vice Museum Normanianum, (1892) p. 17 footnote) × 22.

Haplophragmium. They crawled up the sides of the tanks, clinging to the glass and to the weed-grown rocks placed in the tanks, by their pseudopodia which extended in all directions from the aperture. In these early days their appearance was magnificent. Like the large specimens of *Vernenilina polystropha* which constitute a feature of the sand and mud of the Mixon Reef, these *Haplophragmia* appear to be endowed—one says it with all reservation — with an aesthetic sense. Unlike, or at any rate to a much more marked degree than, the specimens of the same species found among shore gatherings in the immediate neighbourhood, these *Haplophragmia* and *Vernenilinae* deliberately select for the construction of their shells large fragments of finely coloured quartz, garnets, chips of magnetite and coal, glauconite, and particularly of an unidentified gem mineral which is found in the detritus of the Alveolina lime-stone rocks which form the Mixon Reef. The result is a shell built up of shining blocks of black, yellow, crimson, brown and green, of a peculiarly splendid appearance.

In the course of weeks and months, whilst the commoner forms continued to flourish and increased in numbers, most of these beautiful *Haplophragmia* disappeared, though two or three fine specimens still (September) make their appearance at intervals. In two of our tanks in which, owing to the death of larger organisms, the layer of mud putrified, the *Haplophragmia* turned black, and fell to pieces when fished out of the tank. When the tanks were cleared out there was no trace of them. At the end of some months we decided to wash and examine the layers of clean mud which had lined the bottoms of three other tanks—it must be borne in mind that this material had never formed part of any sea bottom but was washed clean from the fronds of the Alga. It was carefully washed on a silk sieve and dried by very gentle sun-heat with a view to its being "floated" to separate the Foraminifera. Before this was done, however, we examined the dried material, and we were astonished to find that on the sieve which retained the medium siftings the perfect shells of *Haplophragmium agglutinans* formed 20% of the washed (not floated) material. From this material the shells represented in Figure 1 were picked. The material was then heated, cooled, and floated in the usual manner and we were provided with a fresh surprise, namely, that in the floatings *Haplophragmium agglutinans* was quite as rare as it ever is in a shore gathering. We are therefore justified in assuming that the species may be a common one in gatherings of living Foraminifera from Algae, and that the shell is constructed with a peculiarly perishable cement which conduces to its disintegration under the action of the waves upon the shore and the processes of drying and floating. On this assumption we may infer that the rare individuals found in shore gatherings are those which have been washed up alive by the last tide and have been held together by their contained sarcode.

In this fragility it entirely differs from our other species *Haplophragmium canariense*, which is solidly built, smooth and robust, and survives the most heroic treatment.

[We take this opportunity of recording that the mud obtained from these tanks contained many fine and typical specimens of *Massilina secans* var. *denticulata* Costa in which the final chamber has a delicate serrate carina. This variety has only been recorded previously in Britain from the neighbouring locality of Bognor[*]. There were also many specimens of *Massilina secans* in which the two final chambers showed deep median constrictions, resembling septal divisions, somewhat like the specimens for which Halkyard proposed the varietal name *obliquistriata*, subsequently withdrawn by the same author, and also of Earland's variety (*loc. ab.*) *tenuistriata*.[†]

As none of these curious varieties were observed either in the fresh gatherings which we made at the Mixon Beacon, or in any of the numerous shore gatherings made at Selsey over a long period and wide area, we are forced to the conclusion that they are the result of starved or unfavourable conditions of life in a confined tank reacting on the shell-secreting powers of the species in question.]

Our second species *Haplophragmium canariense* possesses little in common with *H. agglutinans*. It is, as will be seen from our Figure 2, a regularly nautiloid shell, consisting of several convolutions, the outermost having from six to nine segments. The convolutions are embracing, so that the last whorl entirely, or almost entirely, includes its predecessors. The lateral surfaces sink towards the umbilical depression which is more or less excavated. The peripheral edge is rounded and more or less lobed. The aperture is a thin slit set on the face of the last segment close to the inner margin, and sometimes surrounded by a lip. The surface of shore specimens is usually smooth and neatly finished, the wall being built up of fine sand grains cemented together with a ferruginous secretion which gives a delicate rust colour to the whole shell. The colour, which depends on the cement, is, however, rather variable, ranging from deep brown to light grey, and the earlier segments are generally darker than the later ones.

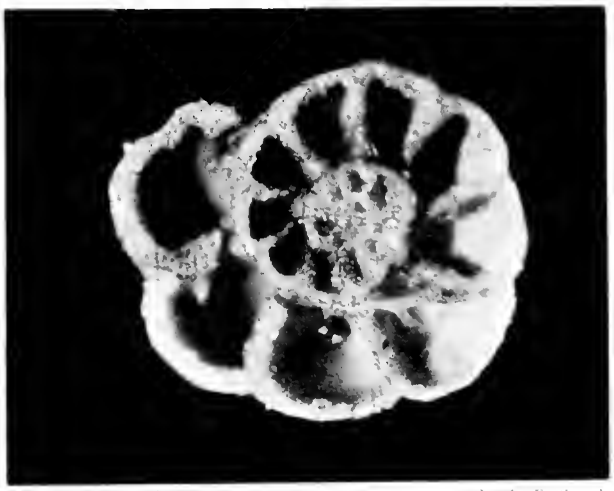
The shell-wall in shore specimens is always thin and nearly smooth, but in deeper water the animal uses larger sand-grains so that the surface becomes somewhat rough. In certain localities, notably the

[*] Earland A. The Foraminifera of the Shore sand at Bognor, Sussex. *Journal Quekett Micro. Club*, 1905, ser. 2, vol. ix., No. 57, p. 198, pl. xi, fig. 4.

[†] *Miliolina secans* var. *obliquistriata*. Halkyard, 1889, Trans. Manchester Micr. Soc., p. 61, pl. i, fig. 7. This variety was subsequently withdrawn by Halkyard in Trans. Manchester Mic. Soc., 1891, p. 20.

North Sea and Arctic Seas, the species often attains a size which can only be described as huge compared with the normal type. We figure some specimens dredged in The Gut, North Sea (57° 59′ N 0° 57′ E) at a depth of one hundred-and-forty mètres which will give some idea of the dimensions attainable under what is no doubt exceptionally favourable environment. We also figure a section through one of these large individuals (Figure 4) which it will be seen is of the microspheric type, as indeed are all such specimens which we have examined in section. We should, however, hesitate in stating that such individuals represent the microspheric form of the species, as their abnormal size is more probably due to age and an abundant food supply, seeing that other arenaceous types in the same attain similarly abnormal dimensions.

Haplophragmium canariense is commonly distributed on muddy bottoms all round our coast, and although not a frequent constituent in shore gatherings, its presence can usually be relied on. Its distribution is otherwise world-wide and its recorded range extends from shore gatherings to nearly 4,000 fathoms. Curiously enough, for such a widely distributed species its geological history is quite scanty. According to Brady it does not extend back beyond the Pleistocene.



From a photograph *by A. E. Smith.*

Figure 4.

Haplophragmium canariense d'Orbigny *var. crassimargo*, Norman. A shell laid open in the median plane to show arrangement of chambers. The opening between the chambers is visible close to the inner spiral. The protoplasmic body in the form of a branching rope is to be seen traversing some of the later chambers. × 28.

In one of our observation tanks started in April, 1910, we were privileged to witness a phenomenon which, unfortunately, we were unable to follow up. A fortnight after our observations began we noticed an individual *Haplophragmium canariense* resting on the front glass of the tank. The whole shell was surrounded and apparently enveloped in a sphere of cloudy protoplasm (not unlike that observed by Lister and figured in our last paper in connection with *Polystomella crispa*) the outer edge and surface of which was defined by a deposit of mud grains. The shell was ·1 mm. in diameter and the whole sphere of protoplasm with the contained shell was ·3 mm. in diameter. From this sphere pseudopodia extended in long straight filaments which did not anastomose, and the two longest filaments extended in opposite directions from the sphere to a distance on each side of twenty to thirty times the diameter of the sphere. Beyond this point they fined off until they became invisible under the magnification (× 65) of the objective.

Next day the whole phenomenon had disappeared, and we never saw another specimen of the species though there were many in the mud of the tank when it was washed and dried in September. We cannot, therefore, say whether a reproductive process was in progress or not.

Synonyms.

Haplophragmium agglutinans d'Orbigny, sp.

Spirolina agglutinans d'Orbigny, 1846. For. Foss. Vienne, p. 137, pl. vii, figs. 10–12.

Spirolina simplex Reuss, 1855. Sitzungsb. d. K. Ak. Wiss. Wien, vol. xviii, p. 232, pl. ii, fig. 30.

Haplophragmium rectum Brady, 1876. Monograph Carb. and Permian Foram., p. 66, pl. viii, figs. 8, 9.

Haplophragmium agglutinans (d'Orbigny) Brady, 1884, Foram. Challenger, p. 301, pl. xxxii, figs. 19–26.

Haplophragmium agglutinans (d'Orbigny) Balkwill and Wright, 1885. Trans. R. Irish Acad., xxviii (Science), p. 330, pl. xiii, figs. 18–20.

Haplophragmium agglutinans (d'Orbigny) Brady, 1887. Synopsis British Foram. Jour. R. Mic. Soc., p. 889.

Haplophragmium agglutinans (d'Orbigny) Goës, 1894, Arctic and Scandinavian Foram., p. 23, pl. v, figs. 140, 141.

Haplophragmium canariense d'Orbigny, sp.

Nonionina canariensis, d'Orbigny, 1839. Foram. Canaries, p. 128, pl. ii, figs. 33, 34.

Placopsilina canariensis (d'Orbigny) Parker & Jones, 1857. Ann. and Mag. Nat. Hist., ser. 2, vol. xix, p. 301, pl. x, figs. 13, 14.

Nonionina jeffreysii, Williamson, 1858. Recent British Foram., p. 34, pl. iii, figs. 72, 73.

Lituola canariensis (d'Orbigny) Brady, 1864. Trans. Linn. Soc. Lond., vol. xxiv, p. 472.

Lituola nautiloidea var. *canariensis* (d'Orbigny) (pars) Parker & Jones, 1865. Pené. Trans., vol. clv, p. 406, pl. xv, fig. 45 a.b.

Haplophragmium canariense (d'Orbigny) Brady, 1884. Foram. Challenger, p. 310, pl. xxxv, figs. 1–5.

Haplophragmium canariense (d'Orbigny) Brady, 1887. Synopsis British Recent Foram. Jour. R. Micr. Soc., p. 889.

Haplophragmium canariense (d'Orbigny) Goës, 1894. Arctic and Scandinavian Foraminifera, p. 20, pl. v, figs. 92–101.

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

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

VARIABILITY OF DOUBLE STARS.

On the question of the variability and colours of Double Stars, Innes has some remarks which are worth reproduction. After stating that only in a few striking cases has he given any attention to questions of variability, he suggests that "It is highly probable that the variation of light so often recorded is in some sense real." In consequence of this remark I have generally included in my notes the question of variability where any materials were available for doing so. It must never be forgotten, however, when one has to deal with or consult photographic magnitudes, that these are often fainter than the visual; a fact in nearly all instances arising in the case of stars which are yellow or reddish, these colours, it is well known, having less actinic power than white light.

As regards colours, Innes's policy was substantially adopted by myself long before I knew that it was his. He says: "Very little attention has been given to colours. Where, however, they seem generally agreed on, they are quoted. The minute differences of shade recorded by some observers have been omitted as useless if not misleading." I have made some remarks on the colour question at an earlier point in this paper.

THE SOUTHERN CONSTELLATIONS.

So many of the Stars which have come into notice lately through the labours of Innes being Southern Hemisphere Stars, it is necessary to pay some special attention to the allotment of constellation names to them in default of his having done so in the vast number of cases. The question of the boundaries, and, indeed, of many of the names of those constellations was long a thorny one, and matters were not improved by the drastic proposals for the radical reform of the boundaries of many of the Southern Constellations put forth by the late Dr. B. A. Gould in his *Uranometria Argentina*, published at Buenos Ayres in 1879. It is no wonder that Dr. Gould's proposals have not met with favour, for under his schemes the Constellations were cut up into slices and pieced together in (to put it mildly) a most inconvenient fashion. Bad as his divisions might have been when recorded on maps, matters were tenfold worse when one tried by consulting his Catalogue to find the whereabouts in it of any particular Star whose magnitude one wished to learn, or to read the "Notes" printed in another part of the Book. Even when a Star was found in the Catalogue, it was always a matter of some minutes more to dig up the "Note." Anyone who may have access to a copy of the *Uranometria Argentina* will readily be able to judge of the time and labour which would be involved in attempting to collate any Star magnitudes, as usually stated, with the Cordoba magnitudes. The advantage of doing this has, however, been in great part removed, since the publication of Dr. Gould's results, by the issue of the *Southern Harvard Photometry*, the value of which two volumes, in combination with the Northern volume, it is impossible to over estimate. I make these remarks on Gould's labours with regret, because his criticism on the names and boundaries of certain Constellations and on the lettering of conspicuous Stars* are very forcible in their way, but his endeavours to build a substitute for what he would pull down have, like many other "reform" efforts, resulted in confusion worse confounded.

The reader will perhaps now expect some statement as to how I should treat the matter, which is one by no means lacking in practical importance, having regard to the large and increasing number of amateur astronomers who are compelled to carry on their labours unprovided with equatorial mountings, and, therefore, are dependent on maps for finding the objects which they wish to observe.

I may state generally that I should for the most part accept the principles laid down by the late Mr. E. J. Stone in the preface to his "*Catalogue of 12,441 Stars for the epoch of 1880.*" Without quoting in detail his statement of those principles, I may give in his own words his prefatory summary of them. After protesting against radical changes (apparently having Dr. Gould in his thoughts), he says: "I have, therefore, in the present Catalogue, followed the system introduced by Lacaille, but with the rectifications of boundaries and modifications recommended by Sir John Herschel. This system

* *Uranographia Argentina*, the 4to volume, pp. 48–79.

ξ Bootis.

Mags. $3\frac{1}{2}$, $6\frac{1}{2}$: Distance $2\frac{1}{4}''$ (1909).

β Scorpii.

Mags. 3, 10, 6: Distances $1\frac{1}{4}$, 13″.

ν Scorpii.

Mags. $4\frac{1}{4}$, 6: Distance 1″.

σ Coronae Borealis.

Mags. 6, $6\frac{1}{2}$, 12, 11: Distance 5″ (1903).

α Scorpii.

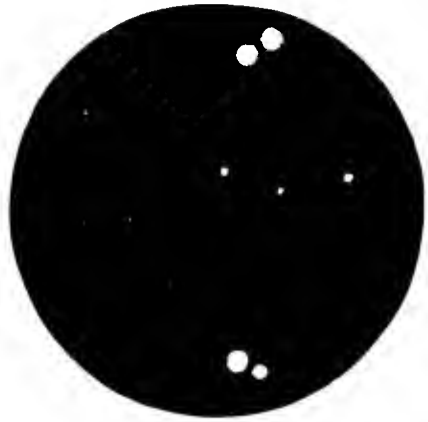
Mags. 1, 7: Distance 3″.

ψ^1 and ψ^2 Draconis.

Mags. $4\frac{1}{2}$, $5\frac{1}{4}$: Distance 30″.

h_2 Sagittarii.

Mags. 4, 11, 13, 9½, 9½.



ε Lyrae.

Mags. 5, 6½, 5, 5½: Distances 3″, 208″, 2″.

β^1 Sagittarii.

Mags. 3¾, 8: Distance 28″.

Σ 2673 and 2674 Sagittae.

Mags. 8, 9½, 8, 11: Distances 3″, 76″, 15″.

β Cygni.

Mags. 3, 5: Distance 35″.

15 Delphini.

Mags. 7, 7¼, 7¾, 12: Distance 15″, 23″, ½″.

was adopted by Baily in the *British Association Catalogue of 8337 Stars*, and in the *Catalogue of 9766 Southern Stars* formed from Lacaille's zones, and it has been generally adopted in recent Southern Catalogues. It has, therefore, the authority of more than 30 [now 60] years' extensive use in its favour. It appears to me very doubtful whether all the changes introduced by Herschel and Baily were necessary or, indeed, desirable, but less confusion is probably now caused by the adoption of these changes than by attempts to revert more closely to Lacaille's original nomenclature."

Stone unfolded the same doctrine in a letter which he wrote to me under the date of September 8th, 1880. I had consulted him as to the nomenclature of the Southern constellations, intending to follow in the new edition of Admiral Smyth's *Cycle of Celestial Objects*, as well as I might be able to do, any advice which he might give me. Stone said:—"I have practically followed the B.A.C. in my nomenclature. Baily followed Herschel's advice after Herschel found that no sweeping changes in Lacaille's system would be acceptable." Stone in effect said "Meddle not with him that is given to change," and as this conservative idea commended itself to me I acted upon it. Some years afterwards Stone, after returning from the Cape of Good Hope, became Radcliffe Observer at Oxford. In the Preface to the *Radcliffe Catalogue of 6424 Stars* edited by him, he tersely summed up his treatment of the subject in the following words: "In the division of the sky into constellations the nomenclature and boundaries adopted by Francis Baily, with the sanction of Sir John Herschel, have been generally followed, but no especial importance has been attached to this part of the work."

The principles which Sir J. Herschel laid down are stated by him under seven heads. As the text of them is not generally accessible, though everybody now-a-days is dependent on them (Gould's organic changes having been very generally repudiated), it will be well to set them out because they furnish a useful clue to the profitable study of the constellations specially affected, including particularly the troublesome constellation Argo.

The following is an authoritative statement * of them:—

"(1) That all the Constellations adopted by Lacaille be retained, and his arrangement of the Stars preserved: subject, however, to certain alterations hereafter specified.

"(2) That all the Stars having a doubtful location, such as those which Lacaille (after the manner of Ptolemy) has considered as ἀμόρφωτοι (unformed), be included within the boundaries of either one or other of the contiguous constellations, so as to preserve a regularity of outline and nomenclature.

"(3) That all the rest of Lacaille's Stars be placed within the boundaries laid down by him, with the following exceptions: first, a few Stars which are located too far from the border of the constellation, in which they are registered, to admit of a uniform contour of the lines: secondly, such Stars as have been previously observed by Ptolemy or Flamsteed and by them located in other constellations, or which interlace, and are confusedly mixed with such previously observed stars: thirdly, the four Stars that are placed by Lacaille in the end of the Spear of Indus, but which are now assumed to form part of the constellation Pavo, in order to render the contour of these two constellations less circuitous.

"(4) That the letters selected by Lacaille be adopted in preference to those introduced by Bayer in Argo, Centaurus, Ara and Lupus. That the Greek letters (with a few exceptions) be retained only as far as Stars of the 5th magnitude, inclusive. That no Roman letters be at present used, except in the sub-divisions of Argo subsequently mentioned.

"(5) That Argo be divided into four separate constellations, as partly contemplated by Lacaille, retaining his designations as Carina, Puppis and Vela: and substituting the term Malus for Pyxis Nautica, since it contains four of Ptolemy's Stars that are placed by him in the mast of the ship.

"(6) That the original constellation, Argo, on account of its great magnitude and the sub-divisions here proposed, be carefully revised in respect to lettering, in the following manner: first, in order to preserve the present nomenclature of the principal Stars, all the Stars in Argo (that is, in the general constellation, regarded as including the sub-divisions above mentioned), indicated by Greek letters by Lacaille, be retained, with their present lettering, under the general name, Argo: secondly, all the remaining Stars to be designated by that portion of the ship in which they occur, such as Carina, Puppis, Vela and Malus, and to be indicated by the Roman letters adopted by Lacaille, as far as the 5th magnitude inclusive. And no two Stars, far distant from each other in the same sub-division, to be indicated by the same letter: but in cases of conflict, the greater magnitude to be preferred: and when they are equal the preceding Star to be fixed upon.

"(7) That the constellations which Lacaille has designated by two words be expressed by only one of such words. Thus, it is proposed that the several constellations indicated by Lacaille as Apparatus Sculptoris, Mons Mensae, Caelum Scalptorium, Equulius Pictoris, Piscis Volans, and Antlia Pneumatica, be called by the respective titles of Sculptor, Mensa, Caelum, Pictor, Volans and Antlia: contractions which have on some occasions been partially used by Lacaille himself, and are very convenient in a registry of Stars."

* I call this "authoritative" because it appears in the Preface to the *British Association Catalogue* as given by Baily, apparently on behalf of Herschel: but it is not expressly stated to be in Herschel's own words, though I infer that the words are Herschel's.

THE DESTRUCTION OF WEEDS BY CHEMICAL MEANS. II.

By HAROLD C. LONG, B.Sc.

(*Author of "Common Weeds of the Farm and Garden."*)

In the course of his investigations Bolley observed:—(1) That succulent plants and those of slow growth are more easily killed than others; (2) That flower parts and parts of plants covered with "bloom" or waxy coatings are more or less protected; (3) That plants possessed of hairy surfaces are, as a rule, more easily killed than those with a smooth surface; (4) That chemicals act differently upon plants of different families, even though the plants be wetted equally readily—charlock and dandelions, for example, are readily attacked by copper sulphate solution, while creeping thistle, wild buckwheat and clover are slowly attacked; and (5) That most of the chemicals readily destroy the tissues of any plant where the surface is broken.

It was found that charlock could be sprayed with absolute success; that king-head or greater ragweed (*Ambrosia trifida*) could be sprayed in much the same way as charlock and with considerable success at certain times, success depending on the age of the weed; that creeping thistle (*Cnicus arvensis*) was most effectively sprayed with sodium arsenite (one-and-a-half to two pounds per fifty-two gallons of water), and common salt (one-half barrel per fifty-two gallons of water); that succulent portions of the stem and leaves were destroyed when the plants were a foot high and seeding was prevented; that spraying of dandelions on lawns and fields with sulphate of iron was a marked success; and that the perennial sow-thistle (*Sonchus arvensis*) was practically unaffected by sprays. (It may be remarked that this weed, only too common in Britain, is quite smooth and covered with bloom.)

From a photograph *by H. C. Long.*

FIGURE 10.

Garden Nightshade (*Solanum nigrum* L.) A pest of arable land and gardens, and poisonous to an extent which varies according to conditions.

Bolley concluded that the following weeds may be eradicated or largely subdued in grain fields by the use of chemical sprays:—*False flax* (*Camelina sativa*), worm-seed mustard, tumbling mustard, *common wild mustard* (*charlock*), *shepherd's purse*, pepper-grass, ball mustard, *corn cockle*, *chickweed*, *dandelion*, *creeping thistle*, *bindweed*, *plantain*, rough pigweed, king-head, Red-River weed, ragweed, cocklebur. The following were found not to be effectively controlled by chemical sprays as now used:—Hare's-ear mustard, *penny cress*, pink cockle, *perennial sow-thistle*, *lamb's-quarters*, pigeon grass, *wild oats*, *chess* (*Bromus secalinus*) *couch grass*, sweet grass, and *wild barley*. (In each case those weeds named in italics are of interest to farmers in Great Britain).

A large number of tests with the sulphates of iron and copper were carried out some years ago by Dr. A. B. Frank in Germany.[*] Thirty-five species of weeds were involved. Clover was but little damaged by a 15 per cent. solution of iron sulphate (seventy gallons per acre, and one hundred and sixty gallons per acre), or a 5 per cent. solution of copper sulphate, the clover soon recovering after losing its first leaves. In addition to charlock, the following plants were more or less damaged by sulphate of iron:—corn cockle, poppy, sow-thistle, cornflower, field thistle, dandelion, groundsel; and the following were more or less damaged by a 5 per cent. solution of copper sulphate (seventy gallons per acre):—spurrey, groundsel, black bindweed. Though these plants appear to be rarely destroyed they are prevented from producing flowers and seed.

In experiments conducted in 1903 at the Holmes

[*] Bekämpfung d. Landw. Unkräuter durch Metalsalze. *Arb. aus. der Biol. Abth. fur Land. und Fortsw.*, I. Bd., 1900.

Chapel College of Agriculture and Horticulture, "clover was untouched" when the covering oat crop was sprayed with one hundred gallons of a 4 per cent. copper sulphate solution. In 1899 a 4 per cent. solution of the sulphate (one hundred gallons per acre) completely killed *Polygonum Persicaria*, but clover was uninjured. A 4 per cent. solution of copper sulphate (fifty gallons per acre) was also used to destroy charlock in mangolds, the latter being uninjured.

Experiments at the Agricultural Experiment Station of the University of Wisconsin showed * that a 20 per cent. solution of iron sulphate (fifty-two gallons per acre) did not injure cereals, clover seedlings or lucerne, but cockle-bur, ragweed, dandelions, daisies, wild lettuce, and several common farm weeds were partly eradicated. Sow-thistles and creeping thistle were not effectively sprayed, and it was concluded that their eradication by spraying is not practical for the average farmer.

FIGURE 11.

Corn Buttercup (*Ranunculus arvensis* L.) × 1. Often very troublesome in corn fields on all soils, especially on chalk. Often termed "watch wheels" from the flat spiny fruits.

In demonstrations conducted throughout Ontario, the effect of copper sulphate was observed in relation to twenty-eight weeds,‖ and while charlock was the only species readily destroyed, it was found that the flowers of field bindweed and white cockle, and the leaves of creeping thistle, sow-thistle, blue weed (*Echium vulgare*), and bull thistle (*Cnicus lanciolatus*), were very sensitive to the spray, and largely destroyed.

At the Yorkshire College, Leeds, experiments showed ‡ that clovers were practically uninjured when sprayed with a 12 per cent. solution of sulphate of iron, while peas, beans, carrots, onions, beet, and parsnips were but slightly damaged, and this was the case also with swedes, turnips and mangolds.

Spurrey (*Spergula arvensis*) has been found to be checked by spraying with a 5 per cent. solution of sulphate of copper (forty gallons per acre), flowering and seeding being checked . In another trial ¶ the results were held to show that a 5 per cent. solution of copper sulphate (fifty gallons per acre) may be relied on to kill spurrey.

At the Woburn Experimental Farm it has been shown by pot trials that the common poppy (*Papaver Rhoeas*) is much injured by a 2 per cent. solution of copper sulphate; when the solution was applied to both surfaces of the leaves these "turned brown, became shrivelled, and to a great extent the plant was killed, for the seeding was almost entirely prevented, the flower heads withering up." § It has also been stated ** that the common scarlet poppy is very sensitive to a 15 to 20 per cent. solution of iron sulphate.

At the Woburn Station also experiment showed that the wild onion (*Allium vineale*) may be destroyed or at least largely reduced by spraying with a 5 per cent. solution of pure carbolic acid.††

FIGURE 12.

Shepherd's Needle, Venus' Comb (*Scandix Pecten-Veneris* L.) × 1. An annual corn-field weed sometimes extremely troublesome on light and chalk soils.

Dr. Hiltner found that dodder on clover may be destroyed by spraying with a 15 per cent. solution of sulphate of iron, so applied that it hits both the plants and the surface soil with some force. The clover was blackened at first and appeared to be ruined, but sprouted strongly afterwards.‡‡

Sulphate of iron has been found to destroy charlock if applied in the powdered condition when the dew is on the leaf, three to four cwt. per acre being necessary. This is considered by M. Hitier to be more easy of application than in the form of a solution, and more practical on small areas.

* Bulletin No. 179, 1909.
‖ Ann. Report, Dept. Agric., Ontario, 1904, Vol. I., p. 39.
† Report on the Spraying of Charlock and Runch, 1899.
‡ Rept. on Expts., Midland Agric. and Dairy Inst., 1900.
¶ Univ. Coll. of North Wales, Bangor, Bull. ii., 1908.
§ *Jour. Roy. Agric. Soc.*, 1902, p. 360.
** Fr. Maier-Bode, *Die Bekämpfung der Acker-Unkrauter*, 1908.
†† *Jour. Roy. Agric. Soc.*, 1900, 1901 and 1902.
‡‡ *Prak. Blatter fur Pflanzenbau und Pflanzenschutz*, Ap. 1908.
Bull. des Séances Soc. Nat. d'Agric., 1909, No. 5.

FIGURE 13.

A plot of lawn upon the North Dakota Agricultural College campus infested by dandelions untreated before blossoming time. Left continuation of Figure 14. (From Bolley's Bulletin, No. 80, see *Knowledge*, No. 507, p. 395.)

Calcium cyanamide has also been found useful for destroying charlock in corn crops.*

The action of petrol on certain plants has been observed at the Woburn Experimental Fruit Farm,† and it was noted that the poppy, teasel and wild strawberry were practically killed.

The efficacy of carbon bisulphide in killing large tropical "weeds" has lately been discussed by E. V. Wilcox in a press bulletin issued from the Hawaii Agricultural Experiment Station, and plants appear to be destroyed owing to the freezing effect.

The results of experiments at the Vermont Agricultural Experiment Station and elsewhere are summarised in Farmers' Bulletin, No. 124 of the U.S. Department of Agriculture —and salt, carbolic acid, liver-of-sulphur, kerosene, copper sulphate, arsenate of soda, and so on, are dealt with.

The foregoing notes show conclusively that in one way or another many weeds may be attacked by means of solutions of chemical preparations, with good prospects of preventing seeding or of destroying the plants altogether. It is, however, still desirable that exhaustive experiments should be conducted on a co-operative basis in different parts of Great Britain, for the effects of the various solutions vary with the plant sprayed, the local meteorological conditions, and the thoroughness with which the work is carried out. With the results of such experiments placed clearly before them, British farmers would have some definite information on which to proceed. We hope that the preparation of this article will not have been in vain.

FIGURE 14.

A plot of lawn upon the North Dakota Agricultural College campus infested by dandelions of the same strength of growth as those shown in Figure 13, but treated with iron sulphate solution thrown by a traction sprayer two weeks before blossoming time. Compare with Figure 13. (From Bolley's Bulletin, No. 80, see *Knowledge*, No. 507, p. 395). These two photographs show in a striking manner the effects of spraying.

* *Jour. Bd. Agric.*, Dec., 1907, p. 568; Jan., 1909, p. 776.

† 10th Annual Report, 1909, p. 20.

THE OBSERVATORY ON MOUNT WILSON, WHERE MIRRORS SUPPLANT THE TELESCOPE TUBE.

By FELIX J. KOCH.

THE recent appearance and disappearance of Halley's comet has thrown the star gazers into the public eye, and among observatories none, perhaps, has given rise to more comment than the great Carnegie one on Mount Wilson, near Los Angeles, California. This, perhaps, largely because it is unique among the world's observatories.

To reach Mount Wilson from the end of the nearest car line means a long burro ride through the mountains. There the one peak of the twins forming the summit is given over to a rustic hotel, and surrounding this, for individual guest rooms, are a series of chalets, each a full-fledged house to be occupied by the guest.

Entrenched in these one proceeds through the forest down into a gulch and on to the opposite mountain, where the great Observatory connected with the Carnegie Institute of Washington, D.C., is established.

The building, to begin with, appears like some huge ark. It is of white canvas, immense, and in the shape of a barn. It stands on the very tip of a mountain, surrounded on all sides by open valley. One surveys lower forested peaks rising out of this valley, and the flat plain leading off into the distance. The scene is sufficiently magnificent to repay for the journey.

Turning, there lie, basking in the sun, a large white series of buildings set in perfect line on this peak.

A professor is at hand to guide you, and he leads into the main building. This is built up of canvas, set in eave form on the sides so as to admit plenty of air. Then outside these canvas eaves there runs another wall of canvas, such that it can be raised or lowered, and thus ensure the same temperature inside the building as out.

The edge of the Ark.

One looks at once for telescopes, but in vain. A series of mirrors appears instead, and it is the third of these, you learn, which does the magnifying instead of the usual tube telescope. You look into this mirror and see enlarged the image of the star or moon. In order to get this, plainer still, a pocket magnifying glass is brought into play. The arrangement is a unique one for an observatory.

Nor is this all. The tent in which this third mirror stands is built upon a track, so that it may slide nearer to or farther from the next building, in which there are two other mirrors, while beyond is a little shed in the canvas building, for star work and for the spectrum instruments.

This telescope, the guide narrates, is a twenty-four inch one, made by their own people, and brought out from the Yerkes Observatory. On the end of the building there is a pier of stone, perhaps three feet wide by twenty long, which contains a concave mirror of twenty-four inch aperture by sixty foot focus. This was made at the Yerkes Observatory. Any good optician, however, could make one of these fine circular mirrors. The concavity is very great. The mirror, as a matter of fact is four inches thick, and silvered on the front surface. It takes about two months for two men to make such a mirror. This is polished by jewellers' rouge on pads of chamois skin. The mirror is burnished every week or ten days to remove the dust. It is then kept covered over with a galvanized cover.

A second mirror is supported by a number of the[illegible] metal (iron) caps. It rests on twelve of [illegible]m. each, in consequence, taking one-twelfth of the weight of the mirror, no matter what position it may be in. When the mirror is set directly on edge, a band about the outside holds it in place. It must be thus exactly weighted on account of the flexures in the glass, which would spoil the definition.

One of the Chalets.

The light strikes the first mirror primarily and from it is sent to the second, a flat circular mirror, which is of twenty-four inch diameter, and stands on a massive iron column. This second mirror is upright, but is racked back so that it can set the reflection in any direction. Thence the rays are sent from it to the third mirror, *i.e.*, the concave one, which does the enlarging, acting substantially as does the lens in an ordinary tubular telescope.

It is impossible to reflect from the first mirror direct to the third, as the light cannot be caught so well, and the station would have to be constantly changed. This changing is now done by the second mirror.

Five-thirty p.m. is supper time with the astronomers here, and one leaves them to return to the mountain hotel and his chalet.

In the evening two Yankees, also on visit, find that the room-mate of one of their sons up at Dartmouth is now observer here, and so he shows them, and you, as their guests, the Observatory in the night time. The moon seen through the great mirrors is a sight long to be remembered. The light of the orb falls full through the two mirrors on to the third, which it fills with its image. The visitors stand round this third mirror and then look at it through a little black hand magnifying glass. The craters and hills and the like take on new interest and beauty.

Again, one marvels at the site. Here on the long tented platform, which stands built out into the canon, with the magnificent forested valleys in the moon-light, black in the shadows, but stretching on to the far lights of Pasadona and Los Angeles. At another place a huge forest fire breaks the night. Over all a magnificent clear starry sky, with the rising moon, surrounds this white tented building. There is something inspiring in this unique little mountain star camp.

Next morning, Professor Ellerton, second in charge here, tells some interesting facts about the place. Harvard, he states, had an observatory here fifteen or sixteen years ago. When then the Carnegie Institute was about to open an observatory, it tested several places hereabouts, trying

In the Mirror.

Mount Lowe and the like, but finding that the place where the least quivering, due to bad definition, *i.e.*, steadiness of the image was here. They also saw that they got out of the way of dust, which will occasionally even come here as the result of some sand storm, and of ordinary fogs. Fogs, though, will arrive in the stormy season.

The site was selected six years ago last June, and the instruments shipped here.

Since April, 1904, observations have been carried on more or less continuously. Professor George E. Hale is director. He came from the Yerkes Observatory, where his chief work was solar physics. He is a man about forty-one or two years old, a graduate of Boston Institute of Technology. Ferdinand Ellerman, next in charge, has had private tuition, and has been at the work about eighteen or nineteen years. His speciality is solar work. Others here of note are Dr. Adams, Backus, and the physicist Dr. Gale. They have their own camp and offices — even generate their own electricity by gasoline engine, and pump up their own water.

The best time for observations is considered to be half-an-hour after sunrise, and for perhaps two hours later, *i.e.*, as long as the definition holds good. This may run through the whole day. The programme is to make photographs of the sun with the spectroheliograph. This is done by forming the image of the sun on a spectroscope, which is so adapted as to enable one to photograph an image of the sun in monochromatic rays of any desired wave length. The light passes through a slit, then through an objective which renders the rays parallel, then falls on a mirror, and thence is sent through two great prisms which form a spectrum. Thence it goes *via* an objective and through a second slit which permits one to select any particular line in the spectrum, and by this means photographs can be taken which will show the vapours over the sun's surface, corresponding to calcium, hydrogen, iron, magnesium and the like. The photographs are the size of the image, *i.e.*, six-and-a-half-inches. The negatives are then developed and one sees some of these glasses. At the centre is the round image, like a great fog spot with a rather crusty, skin-like effect, due to clouds passing over the surface. Such is a direct photograph made by a very fast shutter. It shows the sun as one would see it in a telescope. The spots, with the dark nucleus and the granulation in the surface, are all there. The photographs are almost instantaneous, being made by a high-grade shutter passing before the plate in one one-thousandth of a second. One picture is shown which shows the calcium lines: this by letting only these lines through the slit. The more pronounced waviness in parts is likewise noted. Again one sees that the line which admits the light of the sun for a given chemical travels across the plate in such wise as to get in the whole surface of the sun. There is now a record of over one hundred and fifty plates with this new instrument.

A Front View.

One passes then into the new laboratory; this is of solid concrete work, and with instruments all about. They can take a photograph twice a day, different each time, and never twice the same, the sun changing so constantly. Daily a photoheliograph is taken: two or three calcium plates, and one hydrogen plate. This is the regular programme. If the definition is good, so that they can compare to advantage, they photograph through iron and other lines, and there are special sittings. The difference between the calcium and hydrogen is made apparent. The results then are deduced here and published in scientific publications or monographs.

One has a peep into the professor's home—a series of little offices and bedrooms off from one hall, and all built in the mission style. Windows look out into the tree tops, as at Rila Monasteries in Bulgaria, and the aisle then terminates in a library finished in dark heavy woods, with a huge stone chimney at one side. Round the walls range the open shelves of books, with other heavy splendid furnishings, and heavy desks on which to write. One looks right off from the bluff into the great valley here, twenty-six acres below, to the Institution. As yet they are not troubled by visitors, though they fear they will have some day to enfence. The buildings are permanent, but others are still to come for the great five-inch reflecting telescope.

Some of the stellar photographs shown here, they remark, took four nights to expose. The Observatory is connected with the Carnegie Institute and so there is no fixed sum allotted it. One year they got $150,000 for maintenance.

THE LIFE HISTORY OF A NEW MONAD.

By AUBREY H. DREW.

With illustrations from camera lucida drawings by the Writer.

In December, 1908, whilst examining microscopically a sample of water from a pond at Keston, Kent, I first observed the organism of which the life-history is here given. Whilst swimming, this form seemed to be possessed of but one flagellum, which was apparently motionless. At first its method of locomotion seemed obscure, but by accurate examination with high powers it was seen to possess a second flagellum very much smaller than the other and curved round towards the body. This second flagellum was in rapid motion during swimming. Very careful and repeated observation revealed the fact that the other flagellum was also used in swimming, as it had a fine whiplash-like extremity, which was in rapid motion. I determined to work out, if possible, the life-history of the monad, and after a year and six months steady work on the form I have been able to accomplish my object.

FIGURE 1. Normal free swimming form.

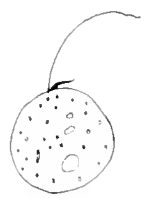


FIGURE 2.

FIGURE 3.

The organism during feeding.

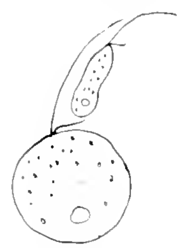


FIGURE 4.

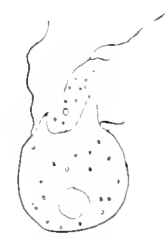


FIGURE 5.

The ingestion of other Monads.

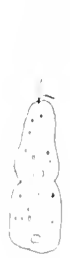


FIGURE 6.

FIGURE 7.

Stages in division.

FIGURE 8. Conjugation.

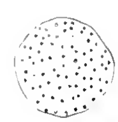


FIGURE 9. The sac.

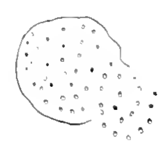


FIGURE 10. The sac discharging young.

NOTE.—All the figures are magnified one thousand times.

This Monad is a long oval, or sausage-shaped, organism, about one three-thousandth part of an inch in length; it posesses two flagella, one, the most conspicuous, being long and curved, somewhat like an eyelash, and the other being short and bent somewhat sharply towards the body. The long flagellum tapers towards the distal end, and becomes like a whiplash; the smaller flagellum is of the same thickness throughout. A contractile vacuole is present, situated about the middle of the organism. The central part of the body is generally very granular. When stained the organism is seen to possess a nucleus, which is usually situated towards the side of the body. In swimming, the smaller flagellum is in constant motion to and fro, the lash-like extremity of the long flagellum being also usually in vibration. The long flagellum appears to be of use also for steering purposes, but its main utility is undoubtedly in feeding, as will be seen later. The normal form, after swimming for a period which may vary from minutes to hours, becomes amoeboid and finally ceases movement. A more or less globular shape is now taken on, and the whole of the long flagellum is vibrated with a serpentine kind of motion, the smaller flagellum being also rapidly vibrated, the body remaining motionless and apparently adhering to the slide. By means of these flagellar vibrations currents are set up in the water towards the body of the monad, and bacteria and other smaller monads are swept towards the flagellar end of the organism. On getting near, the long flagellum is often bent over the other organism, which is thus guided to a point between the two flagella. Here the currents frequently cause the smaller monad or bacterium to rotate rapidly for a time, till finally it gets near the body of the monad. The protoplasm then seems to flow out and completely engulfs the smaller organism, and its body is passed into the interior of the monad and is rapidly disintegrated. During this process the long flagellum is usually vibrated with intense rapidity. Not only bacteria, water plants, and other monads are ingested in this manner, but also smaller monads of the same species, the feeding monad becoming very large in consequence. In one large specimen that I had under observation continuously for nine hours, five smaller monads of the same species were ingested. Three more were captured, but by intense flagellar movements they wrenched themselves free and escaped. There is no doubt that a kind of gastric juice of an acid nature is secreted by this monad, as I have found that if bacteria are stained with a saturated solution of blue litmus, and introduced into the water in which this monad is living, on ingestion they are almost instantly turned red. After feeding in this way for some time, the monad again becomes amoeboid and finally takes on the normal sausage-shaped form, and active swimming is recommenced. This period of alternation between swimming and taking on a globular form, with a repetition of feeding operations, may continue for many hours. Finally, however, the organism comes to a standstill and becomes extremely amoeboid, the body getting very granular. Sluggish swimming now occurs, the body being in intense amoeboid action. While the organism is in this condition, another normal form comes into contact with it, and almost instant fusion occurs, the long flagellum being vibrated with remarkable rapidity. The organism now speedily becomes globular, the long flagellum being cast off, and the smaller one fusing with the body, a motionless globular sac is formed, which gradually becomes very granular, the granules showing movement. This sac may remain in an absolutely motionless condition for a period which varies from six to ten or more hours. Finally, however, it bursts at one end and liberates a number of small granules about a thirty thousandth part of an inch in diameter: these roll away from the sac, and if carefully followed soon show signs of growth. In about two hours they acquire flagella, in what manner I have not yet been able to determine, though I think the long one is suddenly shot through the body wall. This method of reproduction was always obscure and was only discovered after months of work on the form. In the two conjugating individuals there was this essential difference, viz: that one was the ordinary sausage-shaped free swimming form, which was much smaller than the other amoeboid form: this latter by long feeding had greatly increased its size to several times that of the other and was far more granular. The other method of reproduction was by fission, and this occurred in the ordinary form after it had attained a certain average size in the following manner. After nuclear division, a constriction was developed round the body of the monad which divided it into two: one of the two nuclei now passed into each half and the constriction deepened: the smaller flagellum now gradually appeared in the end most remote from the other two flagella. From this time the constriction rapidly increased and the flagella lashed in a manner which pulled the two halves away from each other. Finally, they moved away from each other, the thin connecting strand of protoplasm breaking close to the body of the monad possessing the two normal flagella, and this protoplasmic strand formed the long flagellum of the other form. Periodically, the organism ejects undigested matter, this usually being at the opposite end to the flagella. A rather characteristic appearance is thus often given to the organism, as the effete matter gradually accumulates round the body and remains there for some time, till finally being cast off. The important points with regard to this organism are I think the following:—Firstly, that although presumably a certain amount of saprophytic nutrition does take place during active swimming, the organism is unable to obtain the requisite amount of nutriment by saprophytic means alone, but is compelled to ingest other organisms of as complicated a chemical constitution as itself, this method of nutrition being eminently holozoic. Secondly, the fact that, although there is no buccal opening, yet food is ingested at one particular spot, viz: between the roots of the two flagella, coupled with its method of nutrition, gives to this monad a higher position in the scale of organisation than any other known members of the family: and, thirdly, so far as I am aware, there is no other known instance among the Protozoa of what one may well call a cannibal form.

The anisogamic method of reproduction in this form is of considerable interest, inasmuch as the two conjugating forms differ in several respects. The larger organism or megazooid having increased its size greatly by continued ingestion of other organisms, and, apparently in consequence of its increased size, is far more sluggish in movement, besides being extremely granular and amoeboid. The microzoöid is the ordinary normal form, and is not amoeboid, and, in size, is generally from one-half to one-third the size of the megazoöid: it is far more active in swimming, and, on several occasions, I have noticed that the nucleus, which is very difficult to observe in most of the normal forms, was more prominent than usual. Thus it will be seen that we have here a method of reproduction resembling a true sexual process, as both of the two conjugating gametes differ from one another, not only in size, but also by the fact that the megazoöid had, by continued feeding on similar forms, laid up a store of potential energy for further reproductive processes: whilst the microzoöid had arrived at a certain average size after reproduction by fission, and had not commenced to feed on its own kind in the manner that the megazoöid had done, its size apparently precluding its ingesting other organisms, as large as itself, although bacteria were easily ingested. The ordinary method of reproduction by transverse fission, showed little that was peculiar to this particular monad. On following one of the discharged granules from the parent sac alr... described, one found that, as soon as the ... d obtained flagella, and had acquired a size ... out one-third that of the megazoöid, the nucleus came more visible than usual, and, if specially and carefully looked for, a slight constriction was noticed to be forming round the body, which gradually deepened in the manner I have already stated. A rather striking fact in regard to this monad is that both methods of reproduction are very slow, the organism not multiplying at all rapidly. At first I found it extremely difficult to keep the organisms for any length of time, but since found that they grew very well in an infusion of grass to which a small quantity of the solutions recommended by Dr. Van Huerck for growing Diatoms had been added. On account of its cannibal propensities I have named the organism *Monas sarcophaga*.

SOLAR DISTURBANCES DURING SEPTEMBER, 1910.

By FRANK C. DENNETT.

DURING September there was quite a revival of Solar energy, yet the days between the 14th and 17th yielded only faculae or bright spots. The longitude of the central meridian at noon on September 1st was 103°19.

No. 63 of the August list remained on the disc until September 11th, and is therefore shown on the present chart.

No. 63*a*.—A pore a little north of No. 63, only seen on 8th.

No. 64.—A solitary pore on the 1st, but by the 3rd had increased to a group 40,000 miles in length, the western spotlets being the largest. The 5th found other spotlets enlarged, and on the 6th there was a great spot 22,000 miles across close to limb.

No. 65.—Two spots appeared on the 7th, 58,000 miles apart, in the area of No. 61. The western one, 7,000 miles in diameter, had its penumbra fringed brightly at the inner edge on the 8th and 9th, but was reduced to two pores on the 10th, but only one seen on the 11th and 12th. The eastern spotlet dwindled to a pair of pores on the 8th, one remaining until the 10th. A group of three tiny dots appeared on the 13th, but soon died away. Situated longitude 297°, South latitude 12°.

No. 66.—A minute pair of pores only seen on the 18th.

No. 67, 67*a*, and 67*b*.—A series of disturbances close together. On the 18th and 19th only one pore seen amid faculae, but two on the 20th, 22,000 miles apart. This was replaced in the afternoon by a new group of eight pores and a leader 7,000 miles in diameter. The configuration of the group had changed on the 21st, and next day there was only one pore with a gray marking near by. On the 23rd there was another new group 48,000 miles in length, *b*, which on the 24th was markedly of an elliptical shape. The western spot had the form of an arrow head, 12,000 miles in diameter. Dwindling on the 26th, only two pores were left on the 27th, and one until the 28th, the area being marked after with faculae.

No. 68.—An active faculic area on the 18th showing three tiny pores, one remaining until the 19th, but only a dull marking on the 20th. A pore showed nearer the equator on the 21st, whilst on the 22nd two others 20,000 miles apart appeared within one degree of the equinoctial line. There was a pair of tiny pores in the same region on the 23rd, when last observed.

No. 69.—On the 19th, a group of pores and spotlets, 22,000 miles in length, increasing to 40,000 miles by the 21st, when composed of only two spotlets, only one grayish pore continuing until the 22nd.

No. 70.—The return of No. 64 on the 20th, still 22,000 miles in diameter. The bridges and jets on to the umbrae were interesting. The inner border of the penumbra brightly fringed from the 21st to the 23rd and on to the 30th. Three pores appeared west on the 25th, and others east and north on the 24th, 26th and 27th. Seen until nearly close to limb or edge on October 3rd.

No. 70*a*.—A double spot east of the spot on the 22nd, seen single until the 26th, though a pore showed 20,000 miles north of *a* on the 24th.

No. 71.—On the 23rd, at first two pores showed, but later in day the number increased; only one continued until the 24th. On the 26th, there was a little group of pores in front of a region of faculae, 150,000 miles in length, last seen on the 27th.

No. 71*a*.—Two pores a little south of No. 71, 27th to 29th.

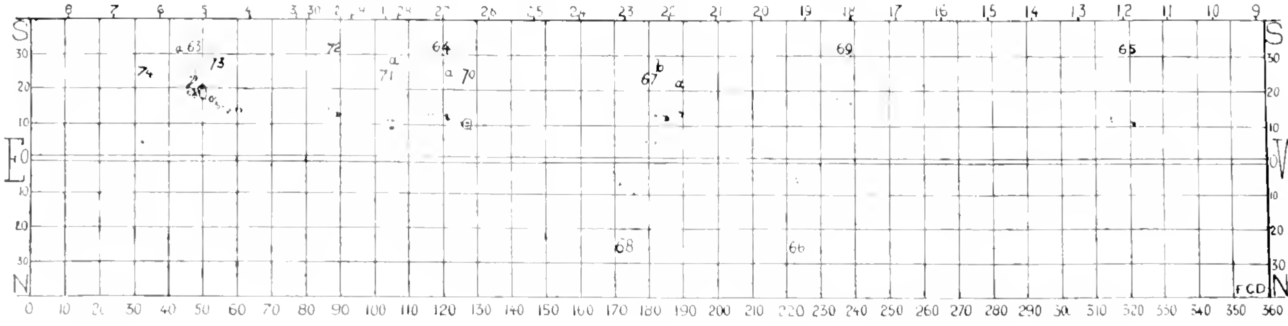
No. 72.—What appeared as a single spot seen just on the disc on the 23rd, proved to be two seen 24th to 28th; then the western spotlet became shaped like a harpoon head. This, however, did not last, but a group of four pores, 22,000 miles long, continued until October 3rd, after which the area was marked by faculae.

No. 73.—On the 26th, pores had come on disc in a faculic area—by the 27th it was evidently the forerunner of a large group. This proved to be 140,000 miles in length, and to be very deficient in umbra. As is usual in such cases, detail changed considerably. The largest member was at one time over 36,000 miles in diameter. The group covers the site of Nos. 63 and 60, seen until October 9th.

No. 74.—Amongst a bright faculic disturbance close to the limb, a black spot showed on the 28th, not, however, seen since.

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

DAY OF SEPTEMBER.



SOME MENTAL ILLUSIONS OF VISION.

By R. T. LEWIS, F.R.M.S.

NOTWITHSTANDING the popular saying that "seeing is believing," neither of our faculties is subject to such complete illusions as our sense of sight, some being optical, others ocular, whilst again others are purely mental.

To the first kind belong those due to refraction—such for instance as the mirage, or the apparent displacement of an object from its true position; to the second kind may be referred the phenomena of irradiation, and of subjective images and colours; whilst the third includes the impression which most persons have of the apparent increase of the size of the Sun and Moon when rising or setting, and the similar increase in the apparent size of constellations, or the distance apart of stars when seen near the horizon, as compared with our estimate of such at their meridian altitude.

That this last-named illusion is neither optical nor ocular is shown at once by the fact that when seen through a telescope no such apparent increase is found to exist; indeed, when accurately measured, after making all necessary corrections for height of barometer, temperature, and refraction in altitude, it is found that the apparent diameter of either body is really greatest when on the meridian, inasmuch as they are then some 4,000 miles nearer to us than when near the horizon, though the difference is too small to be appreciated by the naked eye.

It should be noted, however, that the amount of the apparent augmentation varies considerably with individuals—artists for instance depict the rising moon of a variety of exaggerated sizes up to about 15° diameter, or about thirty times greater than it should be drawn, and one not infrequently hears it described as looking "as large as a dinner plate," whereas a three-penny bit held at arm's length is rather larger than is necessary to hide it completely.

That this almost universal illusion is entirely mental, is not easy to demonstrate, although it will be readily admitted that if a false impression of the distance of an object can be created, the mental estimate of its actual size will be proportionately altered; in other words, if an object we believe to be near to us appears of a certain size, and one of the same kind believed to be at a distance appears also of the same size, we at once from experience correctly judge that the latter must be the larger of the two. Hence though the Moon, whether high or low in the sky, practically subtends the same angle, and therefore its image on the retina of the eye is in both positions the same, we naturally from experience imagine it must be a larger body in the latter case, because though so much further off it appears to be of the same size as the Moon we see when apparently nearer.

The experiment referred to in the accompanying diagram affords a convincing illustration of the curious mental effect produced by the creation of a false impression of distance, and is one which may be performed by any persons who possess sufficient control of the eyes to dissociate the focussing and the convergence, which, though quite separate and independent actions, are from constant habit usually performed automatically together. A-B represents a stereoscopic slide, which we will suppose to be of the full moon, placed at the normal distance of 10 inches from the eyes, when the two pictures are seen clearly in focus. If whilst retaining the focal distance we alter the convergence so that the axis of the right eye (R) passes centrally through the picture B, and that of the left eye (L) through the centre of A, as shown by the two firm lines L-C and R-C, these axes will meet at the point C, which will be more or less distant from the plane of A-B according to the width apart of the eyes of the observer. The result of this will be that three images of the pictures A and B will be seen, of which the central one, consisting of A and B superposed, will be seen apparently at C, and of course perfectly stereoscopic. If then without altering the distance between the eyes and the slide we look so "cross eyed" that the axis of R passes centrally through A, and that of L through B, as indicated by the two dotted lines, we shall again see three images, the centre one apparently at D, but in this case pseudoscopic. It is clear that in both cases the images of the pictures on the sympathetic portions of the retina will be approximately the same, but in the former case where the moon is seen apparently at C, or much further off than it really is, the effect is that of a considerably magnified image, whereas in the latter case where the picture is seen apparently at D, or much nearer than it really is, the mental impression produced (after making due allowance for the difference between R-A and R-B) is that of a considerably smaller moon than either of those seen at A-B, the mental illusion in each case being due to the fact that a false idea has been created as to the distances of the objects observed.

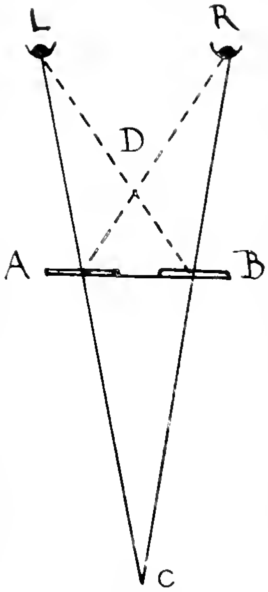


FIGURE 1.

A further experiment may be suggested by means of the subjective image of any object which is gazed upon long enough to produce a continued impression upon the eyes. If, for instance, the filament of an incandescent electric lamp is steadily looked at for a few seconds, the impression produced by it upon the sympathetic portions of the eyes will persist until the vibrations so excited have run down, and a spectral image of the filament will meanwhile be seen so long as the convergence of the eyes is maintained at the same angle as when the lamp was originally looked at. If this image is projected upon the distant wall of the room it will appear of magnified proportions, whereas if thrown upon some surface nearer to the eye than the exciting cause, it will apparently be seen of very reduced dimensions, although in both cases the actual picture formed must be precisely the same.

As yet another, though somewhat different class of mental illusion in the case of vision, I may mention that I have before me a photograph of the "Challenger" medal, taken under a strong oblique light, falling upon it from the top. Knowing from experience that if the light falls in that direction upon a raised surface, the shadows would fall as depicted, the mental impression produced when the top of the photograph is held towards a source of light is that of a design in strong relief, although the sense of touch assures me it is flat; but if the picture is turned round so that the light falls upon it from the bottom, experience immediately suggests that shadows, as they then appear, can only be thrown by an intaglio, and the mental suggestion is that of a sunk pattern, an illusion which would be complete but for the fact that the inscription still reads the right way about.

A false estimate of distance, and therefore of size, is very common to persons in the clear air of high mountainous regions, who under ordinary circumstances are accustomed to see landscapes through our own more murky atmosphere, and the common illusion of meeting suddenly with gigantic figures in the street on a foggy night, because they are much closer than imagined, will occur to most people.

It seems also quite within the limits of possibility that some of the errors of interpretation as to the meaning of what is seen under the microscope may be due to mental suggestion.

It will be understood that the extent of such illusions as have been referred to varies somewhat according to the "personal equation" of the observer, and that what has been described is simply the experience of the writer, who it may be of some interest to mention, has since he thought out the matter, almost entirely lost the impression that the Sun and Moon appear larger when rising or setting than at other times, though he has been quite unable to divest himself from the illusion in the case of constellations or stars.

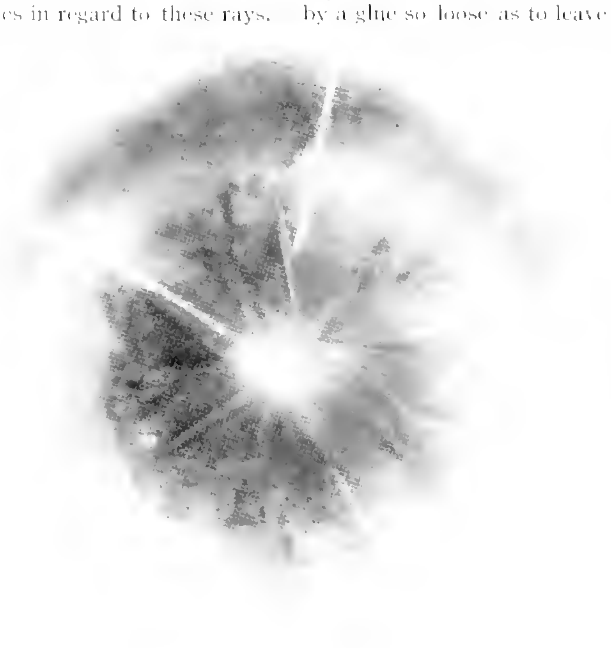
X-RAYS FOR EXAMINING PETRIFACTIONS.

By Dr. ALFRED GRADENWITZ.

The extremely numerous technical and scientific uses of X-rays are known to be based on the differences in transparence shown by the various tissues in regard to these rays. The silhouettes produced by the passage of X-rays therefore give an insight into the internal structure of human and animal organisms, which would otherwise be for ever closed to our eyes.

The latest achievement in this connection is the use of these wonderful radiations in investigating the internal structure of fossils. In fact, a French scientist, M. Pierre Goby, at Grasse, has recently obtained some excellent X-ray pictures of petrified starfishes, of which an example is reproduced in Figure 1.

It is well known that those countries which were formerly covered by the sea contain in their soil great quantities of remnants of the ancient marine fauna. To these countries belong the environs of Venice in Southern France, the fossil treasures of which have been lately investigated with especial care, partly, as has been hinted, with the aid of X-rays.



From a skiagraph *by Pierre Goby.*

Clypeaster latirostris Agassiz.

In order to understand the possibility of using X-rays in this connection it should be considered that all the internal parts of a petrified starfish are filled up by a remarkably homogeneous quartz mass which mainly consists of an agglomeration of minute transparent grains, bound together by a glue so loose as to leave small cavities in the interstices.

Though being little transparent to X-rays, this mineral mass is far less opaque than carbonate of lime, the substance of which the shell of the starfish consists. This is how the X-ray picture of the petrifaction, surprising though this be, absolutely resembles that of a living starfish.

Any slight discontinuity in the various portions of the petrifaction will result in a difference in the depth of shades. The five radial grooves, e.g., are distinctly visible, and the thinnest portions of the petrifaction, viz., those at the edges, are especially clear. The digestive tube which surrounds the central cavity is seen with remarkable distinctness, each of its circumvolutions being clearly marked.

The naturalist recognises in this X-ray picture a number of features of much importance from a scientific point of view, but which cannot be discussed in the present article.

From the above is seen that X-ray pictures are likely soon to prove a powerful aid also in the work of palaeontologists.

THE SHOOTING STARS OF NOVEMBER.

The mere mention of the Leonid meteors is sufficient to arouse a certain amount of enthusiasm amongst meteoric observers. There are many of us who remember the brilliant display of November 13th, 1866, and in many cases it must have formed the chief meteoric spectacle of a lifetime.

There were brilliant and abundant displays of the Andromedids or meteors from Biela's comet on November 27th in 1872 and 1885, but these were partially veiled by clouds at Bristol, and at certain places nothing could be seen. But the Leonids formed the most impressive scene everywhere. They are very rapid, bright streaking meteors, and more striking objects generally than the star morning meteors of Biela's comet.

It is true that observers looked in vain for a great display of Leonids in 1899 and 1900. Planetary perturbation appears to have disturbed the orbit and to have been responsible for the absence of the meteors. They returned, however, in fair abundance in 1901 and 1903, though the numbers fell far below those seen in 1799, 1833 and 1866. Will they return this year? That is a question now being asked, though every astronomer knows that the conditions will be unfavourable. The parent comet of the swarm is now at an enormous distance from the earth, but has probably left a pretty rich train of meteors behind it. As a popular spectacle, however, it cannot be said that the shower is likely to prove remarkable; it is more as an astronomical event and one for strictly scientific observation that we call attention to it. After 11 p.m. on the night following the 14th and 15th a few fine Leonids ought to be seen wherever the atmosphere is clear enough for suitable watching. There will be no interference from moonlight, so that in this respect we shall be favoured.

In our English climate, however, fogs or clouds may quite eliminate the Stars and Meteors. This has been the experience on many former occasions; but with fortunate circumstances it is hoped that the Leonids will be patiently looked for and successfully witnessed.

W. F. DENNING.

CURVED PHOTOGRAPHIC PLATES.

By F. A. BELLAMY, Hon. M.A. (Oxon.), F.R.A.S.

A SHORT note on this subject may be of interest. From the earliest days in photographic astronomy one of the difficulties to be met and overcome was the curvature of the field, or the rapid falling off in the definition or good focus in the images of the stars away from the centre of the photographic plate. It is obviously of the greatest importance, for accuracy and utility, for uniformly good quality definition to be obtained over as large an area on the plate as possible.

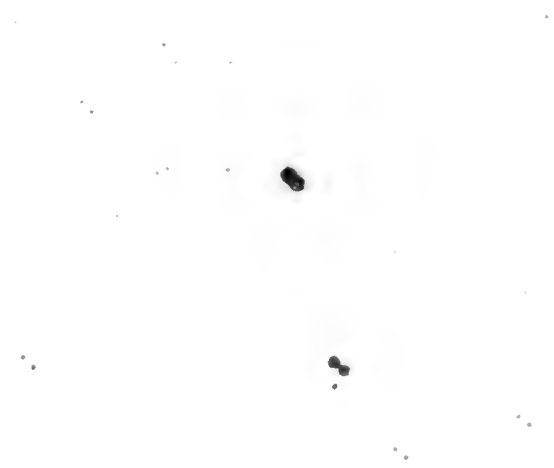


FIGURE 1. The Centre of the Plate.

Two exposures were made on the same plate, the left hand one with the plate curved, the other with it flat.

To an astronomer the reduction of the aperture of the photographic lens is not permissible, or, at least, usually very inadvisable for stellar work, as the maximum aperture is required in order to reduce the time of exposure as much as possible.

Though curved plates have in the past been suggested and used with a view to overcome the want of good focus beyond a very limited area, they have never found favour with astronomers, for various reasons, among these being the difficulty of making them uniformly suit the area of good focus simultaneously at the centre and edges, the great cost of making satisfactory plates (uniformly coating them), greater risk of breakage, difficulty of measurement, storage, and so on. When the first Conference in connection with the Astrographic Survey was held in Paris, in 1887, one of the subjects proposed and discussed was the use of curved plates for the Survey: the plan was rejected as not feasible. In twenty-three years knowledge has advanced, and the utilization of methods and appliances—common in other branches of science—has greatly increased: so that what was impossible or inconvenient years ago is now rendered more convenient and available for use.

The suggestion to use curved plates has been brought up again. This time, from a personal acquaintance with the worker and his excellent work, we may say that there is a much greater chance of the method being tried under every condition that promises success, which, we hope, will ultimately be achieved by Dr. J. H. Metcalf.

The lens he is using is a Petzval Doublet, and the focal length is seven times the aperture and gives a scale of picture of 90" to 1mm. With this lens he has found by re-focussing for various parts of the plate that all parts of a 10-in. × 8-in. plate, equal to an area of 5 degrees square, can be brought into good focus and excellent star images obtained. As the lens can do so much by merely altering the focus gradually between the centre and edges, the extreme amount to be allowed for in changing the focus for these two positions is only three one-hundredths of an inch (0·8mm): it seems quite possible to *bend* a

FIGURE 2. The Edge of the Plate.

Here there were two exposures as in Figure 1.

plate ... mporarily by that amount without fracture.

... ious methods were tried to produce the ... uired amount of bending artificially: of these ... he most successful, as one might expect, is that produced by atmospheric pressure on the outer and film side surface of the plate, caused by exhaustion of the air in a closed chamber at the back of the plate.

From a trial made with the 16-inch Metcalf Telescope in 1910, June 29th, ocular evidence can be obtained by the examination of the two sets of star images shown on the accompanying illustrations. The region is that surrounding R.A. $19^h\ 0^m$ and $+\ 5°$ and is enlarged nine times from the origin plate, so that $10''$ equal 1^{mm}. In obtaining these two exposures the first and left hand image was taken with the plate temporarily curved and the second image shows the same star with the plate flat: each exposure was of ten minutes duration. In Figure 1 the centre of the plate is substantially in the same focus, the flat plate image being slightly the better one of the two. When the outer parts of the same plate are compared a marked improvement becomes obvious with the curved plate images, the bright stars showing less diffusion and naturally smaller images, there being less scattering of light: and the faint stars—the stars' light being more compact and in focus—are distinctly improved; almost invisible and diffused images become quite visible and better formed.

Further plates have since been taken with that instrument to test the effect on the determination of magnitude and position. From an examination of sixty-one stars, fainter than the 10th magnitude, it was found that the flat plate lost 0·17 magnitude at 1°·5 from the centre: in the curved plate the brightness increased by 0·06 magnitude: no systematic error was detected.

The effect on the actual positions of the stars has not yet been determined: this requires careful and accurate measurement of a number of plates, preferably of the same area.

For the convenience of use, storage, and measurement, it will be a distinct gain to be able to have the plates flat rather than have to deal with plates with a permanent curvature. When the temporarily curved plates are measured there are obvious advantages in having them flat in the measuring instrument.

The plate reproduced here is from the Harvard Circular, No. 161.

Knowing Dr. Metcalf's skill in practical photographic astronomy and his power to overcome difficulties, we may expect still better results from his instruments.

CORRESPONDENCE.

SPECTROSCOPIC DOUBLE STARS.

To the Editors of "KNOWLEDGE."

SIRS,—Sir Robert Ball's work, "In the High Heavens," has a chapter entitled "The New Astronomy," in which the author discusses, with all his admirable clearness of exposition, the modern methods of determining the motions and masses of Double Stars by means of the Spectroscope. In illustration of this subject he takes the well-known star Mizar, the principal component of which was discovered by Professor Pickering to be a Spectroscopic Double, "a discovery," says Sir Robert Ball, "which will take its place in the history of astronomy as the inauguration of a new process in the study of things sidereal."

It will be needless to give the readers of "KNOWLEDGE" a detailed account of the method by which the examination of the spectrum of a Double Star is held to afford us information as to the velocity, period of revolution, mutual distance, and masses of its components. Sir Robert Ball explains the whole process in his charmingly lucid manner, and the argument would be absolutely convincing were it not for one most important assumption which seems to be scarcely justified. This is that the earth's line of sight lies in the plane of revolution of the Double Star, or, in other words, that we are observing the orbit of the Double Star "edgeways."

The whole reasoning is based on the velocities of the components as revealed by the spectroscope. But the spectroscope can only reveal to us velocities in the line of sight, and as the orbits of Double Stars may lie in all possible planes, it is surely an unwarrantable assumption that the velocities deduced from the spectrum are the true velocities of the components. If, for instance, the earth's line of sight happened to be inclined at an angle of sixty degrees to the plane of the Double Star's orbit the velocities of the components, as deduced from the spectrum, would be only half their real velocities, and the whole argument as to the masses and distances of the components would be vitiated.

There seems to be one, and only one, condition under which the spectrum may be depended on to give us the true velocities of the components of a Double, and that is the condition that the Double is at the same time a Variable. For if we may assume that variability is due to periodic eclipse of each component by the other, it follows that in the case of a variable star our line of sight lies in or near the plane of its orbit of revolution.

But no such condition is mentioned in any discussion of the subject which has come under my notice, and my object in writing this is to inquire whether any of your astronomical correspondents can explain what (in the absence of the condition just stated) seems to me an insuperable difficulty in the theory of Spectroscopic Doubles.

Yours faithfully,

A. E. MADDOCK.

BANDARAWELA,
CEYLON.

PODURA SCALES.

To the Editors of "KNOWLEDGE."

SIRS.—From the very able article upon the Podura Scale by Mr. T. L. Smith in your September issue, arises Phoenix-like that very old standing enigma to microscopists, "What is its actual structure and wherein lie the difficulties of observation, seeing that the object is comparatively large?"

When we consider the instruments in use upon this scale as far back as 1827, the year about which it loomed forth as a "test," and the very much improved optical appliances of the present day, it would seem that its accurate delineation has not advanced in progressive ratio. This is due to several causes. 1st, the method of mounting: 2nd, the method of illuminating: 3rd, the extreme fineness of the scales usually selected: 4th, the necessity for correct adjustment in tube length for cover thickness: and 5th, the scarcity of fresh scales.

With regard to the mounting, as the refractive index of the scale itself is high, 1·5 at least, to mount it in Balsam is to practically obliterate it, while Realgar or other high refractive mountants do not appear to have been used with success, so that we are left with the only alternative in contrast between the normal of air and the scale itself: here, then, we make no advance upon the very earliest methods. True, we augment very much our view by placing the scale flat upon the under side of cover glass, leaving a small margin for air between it and the slip, but therein lies the difficulty. As the object is not perfectly even, it is almost impossible to obtain optical contact all over, so that where the scale leaves the coverglass ever so slightly we get a distorted appearance, and some of the views thus obtained account in no small degree for conclusions as to new structure being observed.

As to the manner of illuminating, it is usual nowadays to hold fast to the so-called "Critical Method," which means practically placing the scale in the midst of your illuminant and viewing both focussed in the same plane, at the same time having them centred axially. When this is done with the Podura 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 surfaces, or to direct your telescope boldly towards the full moon and expect to trace its finest details. There are many microscopists of the present day who do not find in the practice of this "Critical Method," that which theory would have them believe as *ipso facto*.

I suggest therefore the use of oblique light in this instance, and the photographs here reproduced have been taken more or less in this way.

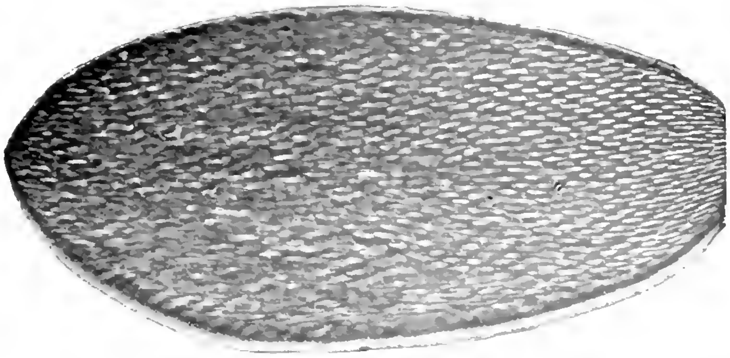


FIGURE 1.

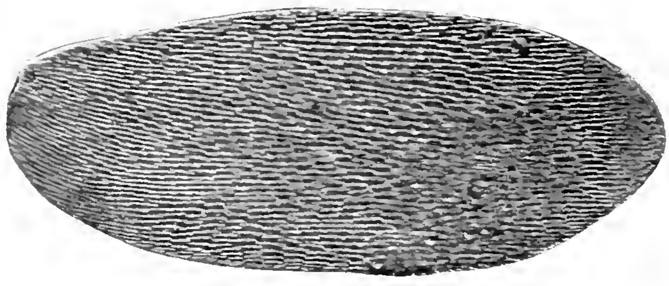


FIGURE 2.

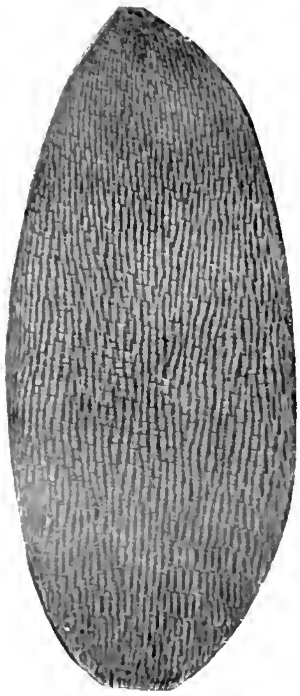


FIGURE 3.
Podura Scales.

Again, the exceptionally fine scales generally experimented with. I believe those usually procurable are taken from near the head of the insect, but it is possible to obtain others much more decidedly marked along the side and dorsal portions. It has also been suggested that one might rear a few Podurae using some innocuous aniline stain along with their food, such as Medical Methylene Blue, with a view to obtaining—possibly—through an absorption of colour, a scale showing greater contrast. To this, however, I can only say my own efforts have been entirely abortive.

I have found that small well-defined scales gave me the best results, whilst some of the larger variety were so exceedingly fine in their longitudinal as well as transverse markings as to appear mere shadows of themselves.

Fourthly, it is very essential to have a well-corrected objective, both chromatically and spherically, and to carefully adjust the tube length for thickness of cover in use.

And lastly, the dearth of fresh scales. A very eminent microscopist wrote recently that Podura scales were "scarcer than diamonds," and it would seem there is much truth in that remark at the present time; yet we are told the insects abound plentifully, that some species are quite common about the houses and gardens, in damp cellars or vaults, or again to be found among the dry refuse and corners of outhouses, potting sheds, and the like.

If some expert entomologist would come to the rescue and place a number of fresh scales upon the market worthy of careful observation, he would not only relieve a much felt want, but at the same time give a much needed impetus to the improvement of condensers and their proper usage for high-angled apochromats; both as regards their aplanatism and the aperture suitable with particular objects.

A word or two with regard to the photographs. In Figures 1 and 2, it will be seen that apart from the usual exclamation marks, there are long sinuous lines from root to tip, while in Figure 3 can be readily observed similar lines transversely.

If the exclamation marks be simply wedge shaped pouches with an oily secretion within, these longitudinal lines appear to run over the outer edges of the wedge and again to dip under beneath the preceding one, interlacing with the transverse lines and forming an elastic but strengthening structure to the whole scale.

It is noteworthy that either side has always presented the same appearance to me, so much so that I am unable to recognize any top or bottom as distinct from one another. The purpose of these markings can only be conjectural at present; it may be they are the edges of a flattened cellular structure, though this can hardly account for the transverse ones, or simply a fine network of tubes for the purpose of conveying some form of nutrition.

F. J. W. PLASKITT.

THE ASTROGRAPHIC SURVEY.

To the Editors of "KNOWLEDGE."

SIRS,—A sentence on p. 399, referring to this work, is liable to misinterpretation. A share of one thousand one hundred and eighty plates, equal to more than one-twentieth, in this International Survey was undertaken at the University Observatory at Oxford. The work was commenced and the first plates were taken in 1892, and it was then understood that twenty-five years would be required to complete it. All the plates were taken, completely measured, reductions made, and the measures of about four hundred thousand star places were copied for printing by 1904, February 17th; this would have been accomplished from one to two years earlier but for interruptions and loss of time due to a new dome being built, during which no progress could be made with the telescopic work; to the planet Eros work; and to a struggle of some months with bad emulsion on the plates. Looking up the Greenwich Observatory reports, I find that in 1906, February, their share of the survey, one thousand one hundred and forty-nine plates, was still unaccomplished; at the present moment none of the other sixteen observatories, with one or two exceptions, are near the end of their shares; in some cases the measurement of the plates has barely commenced, and all the negatives required are not yet taken. The University Observatory at Oxford had thus completed its share of the Catalogue two years or more before that at the Royal Observatory.

These remarks refer to the main portion of the scheme and by far the most important. As to the supplementary portion, repeating the work by exposures of forty minutes on separate plates for the purpose of reproduction only as star-maps, it became apparent soon after the commencement of the work in 1892 that it would be a waste of time, energy and money to carry out this portion. The reasons for the decision not to do the Chart portion at Oxford were the supercession, or doubtful need, of the 1887 and 1889 programmes relating to the Chart scheme, by the advent of the doublet form of photographic lenses of large dimensions (such as the Bruce lens at the Arequipa Observatory, with which it is easy to photograph about five-and-a-half plate areas on each 17 × 14 plate and with less exposure to obtain the same limit of magnitude), so that the whole of the Oxford area could be covered by less than two hundred plates instead of one thousand one hundred and eighty plates and with much less risk of having to reject plates by reason of cloud interference; another reason was the impossibility of obtaining the £10,000 required to reproduce and distribute the maps on the same luxuriant scale as those published by aid of the French Government, and the inadvisability of spending such a sum; and a third reason, which I see is referred to by your correspondent on page 409, may be considered as a strong point—the *enlarged* reproduction of the long-exposure chart plates. Had the prints been kept to the same size or scale as the catalogue plates, it would have been a very simple process to have utilized the numerous measuring instruments already available for the measurement of positions if required; that this can be done with a considerable degree of accuracy was pointed out in the *Monthly Notices* by Professor Turner more than twelve years ago. Thus has the Oxford area for long exposed plates been "in the field" since 1895; it is only this portion of the survey which the Greenwich Observatory has appropriated; that the *short* exposure plates are also to be taken at this near epoch appears to me to be indicative of waste and annoyance.

Notwithstanding all efforts to obtain the money, the printing could not be commenced until 1906, so that no progress could be made in this direction during the progress of the other stages of the work. Since that date the amount printed has been such that six volumes have been published and distributed, and the seventh—the last of the catalogue—is almost completed, the whole giving accurate measures of more than four hundred and fifty thousand star positions contained, besides other information, on two thousand three hundred quarto pages. No assistance for the main share—the catalogue—has been given by the Royal Observatory to Oxford as the words on page 399 would seem, to one unacquainted with details of the scheme, to imply.

It should be added that Prof. E. C. Pickering's suggestion in 1886 to use a large double lens for the Chart portion was rejected by the Astrographic Congress at Paris—probably no one except himself then realized its great advantage for such work as charting the stars; by the generosity of Miss Bruce he was able to acquire such a telescope of 24-in aperture in 1893.

F. A. BELLAMY.

LITERARY NOTICES.

THE CHARACTERISTICS OF FAMOUS MEN.—In a work shortly to be published by Messrs. Rebman—"Makers of Man": A Study of Human Initiative, by Charles J. Whitby, M.D.—the problem of individuality is investigated by means of an analytical study of forty world famous men. The book is not a series of biographies—the lives are treated collectively with a view to the attainment of general results.

LICHEN EXCHANGE CLUB.—The annual report shows that this club is doing a considerable amount of useful work, in the way of distributing specimens, on the part of eighteen out of the twenty-nine members. The report quotes the systematic arrangement of the class of lichens which is used in the recent memoir of the United States Herbarium. The Secretary and Treasurer, Mr. A. R. Horwood, of Leicester Corporation Museum, appeals for information with regard to species which are likely to become exterminated.

THE BACILLUS OF LONG LIFE.—Messrs. T. C. and E. C. Jack announce that they will publish in November, under the above title, a manual of the soured milk industry, by London M. Douglas, F.R.S.E.

HOUSE FLIES AND PUBLIC HEALTH.—A valuable leaflet has been issued on the dangers resulting from house flies and the preventive methods to be employed. Copies may be obtained free on forwarding a stamped addressed envelope to Walter E. Collinge, 59, Newhall Street, Birmingham.

THE MICROLOGIST.—The second part of a new magazine called *The Micrologist* has reached us. It is published quarterly by Messrs. Flatters, Milborne and McKechnie, Ltd., at a price of eighteenpence. The paper contains useful hints to the microscopist, and there is a very good collotype plate of starch grains, Volvox, Hydra, and of Polyzoa.

THE BIBLIOGRAPHY OF AERONAUTICS.—Aeronautics has for years past been universally indebted to the Smithsonian Institute of America for its research work in this new science, and for the clear and concise manner in which it has always published the results of its labours.

To-day, in *The Bibliography of Aeronautics*, we have another work from the same source, compiled with similar care, and wonderful completeness.

In this book we have a complete index to every article of the least value in any language which has been published, and to find any such article we have merely to look under the author's name, when the title of the paper or manuscript in which it appears will be given.

As a test the writer looked up certain small articles, and in every case found the proper references as above.

Everything is indexed under "Authors' Names"; may we some day hope to see the sister volume, in which the articles will be indexed under "Subject Matter"?

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 4.33; on the 30th he rises at 7.43 and sets at 3.54. Sunspots and faculae may usually 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 3rd, the Sun being $16^m\ 20^s$ 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 N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Nov. 2	24° 31′E	4° 11′	5° 11′
„ 7	23° 32′E	3° 30′	290° 16′
„ 12	22° 23′E	3° 5′	233° 20′
„ 17	21° 1′E	2° 30′	167° 25′
„ 22	19° 20′E	1° 54′	101° 31′
„ 27	17° 40′E	1° 16′	35° 37′
Dec. 2	15° 53′E	0° 38′	329° 43′
„ 7	13° 52′E	0° [illegible]	263° 50′

There is a partial eclipse of the Sun on November 2nd, invisible in this country, but visible in Japan, Northern Pacific and Alaska.

THE MOON:—

Date.	Phases.	H. M.
Nov. 2	● New Moon	1 50 a.m.
„ 10	☽ First Quarter	5 20 a.m.
„ 17	○ Full Moon	0 25 a.m.
„ 23	☾ Last Quarter	6 13 p.m.
Dec. 1	● New Moon	9 11 p.m.
Nov. 3	Apogee	6 12 p.m.
„ 17	Perigee	14 48 a.m.
„ 30	Apogee	7 0 p.m.

ECLIPSE OF THE MOON.—There will be a total eclipse of the Moon on the 16th, visible in this country.

The details and times are as follows:—

First Contact with the Penumbra, Nov. 16th, $9^h\ 46^m$ p.m.

First Contact with the Shadow, Nov. 16th, $10^h\ 44^m$ p.m.

Beginning of Totality, Nov. 16th, $11^h\ 55^m$ p.m.

End of Totality, Nov. 17th, $12^h\ 47^m$ a.m.

Last Contact with the Shadow, Nov. 17th, $1^h\ 58^m$ a.m.

Last Contact with the Penumbra, Nov. 17th, $2^h\ 56^m$ a.m.

The Magnitude of the Eclipse = 1·131 (Moon's Diameter = 1).

Diagram showing the contacts of the total Eclipse of the Moon, November 16th.

The first contact with the shadow is at 94° from the North point towards East and the last contact at 227°, as shown below.

During totality observation should be made of the colours of the moon's surface, and also of the varied luminosity of different regions. The general appearance is that of a copper coloured disc, but during the progress of the Eclipse changes of tint may be discerned.

OCCULTATIONS.—The following are the principal occultations visible from Greenwich:

Date.	Star's Name.	Magnitude.	Disappearance: Mean Time.	Disappearance: Angle from N. point to E.	Reappearance: Mean Time.	Reappearance: Angle from N. point to E.
Nov. 11	τ^1 Aquarii	5·6	5.4	52	6.18	248
„ 11	τ^2 Aquarii	4·4	6.40	10	7.30	286
„ 13	14 Ceti	5·4	0.31	344	0.55	303
„ 14	u Piscium	5·3	9.43	57	10.51	234
„ 17	τ^1 Tauri	4·2	8.37	33	9.28	282
„ 17	τ^2 Tauri	5·4	9.17	8	9.40	337
„ 18	118 Tauri	5·4	7.23	135	8.4	215

THE PLANETS.—Mercury (Nov. 1st, R.A. $13^h\ 58^m$; Dec. S. 10° 50′. Dec. 1st, R.A. $17^h\ 11^m$; Dec. S. 24° 52′) is an evening star in Scorpio at the end of the month, setting at 4.12 p.m. on the 27th, and is thus very unfavourably placed for observation.

The planet is in Superior Conjunction with the Sun on the 12th.

Venus (Nov. 1st, R.A. $14^h\ 1^m$; Dec. S. 11° 5′. Dec. 1st, R.A. $16^h\ 32^m$; Dec. S. 21° 48′) is in Superior Conjunction with the Sun on 26th, and hence is invisible throughout the whole month, being in close proximity to the Sun.

Mars (Nov. 1st, R.A. $13^h\ 40^m$; Dec. S. 9° 44′. Dec. 1st, R.A. $14^h\ 58^m$; Dec. S. 16° 35′) is situated in Virgo and rises at 5.40 a.m. on the 15th, thus for all practical purposes the planet is unobservable.

Jupiter (Nov. 1st, R.A. $13^h\ 45^m$; Dec. S. 9° 42′. Dec. 1st, R.A. $14^h\ 0^m$; Dec. S. 11° 52′) is observable for a very short time before sunrise towards the end of the month. The planet rises at 4.45 a.m. on the 25th.

Saturn (Nov. 1st, R.A. $2^h\ 6^m$; Dec. N. 9° 50′. Dec. 1st, $1^h\ 58^m$; Dec. N. 9° 11′) is very favourably placed for observation, being due South on the 1st at 11.24 p.m., and on the 30th at 9.22 p.m. 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.

During the past month the seeing has been very fine, and Saturn has been the admiration of many astronomers, several of whom say it has never been seen to such advantage. Professor Barnard has discovered several new features of the ring, and on Mount Wilson magnifying powers of six hundred and more have been brought to bear on the planet, and still retain excellent definition.

The apparent diameters of the outer major and minor axes of the ring system are respectively 46" and 13", and we are looking on the Southern surface at an angle of 16°, 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 15th.

Uranus (Nov. 15th, R.A. 19^h 36^m; Dec. S. 22° 7') is unfavourably placed for observation on account of his low altitude. The planet is situated in Sagittarius, in a part of the sky devoid of good reference stars, though the 4th magnitude star *h* Sagittarii is about 2° to the South.

The planet sets at 8 p.m. on the 15th.

Neptune (Nov. 15th, R.A. 7^h 32^m; Dec. N. 21° 6') rises about 7.55 p.m., and crosses the meridian at 3.55 a.m. on the 15th. The planet is situated about four degrees South-East of the star δ Geminorum.

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 the 2nd at 9.38 p.m., 5th at 6.27 p.m., 25th at 8.9 p.m., and 28th at 4.58 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".2. 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.

GIOVANNI SCHIAPARELLI

(BORN MARCH, 1835, DIED JULY, 1910).

By W. ALFRED PARR.

THOUGH Astronomy has had to mourn of late the death of many a faithful worker, the name of Giovanni Schiaparelli amongst them brings home the fact that in him has passed away not only the greatest astronomer of Italy, but one of the greatest astronomers of our times. Great as an observer, he was equally great as a philosophic interpreter of what he saw, for throughout his long life the attainment of scientific truth was ever his highest ideal. Even at a time when his name became closely associated with one of the most extraordinary telescopic discoveries ever made, he carefully abstained from offering speculative explanations, or entering upon controversies in connection with the novel facts he was the first to present to the scientific world, for with the discovery in 1877 of the now famous Martian "Canals," Schiaparelli certainly opened a new era in observational astronomy. To the popular mind this is perhaps his best known achievement, and by a curious irony of fate the non-committal name of *canali*, or "channels," which, with his characteristic scientific reserve, he gave to these interesting phenomena, was at once seized upon by an imaginative public to supply the ruddy planet with a complete set of waterways, dug by a longsuffering and famine-stricken populace. The brand-new nomenclature, drawn from ancient classical geography, with which Schiaparelli baptized the Martian markings, was perhaps the only unpopular item in this memorable discovery.

A discovery of far greater scientific import was Schiaparelli's announcement of the close connection existing between comets and meteors, a profoundly philosophic piece of work which secured for its author the "Lalande" Prize, and which vastly extended our knowledge of the constitution of the universe. Scarcely less important has been his work on double-stars, and the rotation-period of Mercury and Venus, while his learned excursions into the domain of ancient astronomical history proved his classical and literary erudition to be on an equal footing with his purely scientific attainments.

Schiaparelli's student-years were passed at the University of Turin, where he graduated as a civil engineer, but he soon obtained the means to dedicate himself entirely to the study of astronomy. Through the influence of a friend some years were accordingly spent at the observatories of Berlin and Pulkowa, where he studied under Encke and W. Struve respectively, and on returning to Italy the young student found himself, at the early age of twenty-five, elected to the post of second astronomer at the celebrated observatory of the Brera, at Milan; on the death of the director of which, Carlini, in 1862, only two years afterwards, he succeeded to the directorship. This famous institution had been founded as early as 1764 by Boscovich, and was in a somewhat neglected state when Schiaparelli took over the leadership. His own indefatigable activity, however, both in the astronomical as well as geodetical departments, and the new nineteen inch Merz refractor, for the installation of which in 1886 the Italian Government voted the sum of two hundred and fifty thousand lire, soon restored to the Observatory its former illustrious name—a name still ably upheld by Schiaparelli's successor, Giovanni Celoria.

Since his resignation on account of failing eyesight, some ten years ago, Schiaparelli, though honorary member of over forty European learned societies, had chosen to lead a comparatively retired life. Nevertheless, despite his dislike of publicity, he was ever ready to come forward in the cause of scientific truth, and almost his last utterance was contained in a newspaper article which appeared only a few months ago, in the *Corriere della Sera*, calmly setting forth the ascertained facts in connection with Halley's Comet, by way of protest against the absurdly fantastic and sensational accounts with which the Italian press was deluged at the time of the comet's near approach to our earth. Throughout a busy life he found time to carry on a voluminous correspondence with most of the great intellects of his time, and it is interesting in this respect to note that Herbert Spencer frequently had occasion thus to consult him on the various mathematical details occurring throughout the Synthetic Philosophy.

Personally, Schiaparelli added to a grave and dignified bearing extreme courtesy of manner, and the writer of this sketch retains the pleasantest remembrance of an interview enjoyed several years ago, when passing through Milan, and the exquisite kindness with which the great Italian astronomer conducted him, though an entire stranger, over the Brera Observatory.

NOTES.

ASTRONOMY.

By G. F. Chambers, J.P., F.R.A.S.

AN ASTRONOMICAL PILGRIMAGE.—Under the above title *The Times* has published an interesting narrative of a trip by some unnamed correspondent to the Mount Wilson Observatory in California. At a Conference of Astronomers there, papers were read on various subjects, one of which concerned a possible Trans-Neptunian Planet. Respecting this we make the following extract:—"Another paper worthy of mention dealt with a possibility only, but a possibility so majestic that its realization would startle the world. Since the discovery of the outermost planet Neptune, there have been several attempts to infer the existence of another planet further out still. Such attempts have been based on one or other of two indications, one cometary, the other planetary. From the fact that several comets are related to the same direction of approach to us, it has been thought that there may be an unknown body in that direction. The planetary indications are based on the disturbance of other planets, similar to that of Uranus by Neptune, which led to the discovery of the latter. No success has hitherto attended any search based on either kind of evidence. But now Professor W. H. Pickering thinks that he has a combination of both clues: he infers that there is a planet of great size, and at the same time of such great distance from the sun as to be very faint and difficult to find, which would not only account for several comets, but also for a peculiar disturbance of Neptune, observed, but not hitherto explained. The startling novelty of his suggestion lies in the direction in which this planet must be looked for. He thinks it is in a direction nearly perpendicular to the ecliptic! Now all the other planets and most of their satellites revolve in orbits nearly coinciding with the ecliptic; and no one has hitherto regarded a planetary orbit almost at right angles to this general plane as even a possibility. But Professor W. H. Pickering has already upset one preconception with regard to the solar system. He found a ninth satellite of Saturn which was going round the wrong way—in the direction opposite to that of the other eight of Saturn, the known five of Jupiter, the two of Mars, and the Earth's one Moon. Since then his example has stimulated the discovery of three more satellites of Jupiter, one of which also goes the wrong way round; and it has been shown that the apparent anomaly can be explained by tidal action."

THE GERMAN ASTRONOMICAL SOCIETY.—This Society, which has done such excellent work in the publication of many meridian Star Catalogues, held its twenty-third ordinary assembly, or meeting, at Breslau this year.

Unlike the Astronomical Society in this country, the German Society does not hold regular monthly meetings at a fixed place, but about once in two years, for three or four days, at a place selected by vote from time to time. Its constitution does not apparently limit the place of meeting to Germany. As it affords a good opportunity for its distant members to meet, discuss suitable subjects, see other observatories, and make friends, it would be a pleasant thing if an invitation could be offered for the Society to meet one year in this country, when many of us who do not travel abroad could make friends with our fellow-workers.

The meeting opened on September 13th, at the suitable hour of 10.15 a.m., in the Music Hall of the University, when a hearty welcome was given by several high officials of the University and State.

The Secretary, Professor von Seeliger, gave a report upon the work achieved during the last two years, and, before doing this, expressed regret that the meeting clashed with the Solar Physics Conference at Pasadena, where Backlund, Lehmann-Filhés and Dunér were. He said that in 1909, January, the number of members was three hundred and eighty-three: eighteen members were lost by death and removal, and as thirty-four members had been elected, and four names were then proposed, the total was four hundred and three: the most prominent losses by death were the veterans, Newcomb, Galle and Schiaparelli.

The Lindemann Prize was awarded to Cowell and Crommelin for their work on Halley's Comet, and two ordinary prizes to Krause and Hnatek for their researches upon the Comets of 1846 vii and 1852 iv: the former essay has been printed by the Society and forms No. xxiii of the series.

The parts of the *Vierteljahrsschrift* have appeared regularly and, at last, the second part of the first series of the *Astronomische Gesellschaft* Zone-Catalogues, for zone + 70° to + 75°, has been published. The observatory to which this zone was allotted having failed to do the work, the *lacuna* was filled in by the Berlin Observatory a few years ago, this being the third portion of the Society's scheme of 1868 that has been accomplished at Berlin: that scheme has thus taken forty-two years to complete. It is now proposed to re-observe these northern zones! *Cui bono?*

Of the second or southern series, which was only commenced a few years ago, all the catalogues are published except those for Harvard (No. 3) and Algiers (No. 5). The manuscript is being prepared for the former, and it is expected that the Algiers zone may be completely observed in 1911, and the whole of the second series, it is hoped, will be published within two years.

The meeting agreed to 1,000 marks being spent in the preparation of the Variable Star Catalogue and to 10,000 marks for printing the work. We heartily commend the appropriation of this and similar Societies funds to such good works, instead of the accumulation of funds derived from profits on annual income, without any more definite object than mere hoarding.

The delay of the publication to July, 1910, of that very valuable annual handbook to astronomical work for 1909 the *Astronomischen Jahresbericht* was due to the non-arrival of the foreign contributions. We much regret that Herr Berberich was compelled, by the state of his health, to withdraw from the enterprise. The committee of the Society have made great efforts to ensure the continuance of this very useful annual, which is of importance, and has become indispensable to astronomical writers in all parts of the world, and it is very gratifying to learn that their efforts have been crowned with success and that the preparation and publication will in the future be carried on at the Recheninstitut in Berlin; Dr. Naumann, the Ministerial Director, promising to procure the necessary means. With this annual available there is no need for the more expensive and less efficient similar annual as conducted by the Royal Society.

Dr. Kobold read a report upon recent Comets and Cometary Work; and Dr. Bruns read the treasurer's report.

Upon the proposals before the meeting, the Chairman was of opinion that the next meeting should be in 1913, as that year would be the fiftieth year of the Society's existence. An invitation had been received from Backlund to meet in 1912 or 1913 at Pulkowa. Battermann gave an invitation for the Society to meet at Königsberg in 1913, as that year was also the hundredth anniversary of the foundation of that Observatory; also Schorr invited the Society to meet at Hamburg in 1913. At the third meeting this was discussed: the year and place were left for future decision by the members and committee.

The members were invited to visit the seismological station at Krietern near Breslau.

Dr. Bruns, after lunch, introduced a discussion upon the "going" of pocket watches, and the compensation for the barometric influence; and Dr. Prey brought forward a point concerning the correction of an astrographic lens.

F.

(*To be continued.*)

BOTANY.

By PROFESSOR F. CAVERS, D.SC., F.L.S.

AMMONIUM SALTS AND PLANT NUTRITION.—According to Prianischnikow (*Ber. deutsch. bot. Ges.*, 1909), the partial substitution of sodium nitrate by ammonium sulphate in cultures increases the power of the plant to gain phosphoric acid from raw phosphates. In the absence of ammonium sulphate the plants (grasses were used in the experiments) show phosphoric acid starvation, while total substitution greatly reduces the harvest, and the best results are obtained by replacing about one-half of the sodium nitrate by ammonium sulphate. These effects are attributed to the liberated sulphuric acid: in partial substitution, the acid was strong enough to aid in dissolving the raw phosphate, while in total substitution it was so strong as to injure the plants seriously. The consumption of phosphate was favoured, and injury by ammonium sulphate prevented, by adding carbonate of lime. With barley, peas, and buckwheat, the author claims that mixtures of sodium nitrate and ammonium sulphate are better sources of nitrogen than either one alone, because the former is physiologically basic and the latter physiologically acid; the two together keep the culture medium neutral.

THE HYDROGEN BACTERIA.—Winogradski's researches established the existence of non-chlorophyllous plants that make their organic food by energy obtained from the oxidation of various simple inorganic substances. Lebedeff (*Ber. deutsch. bot. Ges.*, 1910) has made an extensive study of the hydrogen bacteria, which oxidise hydrogen as the source of energy for the assimilation of carbon dioxide. These bacteria, it appears, are capable of using organic food as well, and they are therefore distinguished from the nitrite, nitrate and sulphur bacteria. The fixing of any given volume of carbon dioxide requires the oxidation of from five to fifteen volumes of hydrogen. The oxygen required for the process is best obtained from atmospheric oxygen, but in absence of it, nitrates can be decomposed as the source of oxygen. The oxidation of hydrogen still continues in the presence of organic food, but no carbon dioxide is fixed in that case.

SOME RECENT WORK ON SELAGINELLA.—A very small xerophytic species of *Selaginella*—*S. preissiana*—has been described by Bruchmann (*Flora*, 1910). In this curious little plant, which grows in West Australia, Victoria, and Tasmania, the cotyledons are larger than the foliage-leaves; the first branching of the young plant gives off an erect shoot a little over an inch high, the other branch becoming the creeping rhizome, which then gives off erect branches right and left. The stem is protostelic; in the young stem (hypocotyl) there is a single exarch protoxylem, hence the structure is very simple. The roots have no root-hairs, but are infested by an endophytic fungus; the hyphae were observed penetrating the epidermis from the soil.

Miss Mitchell (*Ann. Bot.*, 1910) has recorded various observations on the cone of *Selaginella*. The axis may renew its ordinary vegetative growth beyond the sporangia; a second cone may be produced on such an axis, the two cones, or fertile regions, being separated by a sterile region; the cone may undergo branching. The distribution of sporangia is variable, and in different species we may get (1) one large basal megasporangium, (2) several basal megasporangia, succeeded by microsporangia, (3) cones with numerous microsporangia only, (4) cones with numerous megasporangia only, (5) an indeterminate arrangement. Then, there are species with one, two, or three megaspores in each megasporangium, instead of the usual four; also, two rare cases in which there are eight (*S. involvens*), and twelve (*S. vogelii*) megaspores.

Our knowledge of *Selaginella*, familiar to students and teachers as a botanical "type," has been greatly extended during the last few years, especially by the remarkable observations of Lyon, who showed that in some species the megaspore germinates, producing the prothallus and archegonia, in situ in the sporangium, which opens and lets in the antherozoids, so that we get practically a *seed* formed. Lyon showed also that in some species the embryo is formed directly from the fertilised egg cell, without the development of a suspensor.

ACTION OF MANGANESE ON PLANTS.—One of the very few definite examples, so far discovered, of localised action produced by absorption of a specific chemical element by a plant, has recently been noted by Molisch (*Sitz. kais. Ak. Wiss., Vienna*). It was found that the introduction of manganese salts into water containing submerged aquatics—*Elodea*, *Vallisneria*, Water Milfoil, Water Crowfoot—produced, after exposure to light for a few days, a deposit of brown substance in the walls of the epidermis cells, which soon increased so much as to mask the green colour of the leaves.

SOME RECENT WORK ON FOSSIL GYMNOSPERMS.—Bit by bit, our knowledge of the lower seed-plants is increasing, and the gaps between already known forms are being gradually filled up.

Scott and Maslen (*Ann. Bot.*, 1910) have described a new genus (*Mesoxylon*) of Cordaitales, from the Lower Coal-Measures of Lancashire. This genus is intermediate between *Cordiates* and *Poroxylon*, resembling the former in general anatomy—especially in the large pith—and the latter in having centripetal xylem. The wood is dense, with narrow rays and small tracheids. It is regarded as completely bridging the gap, so far as anatomy is concerned, between the Poroxyleae and the Cordaiteae.

Nathorst (*Handl. K. Sv. Vet. Ak.*, 1910) has described the reproductive structures of several Bennettitales. He found both microsporangia (with spores) and seeds in three species of *Williamsonia*, from the Jurassic of Whitby and Scarborough. In a new genus, *Wielandiella*, a remarkable vegetative structure is described—the stem, which is very slender, branches freely in an apparently dichotomous manner; in the cones, which occur in the forkings, there are remains of both pollen and seeds. A third genus, *Cycadocephalus*, has pollen-grains with remarkably close resemblance to fern spores. Nathorst also describes two cones from the Rhaetic of Sweden, in which the seeds apparently had an aril like that of the Yew. In *Palissya*, the ovuliferous cone scales bear two rows of seeds; while *Stachytaxus* has Yew-like foliage, and attached to the ends of the twigs are loose cones with distant scales, each of which bears two ovules.

Gothan (*Handl. K. Sv. Vet. Ak.*), describes various types of fossil wood from the Jurassic of King Karl's Land. In *Cedroxylon transiens*, the wood shows the fitting characteristic of Araucarineae, together with the ray structure of Abietineae.

Of greater general interest are the remarkable results obtained by Hollick and Jeffrey (*Mem. New York Bot. Garden*, 1909), from a study of the plant remains in Cretaceous clays of Staten Island. The Conifers include three genera of Abietineae (*Pinus*, *Prepinus*, *Pityoxylon*), of which the species of *Pinus* are more archaic than any living species, while *Prepinus* is still more primitive. The most important result, however, is the discovery of no less than sixteen genera of Araucarineae, of which nine are new. These Araucarians include types which had previously been referred to other families of Coniferae (Taxodineae, Cupressineae, and so on), from the general appearance of their leafy twigs. The authors believe that the Araucarians of to-day have come from Abietineous ancestors, through a group represented by those Cretaceous Conifers which connect Araucarineae with Abietineae. They also bring forward evidence for the great age of the pine-like Abietineae, and urge that the Conifers have, like the Horsetails and Clubmosses, undergone extensive reduction, those now living representing the degenerate survivors of a once great race.

That the Araucarians are very sharply distinguished from all the other Conifers is further emphasized by the results obtained by various workers on living types. It would seem, in fact, that great modifications will have to be made in the views that have generally been accepted as to the inter-relationships of the Conifer group, which apparently forms a puzzling maze of cross-affinities. The conflicting lines of resemblance among Conifers probably point to a more ancient lineage for all the families than has hitherto been realised.

TRYPANOSOME-LIKE PARASITES IN PLANTS.—It has recently been discovered that parasitic flagellates, resembling the trypanosomes which occur so widely in animals, and which cause malaria and other diseases in man, are found also in plants. The presence of a trypanosome-like parasite in plants was first made known by Lafont (*Comptes rendus*, 1909–1910), who found these organisms in the milky juice (latex) of a spurge (*Euphorbia*) from Mauritius. The discovery has been confirmed by Donovan (*Lancet*, 1909) in the same species of spurge, growing in Madras, and in his second paper Lafont gives a full account of the organism, which he has now found in three species of *Euphorbia*. The infected plants show marked signs of malnutrition, and finally drop their leaves and die. Lafont found that injection of the parasites into the blood of small animals produced no infection, though some of the animals died "from unknown causes." The further development of this remarkable addition to our knowledge of plant diseases will be awaited with great interest.

THE WOODLANDS OF ENGLAND.—An ecological memoir of great interest has recently appeared in the *New Phytologist* under this title. It represents the first satisfactory attempt to give a bird's-eye view of English Woodlands as a whole, and is based on a paper read by Tansley at the Dublin meeting of the British Association in 1908. The authors (Tansley, Moss, and Rankin), after discussing the general characters of British Woodlands, the relations of climate and soil, and so on, proceed to the classification of the Woodlands, of which they recognise three main series:—

I. The **Alder-Willow Series**. This is a lowland type occurring on very wet soils, and is characteristic of low-lying alluvial districts, as along the banks of the slow streams of the New Forest, the remoter valleys and lowland peat-moors of the North of England, and in the fens of Norfolk. The woods of this series at present existing probably represent merely fragments of a once extensive development, by now greatly reduced in consequence of drainage and cultivation. At least two plant associations occur in it, *e.g.*, the Carrs of Norfolk, fed by alkaline and calcareous waters, harbour several woody species characteristic of chalky and limestone soils, such as *Rhamnus catharticus* and *Viburnum Lantana*, while in the Alder-Willow thickets occurring on soils fed with neutral or acidic waters, calcicole species are absent. From this lowland type two great systems occur, the distribution of which follows, in the main, two chief classes of soil, siliceous and calcareous.

II. **Oak and Birch Series.** The woods in this series occur on all the "siliceous" (*i.e.*, non-calcareous) soils, ranging from the stiffest clays to sand and gravel, and derived from rocks of various ages. Within this series three associations occur, but more or less merging into one another. (A) An *Oakwood Association*, by far the most widely distributed of British Woodlands. The dominant tree is *Quercus robur* (=*Q. pedunculata*). Owing to the great variety of soils on which the oak is dominant, the associated trees and especially the ground vegetation, show a wide range, and two groups of associations are distinguished—(*a*) *Damp Oakwoods* on clays and loams of the London Clay, the Gault, the Weald Clay, and so on, in the south of England: these are connected by every gradation with (*b*) the *Dry Oakwoods*, found on coarsely-grained, siliceous, shallow soils of the Palaeozoic and igneous rocks of the west and north of England. In these woods *Q. sessiliflora* is usually dominant, but with a varying admixture of *Q. robur*. (B) The *Oak-birch-heath* association is a type characterised by the presence in the ground vegetation of bilberry, hair grass and ling. Such woods cover wide areas in Kent, Surrey, Sussex, and locally as far north as Cheshire and Nottingham. This wood is probably a stage in the degeneration of oak forest to heath land, similar to that described by Graebner in the great heaths of the north-west German plain. In the hilly districts of the north of England, the woods on non-calcareous soils are dominated by *Q. sessiliflora*, but this tree becomes rare above 1,000 feet, and owing to climatic influences tends to be replaced by (C) The *Birchwood Association*. The Birchwoods are floristically very similar to the Oakwoods, but the ecological differences appear in the rearrangement of the dominant members of the two associations. Judging from the remains of Scots Pine in the peat of the Pennines, this tree was doubtless a constituent, but probably not an abundant one, of the primitive Pennine birch forests.

III. The **Beech and Ash Series** is sharply marked off from the two preceding series. These woods are found on calcareous soils (such as marl, chalk, limestone) where the lime content of the soil is high. Here three associations are distinguished—(A) an *Ash-Beechwood Association*; (B) an *Ashwood Association*; (C) a *Beechwood Association*. (A) and (B) are the characteristic woodland types on all highly calcareous soils, except those of the south-east of England, where the beech is dominant on the chalk. The area of natural and semi-natural beechwoods appears to have a western extension on the Inferior Oölite of the Cotswold, but for the most part it does not extend north-westwards of the chalk escarpment.

For each association in these series, lists are given of the subordinate woody species, as well as the characteristic species of the ground vegetation.

The foregoing summary of this most useful memoir is based upon that given in the *Naturalist* by Dr. Woodhead, well known for his own valuable work in Ecology. Readers interested in the subject should obtain the memoir itself, which has been separately issued as a "*New Phytologist Reprint*" and can be purchased at a shilling (by post, 1s. 1d.) from the Editor, "*New Phytologist*," Botany School, Cambridge, or from Dr. W. G. Smith, Agricultural College, George Square, Edinburgh.

CHEMISTRY.

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

METALLIC RADIUM.—Until recently radium has only been known in the form of salts, such as the chloride or bromide, but Madame Curie and M. A. Debierne have at length succeeded in separating a small quantity of the elementary substance, and give an account of its properties in the *Comptes Rendus* (Vol. cli, 523).

A liquid amalgam of radium was first prepared by electrolysing a solution of radium chloride by means of a cathode of metallic mercury and an anode of an alloy of platinum and iridium. This amalgam was rapidly dried and placed in an iron boat, which was heated in a quartz tube containing an atmosphere of hydrogen, the pressure of which was maintained at a point above the pressure of mercury vapour at the temperatures of the experiment. After the bulk of the mercury had distilled the temperature was gradually increased, until at about 700° C. the remainder of the mercury was expelled, and the volatilisation point of the radium was reached. The residue left in the iron boat was a bright white metal, which melted at 700° C. and at higher temperatures volatilised and attacked the quartz tube.

The radium thus obtained rapidly blackened on exposure to air, a nitride apparently being formed. It also decomposed water, being itself for the most part dissolved in the process. Like its salts it was radio-active.

AN ANCIENT GLASS MIRROR.—The current issue of the *Monatsheft.Chem.* (Vol. xxxi, p. 781) contains a description by Messrs. Wafert and Milkanz of an old Roman mirror that was discovered in the ancient burial ground at Laibach, and is believed to date back to the second or third century A.D. It was a slightly convex glass plate fitted into an indented and ornamented leaden ring, and from its appearance under the microscope and the results of chemical examination, the mirror had probably been formed by attaching lead foil to the back of the thin glass by means of some balsam. In the course of centuries the balsam had become resinified and had combined with the lead to form a resinate. The bulk of the lead of the foil had been converted into red lead (Pb_3O_4), whereas the lead of the frame and on the back was largely in the form of basic lead carbonate.

CLOTH FROM BANANA FIBRE.—A specimen of Cloth made from banana fibre, recently exhibited at the fair at Chunking, has been sent by the British Consul of that place to the Board of Trade.

It is prepared in China by unrolling the stalks of the banana when about a year old, and steaming them over boiling water until quite soft. The green outer skin may now easily be stripped off by passing the stalks through a machine provided with two blunt scrapers, the residue then containing the fibres. The material is next wrapped in a cloth and hammered so as to separate the fibres and expel the moisture, and the fibres are then pulled apart and spun into threads for weaving. The method of separation is thus very similar to that used in the preparation of ramie fibres.

So far only a few lengths of cloth have been woven, and the price is therefore high (£1 3s. 6d. for a roll 15 feet long by 3 feet broad), but with increased demand the price will fall and the material will probably be extensively used in the manufacture of clothes for summer wear.

The ultimate fibres, the microscopical form of which is here shown, are about fifteen inches in length and very strong. It will be noticed that the twisted form of the bottom fibre in the photo-micrograph recalls the characteristic twist of the cotton fibre, from which, however, it may be distinguished by not having the twists along its whole length. The jointed structure is similar to that of the linen fibre, which it also resembles in its general chemical characteristics and behaviour towards different reagents.

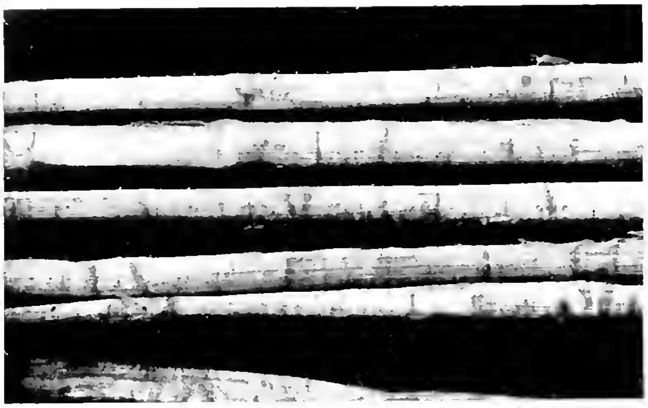


FIGURE 1. Banana Fibres.

A specimen of the pale yellow cloth, for which the writer is indebted to the Commercial Intelligence Branch of the Board of Trade, was exceedingly tough and apparently very durable. It contained 10·5 per cent. of moisture, and yielded, on ignition, 1·7 per cent. of mineral matter (ash), the latter figure being very similar to that given by linen, which usually contains about 1·5 per cent. of mineral matter.

CHEMISTRY AT THE BRITISH ASSOCIATION.—The reports of various Committees to Section B (Chemistry) at the recent meeting of the British Association at Sheffield included those on the "Study of Hydro-aromatic Substances," on "Electro-Analysis," on "Dynamic Isomerism," and on "The Transformation of Nitro-amines, etc." all of which are interesting only to the chemist.

A report on "Gaseous Combustion," by Dr. Bone, gives an extremely interesting summary of the chemical researches upon the nature of gaseous combustion during the last 30 years.

Of the papers read before the Section mention may be made of that on "The Influence of Chemical Composition and Thermal Treatment on the Properties of Steel," by Professor McWilliam, and that on "The Crystalline Structure of Iron at High Temperatures," by Dr. Rosenhain, who shows that between the ordinary temperature and 1000° C. iron exists in three distinct modifications, possessing very different physical properties. There was also a contribution by Dr. Copeman on "Ferro-silicon," the dangers attending the transport of which have already been described in these columns.

The paper by Dr. Howe on "Allotropy or Transmutation" is a plea for regarding the question of transmutation of the elements from a different point of view than the usual one. The allotropism of the two forms of carbon, diamond and lampblack, which may be transmuted into each other, is commonly explained on the ground that they are the same element because they yield the same products of decomposition. In place of the statement that "the elements cannot be transmuted into each other," it is suggested that it would be more philosophical to say, "Hitherto no elements have been transmuted into each other except those which transmute so readily that the derivatives of only one of them have been recognised." Such a point of view would render the transmutation of an element, say copper, into another, say, lithium, not so inherently improbable as to demand exceptionally conclusive evidence.

ECONOMIC BIOLOGY.

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

THE CLASSIFICATION OF BACTERIA.—In the investigation of plant diseases due to bacteria, great difficulty is frequently presented to the investigator in identifying the species under observation. This difficulty of arriving at a conception of species has been experienced in other branches of biological science, and has led to the recognition of groups of related species, such groups being treated as units until such time as the progress of knowledge would allow them to be broken up into their component species.

The early work with bacteria was very largely confined to pathogenic forms, and pathogenicity was relied upon to define the limits of the species, but as the study extended to non-pathogenic forms, reliance was placed on various other physiological reactions, singly or in combination, although, unfortunately, there has been little agreement amongst workers as to the relative value of the different reactions recorded.

Recognizing the importance of a uniform and concise method of recording such reactions the Society of American Bacteriologists adopted an official classification card for this purpose. An important part of this card was the "group number," in which the results of ten different reactions were expressed numerically.

CONSTANCY OF CHARACTERS.—As the usefulness of the group number becomes recognized there is a growing desire to extend its range until it shall classify cultures as closely in accord with the idea of species as possible. It therefore becomes imperatively necessary to know both the constancy of these reactions and the extent to which the group number can be followed in classification without separating various strains of the same species.

In this connection an excellent piece of work has recently been published by Mr. H. A. Harding (Tech. Bull. No. 13, N.Y. Agric. Exp. Station), who has selected an organism (*Pseudomonas campestris*) the limits of which are clearly defined; he has also studied a large number of strains under as wide a variation in conditions as could be reasonably expected to occur in ordinary laboratory work. The study has extended over a year and a half, using media prepared by different workers, and in some cases the observations were made by three different workers separately. In short, the effort was made to find the maximum variation which could be expected where observations were made in accordance with the official directions, or with the deviation therefrom which could be reasonably expected in practice.

CONCLUSIONS.—The results obtained are set forth in great detail, and show that the card system offers a basis for classification which for convenience of application and in certainty of result surpasses anything which has preceded it. It furnishes a form for recording and organizing a mass of observations, and intelligently applied it is calculated to bring order out of chaos, and be a potent factor in raising bacteriology to the dignity of a science.

Tested on forty-four strains of *Pseudomonas campestris* it gave constant results without breaking the species into smaller groups. The author concludes that the qualitative variations and apparently discordant reactions which have commonly been attributed to bacteria are probably due largely to faults either in observation or in technique. Quantitative variations are constantly met, but these are undoubtedly largely due to lack of knowledge concerning the proper revivifying process to be applied before determining the culture characteristics.

FUNGOID PARASITES OF SCALE INSECTS.—In the current number of the *West Indian Bulletin*, Mr. F. W. South gives a valuable account of work accomplished on the infection of various scale insects with fungi. In the Lesser Antilles four species of fungoid parasites occur on scale insects, all of which may be artificially spread either by the spore-spraying method, or the tying-in method. Experiments showed that the fungi were most effective in the islands of Dominica and Montserrat upon the scale insects attacking the limes, but they are of general importance in all the islands. The factors affecting the usefulness of these fungi are temperature, wind, and moisture; of these the two last are the most important locally. Mr. South concludes that the natural means of controlling scale insects is that most suited to the circumstances in the West Indies, both owing to the general conditions and to the much smaller expense involved.

GEOLOGY.

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

DEFORMATION OF MINERALS AND ROCKS UNDER PRESSURE.—In the July issue of "Knowledge" occurred a note in which the work of Profs. F. D. Adams and E. G. Coker on the effects of differential pressure on marble was described. Prof. Adams has extended the investigation to other rocks and various rock-forming minerals. His results are given in the latest number of the *Journal of Geology*. The method of compression used was that invented by Prof. Kick. The specimen is placed inside a stout open copper tube, and the space between the two filled with paraffin wax, alum, or some other material susceptible of deformation under pressure. The ends of the tube are covered with brass plates, and the whole then squeezed in a powerful press. The first effect of the pressure is to force the copper tube into the plates at each end and thus to form a very strong box, from which nothing can escape except by the rupture of the tube. A series of minerals in a scale of increasing hardness was tested. Selenite, rock-salt, calcite, and fluorite (with hardness under five in Moh's scale), showed distinct plastic deformation with some development of twinning and cleavage. The minerals with hardness greater than five showed no marked change of shape, but in some cases evidence of internal movement was obtained. Thus a perfect basal twinning was developed in diopside. No plastic flow was obtained in hard minerals such as quartz and garnet. These were broken down and powdered under the pressure. A very curious phenomenon was observed in fluorspar, green crystals becoming violet-coloured under pressure. The softer rocks experimented on, such as Carrara marble, were readily deformed, the shapes assumed varying with the character of the embedding material. Dolomite was found to be more resistant, and movement within the rock took place chiefly through the development of cataclastic structure. The harder rocks, such as granite, simply crumbled under the pressure. Much higher pressures would be required in order to induce a flow-structure in such hard rocks.

SUBMARINE GEOLOGY.—In a recently-issued memoir of the Geological Survey of Ireland, Profs. G. A. J. Cole and T. C. Crook discuss the rock specimens dredged from the floor of the Atlantic off the coast of Ireland in relation to their bearing on submarine geology. Specimens were obtained from the Porcupine Bank, and from off the coasts of Galway, Mayo, Donegal, Kerry, and Rathlin Island. Off the north-west coast little but submerged masses of rocks common to the west of Ireland were obtained. The Porcupine Bank, however, was found to be composed of an olivine gabbro, which is believed to be allied to the Cainozoic gabbros of Carlingford and the Inner Hebrides. It is therefore suggested that the Porcupine Bank may represent the site of a Tertiary volcanic vent. Another interesting point is that Eocene limestones occur in the dredgings from the coast of Kerry, as well as abundant relics of Cretaceous strata. These observations are held to indicate a westward extension of the types of strata known in the Paris basin, and are in accord with the results of F. H. Worth, who obtained similar rocks from the English Channel.

GLACIAL PROTECTION.—An interesting paper by Professor E. J. Garwood on "Features of Alpine Scenery due to Glacial Protection," appears in the September number of the *Geographical Journal*. The protective action of ice is considered in relation to certain plateaux, arêtes, cirques, hanging valleys, and valley steps in the Alps. It is not denied that moving ice erodes an Alpine district. The problem is whether it is more or less powerful than the ordinary agents of erosion. The author considers that some characteristic Alpine features might be explained on the assumption that ice, on the whole, erodes less rapidly than other denuding agents, and that, under certain conditions, it may act relatively as a protection to the rocks beneath. Similar views have been vigorously advocated in the past, and have been restated by Dr. T. G. Bonney in his recent Presidential Address to the British Association. Professor Garwood's paper is illustrated by many beautiful photographs of Alpine scenery.

THE CANADIAN SHIELD.—In his Presidential Address to the Geological Section of the British Association, Professor A. P. Coleman dealt with the history of one of the corner-stones of the earth—the Canadian Shield. This great mass of ancient gneiss and schist is for the most part destitute of overlying formations save the products of Pleistocene glaciation. There is here, therefore, as in the North of Scotland, the meeting of geological extremes, between which is the most tremendous discordance in geological history. The great masses of gneiss are not, as some have thought, relics of the original crust of the earth. They are definitely known to be intrusive in a still more ancient formation, the Keewatin, in which is found quartzite, arkose, slate, and phyllite, besides metamorphosed representatives of these rocks and great masses of igneous material. All the ordinary types of sediment accumulated in the Keewatin sea apparently under much the same conditions as they do now in modern seas. Thus the ordinary processes of denudation were operating on broad land areas; rocks like granite or gneiss were weathering into sand and mud, long before the Archaean mountains came into existence. The pre-Keewatin land and sea-bottom have disappeared, and have probably been fused and transformed into the Laurentian gneiss. Such considerations as these compel one to think of the immense duration of Pre-Cambrian time, and contrast its vistas with the comparatively short period represented by the fossiliferous formations.

Another interesting point is that the Lower Huronian, which rests unconformably on a floor of Keewatin and Laurentian, has a basal conglomerate which is almost certainly an ancient till. It is the oldest known boulder clay, and upon its denuded surface in many places rests the youngest boulder clay. Professor Coleman remarks "It is not a little impressive to see modern till resting on the Huronian tillite and including fragments of it as boulders. It is possible to break out from the modern glaciated surface stones whose underside received their polish and striae in the Lower Huronian, while their upper surface has been smoothed and scratched by Pleistocene ice-movements."

METEOROLOGY.

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

THE weather of the week ended September 17th was fair and dry, though there was a thunderstorm in London on the 14th, with heavy rain in many places. Temperature was below the average, and ranged from 69° at Stonyhurst to 30° at West Linton. On the grass readings as low as 28° were reported.

Rainfall was more than twice the average in England, E., but was light in all other parts. At many stations in the West the week was rainless. In spite of the low rainfall sunshine was also deficient, except in Scotland and in Ireland N. Douglas reported the largest aggregate, 50·8 hours (56%), and Birmingham the least 1·7 hours (2%). Glasgow had more sunshine (37·6 hours, 42%) than Guernsey (23·3 hours, 26%).

The temperature of the sea round the coast varied from 61° at Newquay, and about 60° on the Southern Coasts, to 52° off the East of Scotland.

The week ended September 24th, was fair and dry very generally, but cool. Temperature was below the average in all Districts. The highest readings were 71° at Scarborough, and 70° at Raunds, on the 24th, but at no other station was 70° reached. In Ireland the highest reported was 65° at Armagh and at Killarney. Rainfall was very light, and the South of England was practically rainless. Sunshine was more abundant than in the preceding week, but it was still defective in Scotland, N. and in Ireland. At Strathpeffer, the total was only 11·0 hours (13%), and at Gordon Castle 11·3 hours. On the other hand many stations in the South reported 50 hours and upwards, Tottenham as much as 56·9 hours (66%). The temperature of the sea water ranged from 61° at Newquay and at Margate to 52° on the East Coast of Scotland. Frost on the ground was reported at many stations, and at Llangammarch Wells, while the minimum in the screen was 27°, the reading on the grass fell to 19°.

The weather during the week ended October 1st was less settled than that of the preceding fortnight. Rain fell on several days in the N.W. and W., and thunderstorms were experienced on the 1st in many parts. Temperature, however, was markedly higher, being above the average in all districts. The highest readings were 76° at Raunds on the 28th, and 75° at Tottenham. The lowest minimum was 34° at Markree Castle, Sligo, on the 30th. At only a few stations did the minimum on the grass fall below freezing point, the lowest being 27° at Cockle Park, Morpeth. Rainfall was less than the average in all districts, except Ireland, S., where both rainfall and rainy days were more than usual. At some stations in the South no rain was reported, and at others the fall was only one-tenth of the average.

Sunshine exceeded the average in some parts, but was less than the average in Ireland, Scotland, England, S.W., and English Channel. Cromer reported the highest aggregate, 46·0 hours (55%), while Falmouth had only 16·4 hours (20%). Glasgow reported 10·1 hours (12%).

The week ended October 8th opened with heavy rain in the Western and N.W. districts, and some more moderate falls with thunderstorms elsewhere, but was afterwards fine and warm. Temperature was above the average in all districts, by as much as 6° in Scotland, E. The highest reading was 74° at Cromer on the 2nd, with 73° at Hillington and Raunds. In Jersey the highest reported was 66°, and in Scilly only 63°. The lowest reading observed was 32° at West Linton on the 7th, the next lowest being 37° at Newton Rigg, near Penrith. On the grass the lowest reading reported was 29°. Rainfall was below the average in all districts, especially so in the East and South of England. At Yarmouth, Felixstowe and Clacton no rain fell, and at a large number of places there was rain on only one day. Sunshine was in excess generally. The highest aggregate was 46·2 hours (58%) at Guernsey, the lowest 6·6 hours (8%) at Castlebay. Birmingham reported 15·5 hours (19%), while Glasgow had 23·0 hours (29%). The temperature of the sea water varied from 61° at Margate and Seafield to 51° on the N.E. of Scotland. Aurora was observed in Aberdeen on October 6th and 8th.

During a kite ascent at Pyrton Hill on October 4th, a remarkable current of dry air was observed. On the ground the humidity was 90% (saturation = 100), at 300 feet no change was observed, but at 1,600 feet the humidity had increased to 95%. At 3,300 feet, however, the percentage was only 40%, at which it remained till the kite reached its greatest height, 4,400 feet.

Pyrton Hill at the time was on the Northern side of a large anti-cyclone, which had its centre over the Bay of Biscay. On the ground the wind was from W. by N., but as the kite rose the direction veered to N.W., and the force increased to 10m. per second. A few clouds were met with at about 2,300 feet, and from 2,600 feet the temperature increased with height instead of falling.

LECTURES ON METEOROLOGY.—Announcement is made by the University of London that Dr. W. N. Shaw, F.R.S., Reader in Meteorology and Director of the Meteorological Office, will deliver two lectures on "Modern Meteorology, Dynamical and Statistical," at the new Meteorological Office in the Exhibition Road, South Kensington, on Mondays, November 21st and 28th, 1910, at 5 p.m. (No tickets required).

MICROSCOPY.

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

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD. ARTHUR EARLAND.
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.

AN INTERESTING LARVA (*Simulium reptans*).—During a recent holiday, camping out on the banks of the river Teme, near Tenbury, Worcestershire, I was much interested in these larvae, which are common in that river, or, at all events, in that locality.

The larvae are only found in the most rapidly running water on various water weeds—in this instance *R. aquatilis*. No mere words can give an idea of the vast numbers in which they were found; one could pull out a length of weed which, as weed, was usually invisible on account of the wriggling mass of larvae attached to it. Had one so desired, a bucket could have been filled solid with them without difficulty.

The larva itself is a curious little animal, when full grown about 11–12 mm. long, of a greenish black colour, and, although not so transparent as the bulk of aquatic larvae, still permits its internal economy to be easily made out. Its nervous system, in particular, is very distinct.

From the nature of its environment of rapidly rushing water, it is provided with most efficient devices for retaining hold of its support, in the form of two suckers, one on the thorax, the other at the extremity of the last segment of the abdomen. These suckers are each furnished with many rows of sharp claws, or hooks, to add to their efficiency.

The larva appears to hang on to its support as a rule by the abdominal sucker, using the other to crawl about the weed in the same manner as a geometer larva. It normally holds on with its body as near to a right angle to the weed as it can get, waving the body to and fro in all directions in search of food. Should it be accidentally dislodged, it has another safeguard in its capacity for spinning a thread, and along which it slowly crawls back to safety. The salivary glands which furnish this thread are of enormous size, and form the most prominent anatomical feature of the insect.

The head is furnished with a powerful biting mouth of the usual type, and, in addition, is provided with two pairs of very beautiful and extraordinary ciliated appendages, with which it continually "sweeps" the water in search of food.

Professor Miall, in his admirable *Natural History of Aquatic Insects*, deals very fully with this larva, but, curiously enough, only refers to the most prominent, or external, pair of sweepers. A smaller pair, within the larger, is, however, easily visible with a low power of the microscope. These appendages the larva keeps constantly in motion, and all food within their range is instantly swept into the capacious mouth.

Figure 1.
The larva of *Simulium reptans*.

Figure 2.
The pupa of *Simulium reptans*.

Figure 3.
The head of the larva showing mouth and thoracic claw.

The larva pupates within a conical silken cocoon, which it firmly attaches to the weed with a glutinous secretion of both silk and cement supplied by the salivary glands. The cocoon is very transparent, and enables one to readily make out details of the imago within. The pupa is provided with delicate tubular gills, visible in the photograph, for breathing purposes.

Unfortunately, my stay in the country was too short to make complete observations; when I first examined the weed (July 24th) I found larvae only, a few pupae were found August 4th, and when I left on August 12th, practically all had pupated. The Flies were due to appear during the last week in August, and these I unfortunately missed.

The Fly in this country is harmless, but [illegible]ers of the genus in the United States (*S. molestum*) and the valley of the Danube (*S. columbaczense*) form a terrible scourge, in bad years driving cattle mad by the hundred. The insides of the ears and nostrils are the favourite points of attack—to such an extent indeed, that these organs are packed almost solid in bad cases. Fortunately, the family is a small one, containing but one genus and about sixty known species.

The larvae I failed to keep in aquaria, as might be expected from their normal habitat, all dying in a few hours. They might possibly be reared in aquaria violently aërated by mechanical means. In a round tank a steady, well-aërated flow of water could easily be assured, that would give a good imitation of their natural surroundings.

The final metamorphosis of the Fly is most interesting, but this I missed, as above mentioned. The perfect insect leaves the cocoon in a bubble of air, floating in safety

... of the water, forming, in all probability, ...st ingenious device for the escape of an insect ... roundings that have become unsuitable. Professor M... gives a spirited description of this act in his book, which is ...ll worth reading by those who wish to pursue the subject farther.

ARTHUR C. BANFIELD.

BATRACHOSPERMUM ATRUM (DILLW.) HARV.—At a recent meeting of the Quekett Microscopical Club, Mr. Higginson exhibited a mounted specimen of the above. It was found growing on the brick-work of a weir at Colnbrook, in May. This species is not nearly so familiar as the common *B. moniliforme*, Roth., in fact many would scarcely recognise it at first sight as belonging to the same genus. The branches which are the salient feature in *B. moniliforme* are here reduced to the smallest dimensions, as shown in the illustration, Figure 1, which is from a photograph by Mr. Banfield of a mounted specimen. Dr. Cooke describes it (British Freshwater Algae, p. 292) as "vaguely and much branched, whorls abbreviated, distant; interstitial branchlets very short, one or two celled." Quoting Hassall, he says: "The articulations, or internodes, may be compared to reversed cones, the superior part or whorls being formed of a few short, simple subulate filaments, which are not beaded. That portion of each articulation which is below the whorl is transparent, and beautifully exhibits the tubular and jointed structure of the layers which invest the primary cells in all the species of the genus *Batrachospermum*; from many of these tubes short branches are given off which have almost the appearance of scales."

FIGURE 1.

Batrachospermum atrum.

At a later date Mr. Higginson had the good fortune to find on the shell of a pond snail another specimen which appears to agree exactly with the variety named by Dr. Cooke, *Dillenii*. In describing it, he says: "Filaments very thin, lower nodes remote, the interstices beset very densely with prominent cells, upper nodes crowded, branchlets very short, consisting of three to four cellules, extreme apical nodes confluent." In a note, he says: "This is usually considered as a variety of *B. vagum*, but it seems more closely allied to *B. atrum*, if that be really a distinct species." In this latter specimen the features Dr. Cooke describes are very distinct; what he speaks of as "prominent cells" are very numerous, and in several cases show short branches, but they cannot be mistaken for the actual branches (which occur at the nodes) and are obviously only proliferations of the cortical cells which envelope the internodes. There are several cystocarps on this example. The colour of the living plants was much masked by the presence of numerous diatoms and other epiphytes, as is so commonly the case with this genus; in the mounted specimens it is a clear pale green, but that is largely due to the mounting medium. In the figure the irregular projecting threads are epiphytes, chiefly diatoms, mostly *Synedra*.

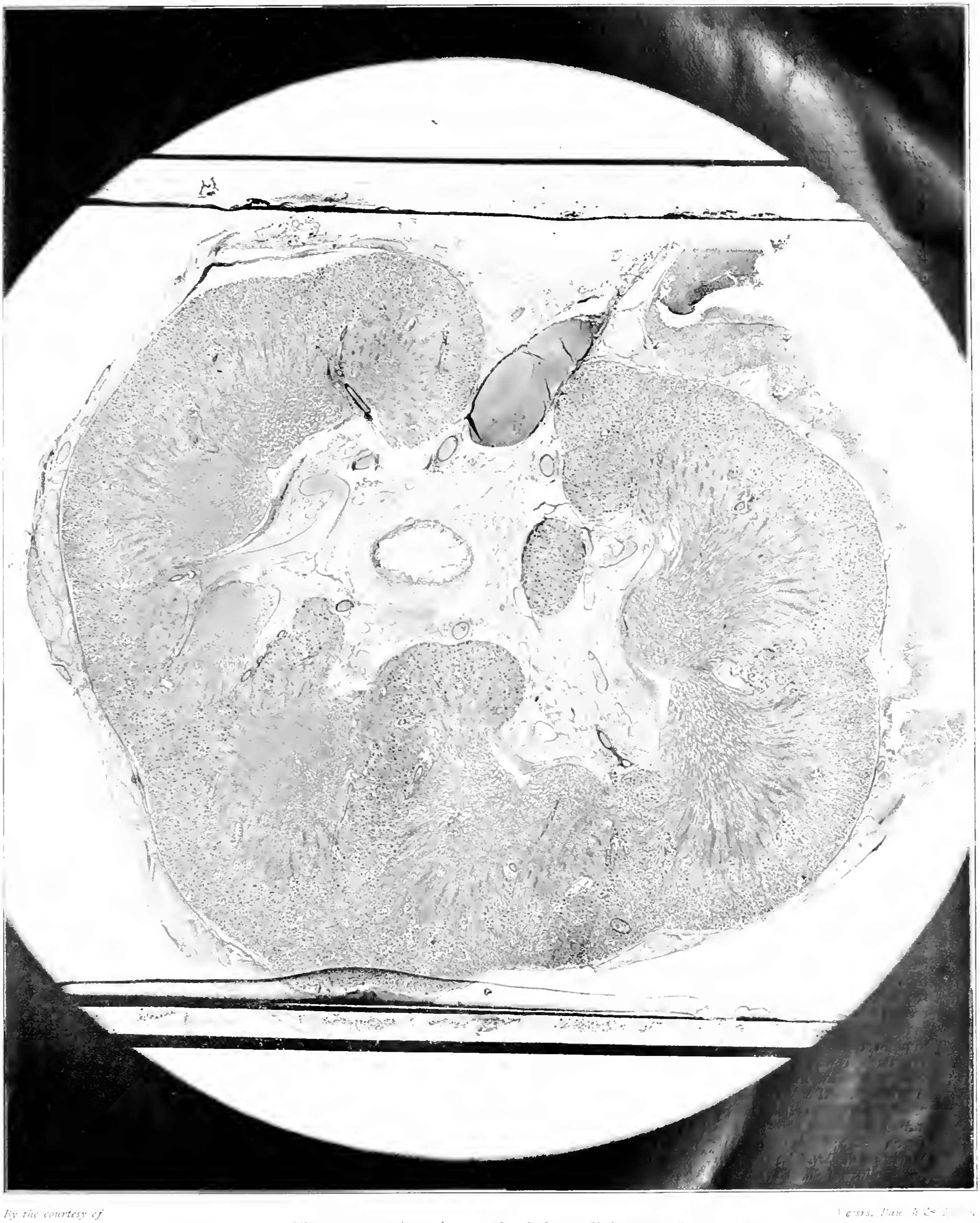
J. B.

A METHOD IN MICRO-TECHNIQUE.—In the *Zeitschrift für wissenschaftliche Mikroskopie*, Bd. XXVII, Heft 2 (Aug. 1910) there are some notes on microscopical technique by J. T. Wilson, F.R.S., Professor of Anatomy in the University of Sydney, in which he gives the following details of a convenient and simple expedient for suspending blocks of tissue in fluid, and more especially for passing them through successive series of fluids. He uses short segments of glass tubing from 18mm. to 30mm. in diameter, one end of which is closed by means of fine net tied round it; the tissue is placed in the tube, which is then closed at the other end by a perforated cork of sufficient size to float the whole in the fluid. Such a floating vessel can be transferred from one fluid to another with the utmost readiness, and without, in any way, handling the tissue. Similar arrangements have been described before, but this has the merit of very great simplicity and cheapness.

If the gauze bottom of the tube, prepared as above described, be dipped in a 10 per cent. solution of gelatine and allowed to set, it can then be formalinised and preserved indefinitely either in very weak formalin or in alcohol. Such a tube may be utilised as a floating differentiator. Thus, a piece of tissue may be placed in it in a small quantity of one fluid, and after inserting the perforated cork it may be floated in a vessel containing another fluid, thus securing a very gradual diffusion of one fluid into the other through the gelatine membrane.

MICROSCOPICAL APPARATUS.—The first section, of more than twenty pages, in Mr. C. Baker's new classified list of second-hand instruments is devoted to microscopes and accessories of all kinds, and of very special interest is the separate list of apparatus that belonged to the late Dr. Dallinger. It contains many interesting items, among which is a water immersion objective of one-fiftieth of an inch focus, by Powell & Lealand.—We have before us also the first catalogue of second-hand apparatus issued by Messrs. Angus and Company. As said in the preface, the possibility of acquiring apparatus at a cheap rate may be a real boon to those who wish to try experiments at the least possible cost.—We advise our readers to get a copy of the little booklet entitled, "Some Hints on the use of the Sliding Microtome for the Paraffin Method," which has been issued by Mr. E. Leitz, and which contains some very useful information.

SECTION OF KIDNEY.—We are able, by the courtesy of the Bausch & Lomb Optical Coy., of Rochester, U.S.A., to publish a reproduction in half-tone of a photograph of a cross section of an entire infant's kidney, under a magnification of 7 diam. This beautiful photograph was taken by the Bausch & Lomb-Zeiss Micro-Tessar 72 mm.; a special condenser was used. The slide was stained with Eosin and Haemotoxylin. The reproduction illustrates, in a measure only, the excellence of the original photograph.

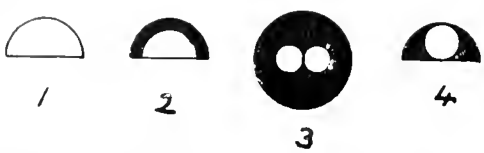


By the courtesy of *Messrs. Bau[illegible]*

The cross section of an entire Infant's Kidney. × 7.

AN ALMOST FORGOTTEN BINOCULAR DEVICE.—As many readers of "KNOWLEDGE" still use that most excellent but discredited instrument, the stereoscopic binocular, it may be worth while to bring to their remembrance a simple yet almost forgotten device, now more than a quarter of a century old, which certainly improves the image.

If one of the eye pieces is removed and the back of the object glass is examined, when a full cone is used, it will appear as in Figure 1. Generally the iris below the substage condenser is somewhat closed, and the appearance seen is like Figure 2. If now, instead of closing the iris, a stop of the form Figure 3, be inserted underneath the substage condenser, the back of the object glass will appear like Figure 4 in each tube, and a much improved picture of the object will be obtained.



Some little care is required in making this double hole in the stop of a proper size. The best procedure is to experiment with stops cut out of cardboard, and when the right effect is obtained to have it copied in brass. Of course it will be necessary to have a special stop for each objective, and to remember that it can only be used with the substage condenser for which it was made—this, however, is a minor difficulty which can be readily overcome.

Some years ago I made experiments by placing at the back of the object glass a stop having two circular apertures, as in Figure 3, but with larger holes; since then experience has shown that nothing much is gained by doing this; the improvement seems to depend entirely upon the stop at the back of the substage condenser.

Great care must be taken with the illumination, so that it appears the same in both holes when viewed at the back of the object glass, the eye pieces being removed for that purpose.

In general, the best illumination for transparent objects, when a stereoscopic binocular is used, is obtained by focussing the image of the flat of the flame upon the plane of the object, of course without a bull's eye.

EDWARD M. NELSON, F.R.M.S.

For the purpose of producing duplex illumination for the binocular instrument Riddell made use of two mirrors, and Stephenson a duplex stop with cylindrical lenses. It was in 1892 that Mr. Nelson first suggested the use of the above described stop in conjunction with the achromatic condenser.—[A. W. S.

VAMPYRELLA LATERITIA LEIDY.—While engaged in an exploration of the Sikkim Himalayas my friend, Dr. Kellas, made his camp for several days near a small lake called the Green Lake, at an altitude of nearly sixteen thousand feet. From this lake he very kindly obtained for me a small quantity of mud. As the "mud" consisted of a coarse glacial detritus, one could hardly imagine less promising material for examination. However, on placing some of this mud in a large specimen-tube and allowing it to remain for a few days, I was agreeably surprised to find I had a small collection of the living micro-fauna from this Himalayan lake. As the material was quite free from putrefactive bacteria, the organisms remained alive for some weeks. Besides several infusorians there were two bdelloid rotifers, which Mr. David Bryce kindly named for me; they were *Philodina acuticornis* Murray and *Callidina elegans* Milne, both, as I understand, recorded from Scotland. But my first and only acquaintance with the Rhizopod named at the head of this paragraph, was from this material. It is recorded by Cash, from Cheshire, and by Professor West, from North Wales, but it certainly seems of interest to find it high up in the Himalayas.

In the first tube I examined I found several actinophrys-like organisms, the protoplasm of which was coloured a bright orange. This was recognised as *Vampyrella lateritia* from the description and figures in Cash's *British Rhizopods* (Ray Society's Publications). It appears to have been first described by Cienkowski in 1863, under the name *Vampyrella spirogyrae*, but Professor Leidy has shown reason for considering that Fresenius had described it under the name *Amoeba lateritia* in 1856, hence this specific name takes priority over *spirogyrae*. Professor Leidy, in *The Fresh-water Rhizopods of North America*, in 1879, describes the "granular protoplasm as pervaded with colouring matter of different shades of orange. The periphery of the body is hyaline, and it is surrounded by pseudopodial rays giving it an actinophrys-like form." The pseudopodia are further described as being "of two kinds, the ordinary delicate, straight rays and pin like rays ending in a minute round head."

As the specimens had travelled from India in an encysted condition, my observations were carried out under adverse circumstances—since they never really attained a state of active metabolism. The pin-head appearance of certain of the pseudopodia seemed to be the effect of refractive granules passing outwards along the threads of protoplasm. It is very possible the small lake from which the specimens came was so named from some filamentous alga which coloured it green. This also would be the food of *V. lateritia* which feeds on the chlorophyll of such algae as spirogyrae. I was, of course, unable to observe its method of feeding, but there seems to be some divergence of opinion as to how it is effected. The earlier observers describe the Vampyrella as perforating the cell wall of *Spirogyra*, and thus extracting the chlorophyll. M. Penard adds that in addition to perforation of the cell wall there is a suction action on the part of the Vampyrella. Mr. Cash in the above mentioned book describes and figures a method which differs from that of the other observers. He says the Vampyrella anchors itself by means of its pseudopodia to the terminal cell of a thread of *Spirogyra* and actually bends this cell until it separates from the thread, when it is able to extract the chlorophyll; it proceeds in this way until there are a number of empty separated cells.

PHOTOGRAPHY.

By C. E. KENNETH MEES, D.Sc. (LOND.), F.C.S.

PHOTOGRAPHY BY INVISIBLE RAYS.—Professor R. W. Wood, of The Johns Hopkins University, gave the Thirteenth Traill Taylor Memorial Lecture before the Royal Photographic Society on September 27th. He discussed the methods which he has adopted for photography by the infra-red and ultra-violet rays, and the results obtained.

Photography by the infra-red requires only plates having sensitiveness in that region and a screen removing almost all the visible spectrum, and permitting only rays of wavelength superior to 7,000 A.U. to pass. These long infra-red, or rather deep red, rays are very little scattered in their passage through the atmosphere, and are almost wholly absent from the light reflected from blue sky, so that by their use blue skies appear very dark, entirely black near the zenith and lightening towards the horizon. Even the lightest clouds become very bright compared with the sky, so that the method seems well adapted for the study of faint cloud forms in meteorology. Vegetation, on the other hand, has but little absorption in this region of the spectrum and reflects the light plentifully, so that trees appear snow-white against the black sky.

The photographs in the ultra-violet were taken by means of a quartz lens silvered until it was opaque to ordinary light. Such a silver film transmits light between the wavelengths 3,000 and 3,200 A.U., by which light the photographs were produced.

These rays are scattered so powerfully by the atmosphere that the air always appears to be full of haze; the general appearance of landscapes in clear bright sunshine being similar to that presented to the eye when the sun shines through a light haze. Owing to this effect, shadows, which by infra-red light appear solidly black, are, in ultra-violet light, almost entirely absent, the diffused light from the sky preventing the formation of clear shadows.

The reflecting power of natural substances for ultra-violet light is, of course, very different from that which they possess for visual light.

Silver has only about the same reflecting power as glass, and would appear like anthracite coal, while Chinese white absorbs the rays more powerfully than printer's ink. White garden flowers also absorb the ultra-violet light strongly.

Photographing the surface of the moon, Professor Wood found a large deposit near Aristarchus which appears quite black by the ultra-violet light, though it is not distinguishable by visual light.

The method seems to hold out some promise for the investigation of the petrology of our satellite.

METHODS OF IMPROVING UNSATISFACTORY TECHNICAL RESULTS.—While some scientific photographs leave nothing to be desired, the technical quality of others is so poor that they prove less satisfactory for purposes of demonstration than their author might desire. Apart from actual bad work, there are two chief causes tending to produce inferior results:—

(1.) Sufficient exposure cannot be given, or is very difficult to give; e.g., in photographing objects in motion.

(2.) The contrast in the subject is insufficient.

The results obtained in both these cases are susceptible of improvement by after treatment, and I have found that the following methods are satisfactory:—

(1.) If the negative is so badly under-exposed that after development to the limit only a ghost is obtained, ordinary methods of intensification are not of much use. After thorough washing, the plate should be completely bleached by leaving in a solution of mercuric chloride until the whole deposit has become quite white to the back. The negative is now washed and dried, care being taken that it does not come into contact with developer, hypo, or ammonia solution. After drying, the back of the glass is covered with a black varnish, or with "Photopake," or Indian Ink. The photograph will now appear as a good *positive*, which can be put in front of a camera and copied.

(2.) If the contrast in the subject is insufficient much may be done in the case of coloured subjects by using colour filters with appropriate plates to increase the contrast, but sometimes this is useless. A case in point was supplied by the photography of the A and B lines in the solar spectrum with considerable dispersion and a high sun. The resulting negative, while admirable for purposes of measurement, gave quite insufficient contrast for printing, even when intensified. I therefore made a contact positive upon a slow lantern plate, and developed the positive with a physical developer, consisting of an acid solution of metol to which a small quantity of silver nitrate had been added. By this means the blackness of the deposit can be increased to any desired extent. A contact negative was then made from the positive, in the same manner, and from this excellent prints were easily obtained.

A PHOTOGRAPHIC PROCESS BY FERMENTATION.—Dr. Leo Jacobsohn, in a paper in *Photographische Rundschau*, describes some experiments which he has made on the peptonic fermentation of gelatine by the gastric juice, or by solutions of pepsin. Gelatine coated upon glass plates, and containing bichromate, was exposed to light and then subjected to the action of pepsin solutions, with the result that the unexposed gelatine was dissolved, while that which had been exposed to light proved incapable of digestion.

Gelatine which was hardened by the usual hardening agents, such as alum or formaline, proved as subject to attack by pepsin as unhardened gelatine.

Dr. Jacobsohn has employed pepsin for "developing" pigmented gelatine prints, instead [illegible], but it would seem doubtful if there is any real use [illegible] the [illegible]cess.

Further investigations upon the same [illegible], however, might prove useful as a means of enquiring into [illegible] structure of gelatine, and the alterations produced in its mo[illegible] structure by various reägents.

PHYSICS.

By W. D. EGGAR, M.A.

RADIUM STANDARDS AND NOMENCLATURE.—In *Nature* of October 6th, Professor Rutherford gives an interesting summary of the discussions which took place at Brussels in September, at the International Congress of Radiology and Electricity. At the opening meeting he himself read a report on the desirability of establishing an international radium standard. He had compared by the X-ray method several European standards and had found differences in some cases amounting to twenty per cent. It is possible to measure with considerable accuracy such magnitudes as the heating effect, the rate of production of helium, and the rate of emission of α and β particles. But the value of such determinations depends on the accuracy of the radium standard used in expressing the results. A powerful Committee of representative workers was appointed to report on the best method of fixing an international standard. This committee recommended, and the congress adopted their recommendation, that Madame Curie, herself a member of the Committee, should prepare a radium standard containing about twenty milligrammes of radium. This standard will cost about £500, and will become the property of the International Committee. It will probably be kept suitably at Paris.

It has been suggested that the name Curie should be used to express the quantity or mass of radium emanation in equilibrium with one gramme of pure radium. The amount in equilibrium with one milligramme of radium would then be called one millicurie. The question of names of radioactive products was discussed informally at the Congress. The present system seems to be fairly satisfactory, and capable of extension. For instance, if radium C is found to consist of several constituents, these might be called C_1 C_2, etc. But the giving of fancy names by individual workers is regarded as undesirable.

A NEW OPTICAL GRATING.—Prof. R. W. Wood, whose reputation as an experimenter extends far beyond the United States, delivered the "Thomas Young Oration" to the Optical Society on September 29th. In this he described a new form of grating, occupying a position intermediate between the ordinary diffraction grating and the echelon. It is ruled on gold deposited on copper, using a crystal of carborundum, which possesses an advantage over diamond in having straight sides meeting at an angle of 120°. The gold is compressed so as to form ridges and hollows with highly polished and almost perfectly flat sides. The spacing is coarse. These gratings are specially suitable for heat waves, and are much more efficient than prisms of rock-salt. Prof. Wood has given the name echelette to this form of grating.

ZOOLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

BARNACLES AND SNAKES.—One of the most curious of zoölogical pictures, mediaeval at first glance, is that given by Dr. Willey (in *Spolia Zeylanica*, May 1910), of a sea-snake, *Hydrus platurus*, bearing a bunch of barnacles on the end of its tail. The barnacles are of two kinds (*Lepas anserifera* and *Conchoderma hunteri*) and form a dense group. The attachment of barnacles to the skin of sea-snakes has long been known, but the case figured is very quaint. The specimen was brought alive to the Colombo Museum. Dr. Willey writes: "The barnacles are not ectoparasites, as they d... ...ed upon the skin of the snake, nor do they assist the sn... in any way; on the contrary, their presence must have s...sly impeded the movements of the snake. Moreover, ...y thrive equally well when attached to floating bottles and drifting spars. So far as the snake is concerned they are simply an incubus which cannot be shaken off, and the snake is merely their facultative vehicle. These barnacles are sedentary animals destitute of proper powers of locomotion, although capable of securing their own nourishment, but they have acquired a planozoic or passively vagrant habit, and they must be kept on the move." Dr. Willey recalls the association (described by Alcock) between certain Hydroid polyps (*Stylactis minoi*) and a small rock perch, *Minous inermis*. He also notes that the barnacle *Lepas anserifera* is frequently accompanied by two Annelid worms of the family Amphinomidae.

LUNGLESS NEWT.—There is a newt (*Triton* or *Euproctus montanus*) in Corsica which lives under stones in the dry beds of streams and dispenses with lungs. A number of similar cases are known and there are two opinions as to their respiration. Wilder's view is that the respiration is essentially cutaneous; Camerano's view is that the bucco-pharyngeal cavity, which may be very rich in blood-vessels, is the main respiratory area. Observations and experiments have led Lapicque and Petetin to the conclusion that in the Corsican newt the skin plays the essential rôle in the gaseous exchange, and that the bucco-pharyngeal cavity, highly vascular as its walls are, and in spite of persistent pumping movements, has only a secondary rôle, and is insufficient by itself to keep the animal alive.

AN ADAPTATION TO LIFE AT HIGH ALTITUDES.—It is a familiar fact that living at a high altitude puts a strain on the heart, which has more work to do. In this connection it is interesting to notice Strohl's recent comparison of ptarmigan from high altitudes and willow grouse from the plains. He found that in ptarmigan, even in the young bird, the right ventricle of the heart is very distinctly stronger than in the willow grouse,—a specific adaptation to the difference of habitat.

ADAPTATIONS BEFORE BIRTH.—In an interesting account of a large saw-fish (*Pristis cuspidatus*), which was fifteen and a half feet long, Mr. T. Southwell notes that twenty-three embryos were present in the oviducts. As each of these was about fourteen inches long, including a toothed rostrum of five inches, one naturally becomes curious as to the relation of the weapon to the wall of the oviduct. Mr. Southwell points out that, while the dentition on the rostrum was quite apparent, it was "entirely covered by a transparent cartilaginous tissue, which of necessity must disappear later." This reminds one of similar adaptations before birth, such as the finger-stool cushions which Dr. Agar has described over the claws of some unborn Reptiles and Birds.

MYRMECOPHILOUS PUPA.—H. Viehmeyer got from Manila a number of Lepidopterous chrysalids, which were discovered in the heart of the well known hanging earthen nest of the ant *Camponotus quadrisectus*. When the nest was broken the furious ants grouped themselves around the chrysalids (which lay in special cells) as if to protect them. An examination of the chrysalids showed that the anxiety of the ants was far from disinterested, so to speak. At the end of the abdomen there is a chitinous crater into which opens a secretory gland, apparently making a sort of honey-dew. "We have here undoubtedly the peculiar spectacle of a lepidopterous pupa acting as a food purveyor to ants." . . . "It would be very interesting to search further for the reciprocal relationship of the symbionts on the spot, chiefly to find out if the butterflies, when emerging, are not possibly in need of assistance from the ants, as well as to verify the secretion by actual observation."

HORN-FEEDING LARVAE.—August Busck has published two fine photographs of the horns (two feet long) of a water-antelope (*Cobus* sp.) much infested by the larvae of a microlepidopteron, *Tinea vastella*, which had burrowed in the horn and formed numerous projecting tubes. The specimen was picked up on the ground in British East Africa by the Smithsonian African Expedition, under the direction of Col. Theodore Roosevelt. The dark brown tubes, which occur in thick bunches, are about a quarter of an inch in diameter and half an inch to two and a half inches in length. They are made of silk plus earth and chewed horn. They are "closed at their outer end like the fingers of a glove and are connected at their basal end with round holes leading into galleries in the horn, where the larvae found their nourishment."

REVIEWS.

GEOGRAPHY.

A First Book of Physical Geography.—By W. MACLEAN CAREY. 4½-in. × 7-in. Pp. viii + 150. 57 figures.

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

This little book is intended to provide a basis for general geography, by explaining the principles relating to land forms, climate, vegetation, and so on, which control its physical conditions. The requirements of such examinations as the Oxford and Cambridge Locals, London University Junior School, and the College of Preceptors have been specially kept in view. Each chapter is headed by a few suggestions as to practical exercises for pupils to work at before reading the text. Following each chapter comes a series of questions culled from the examinations of the above bodies. The first five chapters are devoted to the morphological aspects of the earth. Meteorology occupies the next eight chapters—a proportion of space justified by the author on the ground that observations on the weather are easily carried out, and form a valuable training in the methods of science. Remaining chapters deal with the sea, the structure and movements of the earth, and the distribution of mankind. In general, the book seems quite adequate to its purpose. The style is simple and clear, the facts as a rule unimpeachable. We do not believe, however, that the tor-scenery of Devon and Cornwall is due to sand-erosion (p. 10). The book can be recommended to teachers who have to train pupils for the above examinations.

GEOLOGY.

Principles of Chemical Geology.—By J. V. ELSDEN, D.Sc., F.G.S. 5½-in. × 8¾-in. 222 pages. 42 figures.

(Whittaker & Co. 5/- net.)

Apart from its own peculiar contributions, such as stratigraphy, geology calls in the aid of many sciences in unravelling the history of the earth. Geology has therefore many boundaries with sister sciences. One of these boundaries is dealt with in the book under review. Dr. Elsden undertakes to indicate the main points of contact between recent chemical and physical researches and the various problems of geological chemistry. The title of the book connotes more, perhaps, than its pages contain. Dr. Elsden deals almost exclusively with the principle of equilibrium in relation to the formation of minerals from solution, and especially to the conditions obtaining in igneous magmas. Under the heading of "Chemical Geology," we are accustomed to put a much wider range of phenomena, such as is covered by Clarke's recent "Data of Geochemistry." This does not detract, however, from the real usefulness of the book. Much work has been done recently in elucidation of the physico-chemical conditions obtaining in rock-magmas and other mineral solutions; and this adds physical chemistry to the number of sciences with which the unfortunate petrographer is expected to be acquainted. He will find all that he wants in Dr. Elsden's book. Herein are treated the subjects of viscosity, diffusion, vapour-pressure and surface-tension, as factors of equilibrium, in their relation to mineralogical and petrological, or as the author prefers to say, geological phenomena. Other subjects dealt with are polymorphism, eutectics and solid solutions, each with their appropriate petrological application. The book is not intended to be a complete exposition of the subject, and is therefore not written for the beginner, but for the mature student. A certain knowledge both of physical chemistry and of petrology and mineralogy is assumed. Its chief value is to the student of petrogenetics who needs a concise manual dealing with physico-chemical theory in relation to petrology. The book has a somewhat wider range than is covered by the chapters on this subject in the recent books of Harker and Iddings. Not the least valuable part of Dr. Elsden's book is the wealth of references to foreign literature. Both author and subject indexes are provided.

The Rocks of Hunstanton and its Neighbourhood.—By J. T. JACKSON. 5-in. × $7\frac{1}{2}$-in. 56 pages. Illustrated. 3 plates and map.

(Premier Press, Ltd. Price 1/- net, interleaved, cloth; 6d. net, paper wrappers.)

This little book is remarkable, if only for the fact that it is the production of a boy of fifteen. "B.L.," who contributes Forewords and Afterwords, tells us something of the author's history and makes an appeal. He says "The author has read little but geology; he talks geology, thinks geology. Given a chance he might make the name of Hunstanton as famous in the annals of the science as now is Cromarty. But the lad needs help if he is to do much. He needs books, a petrological microscope, access to Jermyn Street or South Kensington, and freedom from the necessity to earn his living as a house-painter or attendant on beach chairs." This appeal is well worth sustaining, for the book is an excellent guide, and shews far less immaturity than the age of the author would lead one to expect. It is a work of great promise, and, given the chance, Mr. Jackson will do well in the future. The book is divided into chapters dealing with the various strata, beginning with recent deposits and ending with the Carr Stone (Lower Greensand), the oldest rock in the district. Naturally the famous cliffs and the Red Chalk receive detailed attention. All exposures are indicated, and lists of fossils given. The latter are illustrated in several plates. The work thus forms a very efficient guide to the geology of Hunstanton, and should be in the hands of every geologist visiting this interesting district, for his own sake, as well as for the sake of helping a lad who has thus early shown great aptitude for the science.

University of California Publications. Bulletin of the Department of Geology. Vol. 5. No. 29. pp. 411–437; No. 30. pp. 439–448. 7-in. × 10-in. Illustrated.

(Prices 15c. and 10c. respectively.)

No. 29, by Louise Kellogg, describes the rodent fauna of the Late Tertiary beds at Virgin Valley and Thousand Creek, Nevada. One new genus and eight new species are figured from this rich collecting ground.

No. 30. The Wading Birds from the Quaternary Asphalt Beds of Rancho La Brea, California, are described by L. H. Miller. New species of Ciconia and Grus have been found, together with *Jabiru mycteria* (Lichtenstein), *Grus canadensis* (Linn.), and *Ardea herodias* (Linn.). The fossil forms of these seem to be smaller than their living relatives in the Western Hemisphere.

MEDICINE.

Diseases of the Skin.—By ERNEST GAUCHER; translated and edited by C. F. MARSHALL, M.Sc., M.B., F.R.C.S. 6-in. × 9-in. 460 pages.

(John Murray. 15/- net.)

This book is in the main a translation by Dr. C. F. Marshall of the volume on Diseases of the Skin, written by Professor Gaucher in collaboration with other authorities in the *Nouveau Traité de Médecine*. It gives a very clear account of the subject, and is thoroughly up to date. The illustrations, reproduced from photographs of the actual diseases and from those of wax models in the St. Louis Hospital Museum, are also for the most part excellent.

To the ordinary reader it is probable that the section dealing with the treatment by radium and X-rays will probably appear most interesting. We have heard so much recently of the marvellous curative effects of these agents on cancer of the skin and other organs that the opinion of one of the foremost of French authorities on skin diseases, practising where the radium treatment has been tried more thoroughly than anywhere else, cannot fail to claim attention. This is what Professor Gaucher says: "It is necessary to deal with radiotherapy at some length because it is the treatment in vogue, but it does not appear to me to be notably superior to the older methods of treatment for cutaneous epithelioma" (cancer). The radium treatment is a new treatment, and there is a tendency to expect too much from it. The above quotation from Professor Gaucher's recent work may therefore be usefully remembered by those interested in this subject.

Lessons on Elementary Hygiene and Sanitation, with special reference to the tropics.—By W. T. PROUT, C.M.G., M.B., C.M. (Edin.) $5\frac{1}{4}$-in. × $8\frac{1}{4}$-in. 159 pages.

(Messrs. J. & A. Churchill. Price 2/6 net.)

The subject-matter of this volume takes the form of fourteen lessons which are written in lecture style, and would appear to have been originally delivered at Freetown, Sierra Leone, for examples from this town are constantly recurring in the text. Everything of value, usually to be found in a book of this description, is here included—in particular there is an excellent account of bacteria and the diseases which they cause. But the special feature of the book is the clear description which it contains of the special diseases of the tropics. Thus two lessons are devoted to Malaria, and besides this, sleeping sickness, yellow fever, and many other tropical diseases are fully dealt with. The lessons are exceedingly clearly worded and should be understood by everyone, and the suggestions for preventive treatment are above all things practical. There must be a very considerable need for a book of this kind, and the present volume exactly meets it.

MINING.

First Steps in Coal Mining.—By ALEX. FORBES, M.INST.M.E. 5-in. × $7\frac{1}{2}$-in. Pp. viii + 320. Illustrated.

(Blackie & Sons, Ltd. Price 2/6.)

This book is for the use of pit-lads, from twelve to sixteen years of age, in supplementary and continuation classes, and is intended to give them instruction in the subject of their calling and the rules framed for their safety. After an introductory section, the first eight chapters are devoted to geology, especially such as is necessary to understand the formation and occurrence of coal. In general this is well done, but there is one serious misstatement which calls for correction in any future edition. In the table of formations (p. 91), the Archaean or Pre-Cambrian is made a mere sub-division of the Palaeozoic. The same error occurs in the text. The stratified rocks are divided into Palaeozoic, Mesozoic, and Cainozoic; but the student is not made aware that the Archaean base on [illegible] Palaeozoic, Mesozoic and Cainozoic rest, probably [illegible]sents a longer period of time than these three groups put [illegible]ther. If it were intended to restrict the reference to the [illegible]ssiliferous rocks, then Pre-Cambrian or Archaean might have been omitted from the stratigraphical table altogether. Figure 56 is intended to give an idea of the appearance of a granite, but actually it represents a granite-porphyry, a rock of somewhat different aspect. The remainder of the book is occupied with the technique of coal-mining. The methods of proving, reaching and working the coal, the use of explosives, the means of ventilating and lighting the shaft and workings, the raising and preparation of coal for the market, are expounded in simple language and with the aid of numerous diagrams. Four chapters on elementary chemistry and physics are intercalated in this part, which concludes with a chapter on such miscellaneous subjects as electricity, surveying, accidents, rescue appliances, ankylostomiasis, and baths. The whole of this technical description, in which the author is on his own ground, is excellently done. The style is clear and direct, well suited to the type of boy for which the book is intended. Further points for commendation are the freedom from misprints, and an adequate index. No better book could be taken up in the supplementary and continuation classes in which pit-lads receive some training in the principles underlying their work, and we agree with the remark in the preface that such instruction tends to reduce the deplorable number of fatal and serious non-fatal accidents in the mines.

The Bearing of Recent Theories on the Nature of the Earth's Interior upon the Question of Deep Mining.—By Professor E. H. L. SCHWARZ, A.R.C.Sc., F.G.S. *South African Journal of Science, April, 1910*, pp. 234–241.

(South African Association for the Advancement of Science.)

This paper is really a condensation of the author's daring speculations on the nature of the interior of the earth which were more extensively developed in his *Causal Geology*. He is a whole-hearted supporter of Professor T. C. Chamberlin's Planetismal Hypothesis. The earth's crust is believed to be self-heating by means of various chemical reactions, radium, and frictional heat, and is supposed to rest on a solid nucleus which is probably near the temperature of outer space. On this theory the temperature gradient in the crust will increase downwards until a certain limit is reached, and beyond that there will be a decrease. The author finds confirmation for this idea in the low temperature gradients of South Africa, an ancient denuded region (the stalk end of Jean's pear-shaped globe), which has not been covered by the sea for an immense period, and therefore represents as deep a part of the crust as can be got anywhere on the earth. In view of the above theory, the old objection to deep-level mining on the score of temperature is disposed of—in South Africa, at any rate. Whilst we do not endorse many of the ideas contained in this paper, it is interesting to find the problems of the earth's interior and origin so fully and freshly discussed in South Africa.

PHYSICAL CHEMISTRY.

The Relation between Chemical Constitution and some Physical Properties.—By SAMUEL SMILES, D.Sc. pp. xiv. + 583. Crown 8vo. $7\frac{3}{4}$-in. × $4\frac{3}{4}$-in.

(Longmans. 14/-.)

This book forms one of a series edited by Sir William Ramsay, of which ten volumes have already appeared, while four more are announced as in preparation. The immense development of the Physical side of Chemistry in recent years is remarkable, and Dr. Smiles' book is itself a mine of information about the work done in certain directions, which it would be difficult to obtain from the original sources for any chemist who did not know exactly where to look. As the author points out in his preface, the relations between constitution and optical rotation, electric conductivity and heat of combustion are dealt with in other volumes of the series. Crystalline form has been omitted as requiring a volume to itself. But the student who wishes a statement of the present state of knowledge on the relation of chemical constitution to capillarity, viscosity, specific heat, volume, fusibility, boiling point, refractive and dispersive power, absorption, fluorescence, magnetic rotation, and electric absorption, will find in this book abundant information, with many references to the original sources. The author is careful to state that he has written from the standpoint of the organic chemist.

A Text-book of Physical Chemistry Theory and Practice.—By ARTHUR W. EWELL, Ph.D. pp. ix. + 370. $8\frac{1}{2}$-in. × $5\frac{1}{2}$-in.

(J. and A. Churchill. 9/6 net.)

This book is written for American students who have been through the College course of elementary physics, chemistry, and mathematics. It will serve as a laboratory manual, and a book of reference. The ground covered is very wide, and the text is intended to be supplemented by lectures; but the business-like brevity and conciseness of the statements and explanations show the hand of an experienced teacher, and we can imagine the book proving extremely useful to an English student who wishes to revise old work, at the same time that he is continuing his laboratory practice. The range of the book may be gathered from the statements that it contains sixty-three tables, that the subject matter ranges from the use of the balance to radioactivity, and that sixty experiments and twenty-nine collections of problems are included.

Physical Chemistry: its bearing on Biology and Medicine.—By JAMES C. PHILIP, M.A., Ph.D., D.Sc. pp. vii. + 312. $7\frac{1}{2}$-in. × $4\frac{3}{4}$-in.

(Edward Arnold. 7/6 net.)

This book is intended for students of biology and medicine who wish to obtain a grasp of the fundamental principles underlying the application of the methods and ideas of physical chemistry to physiological and biological problems. It has grown out of a course of lectures delivered to such students in the University of London, and appears admirably adapted for its purpose. Naturally stress is laid on such parts of the subject as osmosis, permeability of membranes, colloidal solutions, etc., which have a special bearing on the problems in question, and the treatment is, as far as possible, non-mathematical. The style is clear and easy.

PHYSICS.

Wonders of Physical Science.—By E. E. FOURNIER, B.Sc. 7-in. × $4\frac{1}{2}$-in. Pp. viii. + 201. 77 Illustrations.

(Macmillan & Co. Price 1/6.)

This is one of a projected Series of Readable Books in Natural Knowledge. To quote from the publishers' note "An intimate knowledge of the simplest fact in Nature can be obtained only by personal observation or experiment . . . but broad views of scientific thought and progress are secured best from books in which the methods and results of investigation are stated in language which is simple without being childish." In this little volume, which is intended to promote interest in physical science, there are seventeen chapters, each of which contains a bright and brief history of some important discovery. The chapters on Archimedes, Dr. Gilbert, the Air Pump and the Electric Telegraph strike us as particularly fresh, and indeed the whole book is admirably suited to its purpose. In the chapter on Arabian Days we find no reference to the Arabic numerals which have made physical calculations possible; and perhaps more might have been made of Faraday's life and example in the chapter which is headed by his name. The final chapter on Airships and Flying Machines is somewhat unnecessary in a book of this kind.

ZOOLOGY.

Threads in the Web of Life.—By MARGARET R. THOMSON and J. ARTHUR THOMSON. 4¾-in. × 7-in. 198 pages. 72 figures.

(Macmillan & Co. Price 1s. 6d.)

"*Threads in the Web of Life*" belongs to the same series as the book last noticed, and, like it, is intended to promote an interest in science in a way quite different from laboratory guides, text books, or works of reference. Our readers have been long familiar with the fascinating way in which Professor Thomson is able to put his facts before us, and in the production of the little volume under consideration he has successfully collaborated. The book is very skilfully planned to suit its special purpose. It begins with an account of man as a hunter, which must appeal most strongly to the interest of the reader, and proceeds through the consideration of domesticated animals which are well known and of value to man, to the flesh-eating forms with which he has had to struggle, and those that destroy his crops. The balance of nature, which it is so important not to upset, comes in for attention, and as an instance of the scientific spirit which leads men to devote their lives to the advancement of natural knowledge, Pasteur and his work, are considered. This "readable book in natural knowledge" is one from which every nature student should obtain inspiration and new interests.

QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are printed on this page.

13. THE FINDING OF TIME AT NIGHT.—F.R.A.S. asks whether he may repeat Question 2, which is as follows:—Without instruments, books, or knowledge of the compass bearings, how can time be found approximately at night? The substance of it is asked of boy scouts who desire to obtain the Star Badge of Astronomy; as it seems a question which would be more suitable for University examinations and is unfair to boy scouts it would be interesting to learn what answers our readers would give.

14. SIGHT AND HEARING.—Which is the quickest, sight or hearing?

F. P. H.

15. EARTH TIDES.—Has any account appeared other than that of Mr. Hardcastle in the September number of "KNOWLEDGE" of Dr. Hecker's work? I am anxious to follow up the subject and should be grateful for any information.

T. E. HODGKIN.

16. STAR ATLAS.—The enquirer would be glad to know if any amateur astronomer could refer him to a simple and reasonably priced Star Atlas giving particulars of the R.A. and Dec. of the principal objects of interest in the constellations visible in the northern hemisphere. Owing to short sight and the usual unsatisfactory atmosphere, the writer finds some difficulty in picking up the various objects from "Serviss's Pleasures of the Telescope." The difficulty would be almost entirely overcome if the book referred to gave declinations only, as with an equatorial with a declination circle it is a fairly simple matter to find an object, knowing the constellation in which it should be. The ideal atlas for the amateur having a telescope with or without divided circles should satisfy the following main requirements:—

1. Portability for use outdoors and fairly large print.
2. Whole page map of each constellation with small portion of the surrounding constellations, the map being as near as possible to the descriptive matter.
3. Each constellation to be shown and described in the rotational order in which it becomes visible.
4. The R.A. and Dec. and short pithy descriptions of each sufficiently important object of interest.

REFLECTOR.

17. METEOR AT HONOR OAK.—On September 19th, at exactly 11 p.m., at Honor Oak Park, a magnificent Meteor of a yellowish tint travelled in direct line from N.E. to S.W. leaving a fairly developed tract along the entire line. Radiated almost directly under Cassiopeia, took four seconds from appearance to disappearance. Any other information would be interesting. Brilliance, double that of Jupiter at his best.

W. B.

18. STARS BY DAYLIGHT.—On page 63 of Sir John Herschel's "Treatise on Astronomy" he states that stars are visible by daylight from the bottom of a deep narrow pit, such as a well or shaft of a mine.

Professor Maunder in "Astronomy without a Telescope," page 240, mentions this assertion of Sir John's, and suggests that a first-hand scientific testimony of an observer is still to seek: by scientific testimony meaning the day, hour and minute when the star is seen, the latitude of the place, the depth of shaft and the breadth of its mouth. Professor Maunder says, "There must be not a few . . . who could report 'I have seen such a star at such a time,' or 'I have watched for such a star at the time of its transit across the zenith on so many occasions . . . and could see nothing'."

19. THE PLANET NEPTUNE.—Would any of our friends who are fond of the study of Astronomy and follow the orbital motion of the Planets kindly inform me if the calculations with regard to the orbit of Neptune agree with those made shortly after the discovery of the Planet in 1846. The distance given in the various books on Astronomy is so much at variance with the "formula of Bode" that it does not seem to follow the order of the other Planets. The distance of Jupiter to Saturn is almost double; again, the distance of Saturn to Uranus is almost double, but that of Uranus to Neptune does not bear anything like the same proportions.

W. C. DIXON.

20. THE DISTANCE OF THE EARTH FROM THE SUN.—Would some reader inform me if a reward has ever been offered for the discovery of a more accurate means of determining the distance of the Earth from the Sun than by the observation of the transit of Venus, or by means of the minor Planets? Professor Newcomb, says:—"As we before observed we cannot ascertain the distance of the Earth from the Sun within a few hundreds of thousands of miles." Sir R. Ball, says:—"These circumstances make it difficult to determine the distance of the Sun from observations of the transit of Venus with the accuracy which modern science requires. It seems therefore likely that the final determination of the Sun's distance will be obtained in quite a different manner." Sir R. Ball, also says:—"The transit of Venus cannot be described as a very striking or beautiful spectacle. It is not nearly so fine a sight as a great comet or a shower of shooting stars. Why is it then that it is regarded as of so much scientific importance? It is because the phenomenon helps us to solve one of the greatest problems which has ever engaged the mind of man. By the transit of Venus we may determine the scale on which our solar system is constructed." When it was considered desirable to ascertain a correct mode of ascertaining the longitude at sea a large reward was offered; surely the distance from the Sun, on which all the other data are based, is a matter of great interest to the scientific world and should be worthy of a like reward.

W. C. DIXON.

REPLIES.

SCIENTIFIC IDEAS OF TO-DAY.—There are probably many readers who will sympathise with the difficulty experienced by your correspondent "Perplexed." The truth at the present time is that hardly anything is known for certain about the *formations* of the radiating systems associated with the atoms and molecules of a body reflecting light.

The complexity of optical phenomena calls for the detailed investigation of special cases before it is possible to do more than generalise. The problems of radiation are now in the process of solution, and such notable advances as the discovery of the Zeeman effect are gradually throwing some light on the question of the forms of orbital or other motion performed by the radiating electrons; but there is a very great deal to be done before any definite statement of what occurs in special cases can be made with safety—until then only the most comprehensive generalisations are possible.

The formation of mental pictures of the processes involved in the radiation and reflection of light is a great help to understanding them, but, in the present state of our knowledge, such pictures must not be too definite and rigid; there must be ample room for modification. I am sure that the author of *Scientific Ideas of To-Day*, will agree with me that we cannot yet form any adequate idea of the motions performed by the electric charges in a body which is reflecting light. The book in question, being a popular treatise, contains some forceful, and, I think, skilful descriptions and analogies. The temptation in writing such a work is probably towards too definite a form of statement, but where emphasis and simplicity of illustration are essential in order to make the subject as clear as possible to readers who have no special scientific training, it is hard to see how this can be altogether avoided. Personally, I would congratulate the author on his generally successful attempt to accomplish an admittedly difficult task.

To turn to the special difficulty mentioned by your correspondent, I will point out that in the case of solids we have to deal with more or less complex molecular aggregates. The effect of increased temperature in many cases is to modify and partially break down such groupings into simpler forms. The selective reflection of incident waves of any particular frequency seems to depend on what may be termed the "laxity" of the electron system in the reflecting body.

Stated somewhat crudely, the question becomes one of the natural period of oscillation of the electric charges within the complicated molecular groupings as related to the periods of the mixed incident radiation. If, now, we break down or otherwise modify these molecular aggregations, the "tuning" of the whole system is altered, and the freedom of excursion of the receptive electrons is affected either on the side of increased or decreased frequency. We do not know in such cases the distribution and subsequent redistribution of the restraining forces which come into play in controlling the movements of the electrons, and the acquisition of such knowledge is one of the problems for future science to endeavour to solve. In the case under consideration—the double iodide of mercury and silver—I would put the matter thus:—Increase of temperature to about 110° F. results in partial dissociation of the molecular groupings which were characteristic of this compound at normal temperatures. As a result, a different electron system or arrangement is instrumental in the selective reflection of light, in this case the period being longer.

I venture to think that we can form a more definite conception of the probable interior structure of an atom as made evident by the phenomena of radio-activity, than we can of that particular radiating portion of it which is responsible for the emission of light-waves, or of the complex groupings of the electrons bound up in molecular aggregates on which selective absorption and reflection depend. The electro-magnetic theory tells us this:—That light (and similar radiation) is due to electro-magnetic disturbances, periodic in space and time, propagated in the ether of space, and that these waves are originated by the oscillation of electric charges about a mean position, or position of equilibrium within the radiating body. From such a broad generalisation, science is proceeding to the investigation of special cases. A host of facts have to be embraced in any future theory of optics which claims an approach to completeness, but the work already done is a splendid testimony to the zeal and skill with which the subject is being investigated, and to the success with which the enquiry has so far been attended.

CHARLES W. RAFFETY, F.R.A.S.

10. WATER AND ITS OWN LEVEL.—Things are said to be on the same level when they are equally distant from the centre of attraction of the earth. The radius of the earth is so large that such things appear to lie in a plane instead of on a curved surface, and hence a small surface of water appears to be flat, and the curvature is only seen on a large extent of surface, such as the ocean.

A. T.

NOTICES.

A PICTORIAL BAROGRAPH CHART.—Mr. John Browning has published a new form of chart for the barograph. It is printed in colours, and pictures of clouds have been introduced with such pleasing effect that a greater interest will, no doubt, be taken in barometrical records if made with its help.

BRUSSELS EXHIBITION AWARDS.—Among the scientific instrument makers who have received awards at the Brussels International Exhibition we notice that Messrs. Adam Hilger, Ltd., obtained a grand prix for spectroscopes and spectroscopic apparatus, and Mr. J. H. Steward a grand prix and gold medal for surveying and military instruments.

THE CAMBRIDGE POCKET DIARY.—We have received a useful little diary from the Cambridge University Press, which covers the period of the academical year, namely from September 20th, 1910, to the end of December, 1911. On one side of the page information useful to members of the University is given, and the price in roan, limp, with gilt edges, is one shilling. A larger diary is also published, each sheet of which, measuring ten inches by eight inches, contains seven days, and the price is one shilling net.

NATURE-STUDY LANTERN SLIDES.—We are pleased to notice the series of slides made by Mr. Holmes, of Rochester, of which he has submitted a number to us. They illustrate trees and their life-history, mammals and birds' nests and many British plants. The slides are really excellently turned out and the only criticism that we may offer is that the parts of plants, at any rate, are too large, and remind one of crowded plates rather than nature photographs. We would suggest that the effect would be better, and greater justice done to the photographs if a little more margin were left.

LEWIS'S CIRCULATING SCIENTIFIC LIBRARY.—We have received from Mr. H. K. Lewis, 136, Gower Street, W.C., a copy of the list of new books and new editions added to the library during July, August, and September, and find, as usual, that it includes every book of any importance published during that period. We have previously called the attention of readers of "KNOWLEDGE" to the great utility of this library, providing access, as it does, to all books on scientific subjects for a comparatively nominal subscription. The list also affords a valuable means of selecting scientific books for purchase, as it gives full particulars of each one, together with the published price and postage. It is sent post free on application.

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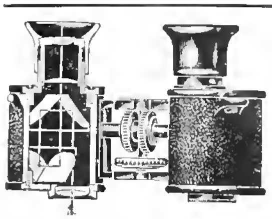

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