THURSDAY, SEPTEMBER 21, 1905.

THE EVOLUTION OF MATTER.

L'Evolution de La Matière. By Dr. Gustave Le Bon. Pp. 389. (Paris: Flammarion, 1905.) Price 3.50 francs.

DR. GUSTAVE LE BON has written many books. Some twenty volumes, besides papers in current scientific periodical literature, have issued from his pen. History, travels, tobacco-smoke, anthropology, horsemanship, and psychology have in turn attracted his sympathetic interest.

The work before us sets forth Dr. Le Bon's theories of matter and energy, and contains, in a small-print appendix, an abstract of the experimental evidence on which he is content to rest those theories.

According to the author, matter itself is merely a form of energy—probably vortex energy in the luminiferous æther. Matter disintegrates—spontaneously in radio-active substances, but also under the influence of certain agencies such as heat or chemical action, which are compared with the spark that fires a barrel of gunpowder. After giving rise to "les produits de la dématérialisation de la matière: ions, électrons, rayons cathodiques, &c.," all things finally pass into "l'élément immatériel de l'univers: l'Éther." By the dissociation of matter, energy is transformed, and "c'est de l'énergie intra-atomique libérée par la dématérialisation de la matière que dérivent la plupart des forces de l'univers."

The chief experimental evidence on which Dr. Le Bon relies may be grouped under two heads:—(1) the emission of negatively electrified particles by metals when incandescent and when subjected to the action of ultra-violet light; (2) the slight radio-activity which may be detected in ordinary materials.

The emission of negative corpuscles from metals under the influence of heat and light undoubtedly occurs, though it is not to the author's speculative opinions that we owe the experimental demonstration of the fact. As a speculative hypothesis, the idea that the corpuscles are emitted during the disintegration of the atoms of the metal is perhaps worth bearing in mind. But, on a review of the evidence known at present, it seems unlikely that the removal of these slow-moving negative corpuscles results in the instability of the atom from which they are derived. There is no evidence that an electric discharge through a gas produces new elements, while the ions of liquids and gases, which result from the removal of the corpuscle, again yield the original atom when neutralised. Such processes are to be distinguished sharply from the irreversible changes which occur in true radio-activity, when bodies of atomic mass (α rays) or fast-moving corpuscles (β rays) are projected. In this case, new chemical substances always appear, and the process seems to be unaffected by heat, light, or any other physical or chemical agency. This essential distinction is not noticed by Dr. Le Bon, who assumes that the production of a corpuscle is itself a proof of atomic disintegration.

The author claims that he was the first to show that radio-activity is a universal phenomenon, not confined to a few substances:—

"Mon premier mémoire sur la radio-activité de tous les corps sous l'action de la lumière a paru dans la *Revue Scientifique* de mai 1897. Celui sur la radio-activité par les actions chimiques a été publié en avril 1900. Celui montrant la radio-activité spontanée des corps ordinaires a paru—toujours dans la même revue—en novembre 1902. Les premières expériences par lesquelles les physiciens aient cherché à prouver que la radio-activité pouvait s'observer avec des corps autres que l'uranium, le thorium et le radium n'ont été publiées par Strutt, McLennan, Burton, &c., que de juin à août 1903."

We may first notice that Dr. Le Bon classes the effects of light under the head of radio-activity. This, it may be argued, is a matter of definition, and the author is at liberty to give a meaning to the word radio-activity different from that adopted by all other physicists. But it is well to point out that many experiments on the electric effects of the incidence of light on metals had been made before the year 1897, notably by Elster and Geitel between 1889 and 1895. Dr. Le Bon may have been the first to suggest that the effects were due to the emission of particles, but no conclusive evidence was obtained until the experiments of J. J. Thomson and Lenard, in 1899, had determined the ratio of the charge to the mass, and identified the particles with those found in kathode rays.

Secondly, doubt has been thrown on the emission of rays by substances undergoing chemical action by the recent experiments of Mr. N. R. Campbell, who has traced some, at all events, of the effects to secondary causes connected with the heat of reaction. Here Dr. Le Bon does not seem always to separate clearly the ionisation which may be produced in a gas by contact with substances undergoing chemical change, and the emission of radiations, more or less penetrating, characteristic of true radio-activity.

Thirdly, in examining the spontaneous radio-activity of ordinary materials, the author seems to underestimate the effect of the minute traces of radium which are now known to be distributed widely. He claims Prof. J. J. Thomson's experiments on the emanations emitted by various natural substances and underground waters as a confirmation of his view that all matter is radio-active. Now, Thomson found that the rate of decay and the phenomena of excited activity in those emanations which he examined closely were about the same as those of the radium emanation, and his experiments should be regarded as an indication of the prevalence of radium rather than of the radio-activity of ordinary materials. It is true that further experiments by Thomson, Cooke, Campbell, Wood, and others have now made it probable that ordinary metals, at all events, are slightly radio-active. But, to eliminate the effects of strongly radio-active impurities, it is necessary to take the utmost precautions, both in the experiments themselves and still more in the interpretation of the results. There seems little evidence that, in either respect, Dr. Le Bon recognised the necessity of such precautions.

It will be gathered that the author takes a point of view which is not that of the majority of physicists who have investigated these subjects. Revolutionary opinions may prove a valuable tonic to the orthodox in physics as in other matters. It is not because he is heterodox that we are not satisfied by Dr. Le Bon's book. It is because he seems to us to fail in grasp of the subject, to confuse phenomena which are essentially different, and to be blind to evidence which does not support his hypotheses.

A belief in the evolution of matter is fast becoming not only possible but inevitable. Dr. Le Bon has written readable speculations about that evolution, and here and there has thrown out an interesting idea; but the evidence on which that belief must be founded is not that put forward by him. His book calls to mind the advice offered by a famous Lord Chief Justice to a brother judge, that it was sometimes safer to give one's conclusions without the reasons which had led to them.

W. C. D. W.

THE FÆRÖES AND ICELAND.

The Faeröes and Iceland; Studies in Island Life. By N. Annandale. With an appendix on the Celtic Pony by F. H. Marshall. Pp. vi+238; illustrated. (Oxford: Clarendon Press, 1905.) Price 4*s.* 6*d.* net.

THE name of Mr. Nelson Annandale has been of late years so intimately associated with the Malay Peninsula and its zoology and ethnology that it comes somewhat as a surprise to find it on the title-page of a work dealing with such totally different surroundings as those of the Færöes and Iceland. It appears, however, that between the years 1896 and 1903 the author spent several summer holidays in these remote islands, and contributed a series of articles on his experiences to *Blackwood's Magazine* and the *Scotsman,* and that it is these delightful articles, in a more expanded and elaborated form, with the omission of certain purely technical details, which form the basis of the work before us.

As Mr. Annandale suggests in his opening chapter, most persons probably regard the Færöes as little more than mere Arctic rocks, teeming with sea-birds, in the ocean; and they will accordingly be surprised to learn that, as a matter of fact, although lying nearly a couple of hundred miles to the north-west of Shetland, they enjoy a climate warmer than that of many parts of Scotland, while their vegetation, if rarely more than a few inches high, is as luxuriant as the shallowness of the soil and the winter storms will allow. The buttercups, too, seem larger, and the bushes of a brighter green, than on the mainland. These islands have also to be regarded as desirable spots, for it appears that although a few years ago they possessed a couple of dozen policemen, the *moral* of the population has been so excellent that the services of these guardians of the peace were found no longer necessary, and the force has consequently been disbanded. A truly remarkable record!

The first two chapters deal with the people of the Færöes and their mode of life, and will be found to contain a number of interesting observations on their ethnography and the implements of the islanders. The invasion of Iceland by the Moors in the seventeenth century forms the subject of a third chapter, but perhaps the most interesting part of the whole book is that dealing with the wonderful bird-cliffs of the Westman Islands, and the clever manner in which the natives capture puffins and other birds in nets. The fulmar appears, indeed, to be very valuable to the Westmaners, supplying them with both food and light. Other chapters deal with Iceland and its products, and the insects and domesticated animals of both that island and the Færöes.

Mr. Annandale deserves, indeed, our most hearty congratulations, and has succeeded in producing a most admirable little work which may be perused with interest alike by the general reader and by those who have enjoyed, or expect to enjoy, the opportunity of visiting the islands he so happily describes. Whether similar congratulations should be extended to Dr. Marshall for his share of the work we are not fully assured. That gentleman seems, indeed, to be under the impression that no one save Profs. Ewart and Ridgeway has written in this country on the origin of the horse. Otherwise he would have scarcely credited the former with being the first to regard Przewalsky's horse as a variety of *Equus caballus.* Neither would he have omitted to notice that an earlier name than *przewalskyi* has been suggested as referable to this animal, and also that Prof. Ewart's *E. celticus* is probably inseparable from the earlier *E. hibernicus.* Moreover, he might have pointed out that it is difficult to understand how Prof. Ridgeway's new name of *E. c. libicus* can stand for the barb, when the Arab horse has long since received a technical name of its own.

R. L.

OUR BOOK SHELF.

Le Système des Poids, Mesures et Monnaies des Israélites d'après la Bible. By B. P. Moors. Pp. 62+1 plate of figures and 6 tables. (Paris: A. Hermann, 1904.)

THE first part of this work consists of an inquiry respecting the numerical value adopted by the Israelites at the time of Solomon for the constant π, the ratio of the circumference of a circle to its diameter. M. Moors obtains the greater part of his material for this investigation from the dimensions of the "molten sea" in Solomon's temple, as stated in I. Kings, vii., 23–26, and II. Chronicles, iv., 2–5. These dimensions have led some writers—notably Spinoza and Hoefer—to the opinion that the Israelites knew of no nearer approximation to π than the whole number 3. The specification of the molten sea is not, however, sufficiently complete to determine its shape with any degree of certainty. Some commentators have considered it as cylindrical, others have followed Josephus in ascribing to it a hemispherical form, whilst Zuckermann suggests a combination of cylinder and parallelepiped. The author of this work, who is firmly of opinion that the Israelites accepted a value for π very close to 3·142, has found it necessary in support of his argument to assume that the molten sea had the form of a lipped cylinder. Adopting the description given in I. Kings, which differs somewhat from that of II. Chronicles, M. Moors has deduced for the cubic contents of the *bath*, a measure of capacity frequently met with in the Old Testament, the relation

$$1 \text{ bath} = \tfrac{1}{6} \text{ (Mosaic cubit)}^3.$$

The remainder of the work deals with the system of weights, measures, and coinage in use among the Israelites. Carefully disclaiming any bias in questions theological, he adopts the Bible as the chief authority on the subject of which he treats. The weights and measures mentioned in the Bible are not, however, always very clearly defined, and in attempting to combine them in a homogeneous system we are confronted with apparently hopeless inconsistencies. Owing to this difficulty M. Moors finds it necessary to have recourse to materials of somewhat incongruous character. From a strange medley of midwives, manna and mummies, he evolves, with much ingenuity, a series of metric equivalents for the weights and measures of the Israelites. He claims that his equivalents are confirmed by all those passages in the Bible which contain references to weights and measures. It is interesting to note that his value for the length of the cubit, viz. 443·61 millimetres, agrees very closely with the value obtained recently by Sir Charles Warren (17·64 inches, = 448·05 mm.).

It is hardly possible to accept the view of M. Moors that the Bible was intended *inter alia* as a text-book on mensuration. In spite of his laudable effort to throw light on the old Hebrew weights and measures they still remain dim to us. In the region of metrology the Israelites would indeed appear to have baffled the commentator, and to have buried their authoritative standards "deeper than did ever plummet sound" out of the excavator's reach.

So far as we have checked the numerical calculations made by M. Moors, we have found them invariably accurate. There is, however, an obvious misprint in the last line of his letterpress; "43·5" should read "43,500."

A Primer on Explosives. By Major A. Cooper-Key. Edited by Captain J. H. Thompson. Pp. xii+94. (London: Macmillan and Co., Ltd., 1905.) Price 1*s*.

THIS little book should prove of great value to those for whose benefit it has been mainly written, viz. the local inspectors under the Explosives Act, and those dealers whose trading necessitates the handling and storage of explosives.

No one can better realise the want of some little handbook on the subject than H.M. Inspectors, and it is to meet this want that Major Cooper-Key has written this useful book, which, it is pointed out, is "not a treatise on explosives." The author gives a short description of the manufacture of the chief explosives, but its great value will be found in the sections devoted to special risks with each class, the methods of packing and storing, and a particularly useful chapter on the general construction and management of a store, the destruction of explosives, &c.

It is certain that a careful study of the book by local inspectors will lead to a better understanding of the whole question of explosives and the Act generally, and hence to a more intelligent performance of their responsible duties. For those traders and users who have the handling of these goods after they have left the manufactory the book should be equally valuable, and it should do much to lessen the risk of those untoward accidents which occur from time to time, generally from ignorance of the properties of the bodies dealt with. J. S. S. B.

A Note-book of Experimental Mathematics. By C. Godfrey and G. M. Bell. Pp. 64. (London: Edward Arnold, 1905.) Price 2*s*.

THIS book gives concise instructions for carrying out a number of simple quantitative experiments in mechanics. It is specially suited for students who intend to sit for Army Entrance Examinations, but the excellence of the course outlined renders the book very serviceable for general use in schools; the students get accustomed to fundamental methods of measurement, obtain concrete conceptions of elementary science, and secure much data well adapted to serve as examples and illustrations in a course of practical mathematics. The experiments include measurements of lengths, areas, volumes, weights, specific gravities, fluid pressures, forces, moments, velocities, accelerations, and many other physical quantities. A full and careful list is given of the requisite apparatus and fittings, and the book will be of very great assistance to teachers in the arrangement of a thoroughly sound elementary course of experimental science.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Cause and Prevention of Dust from Automobiles.

THE article on the above subject in the issue of NATURE for September 14 (p. 485) is an important contribution to a subject of great interest and importance to the community, but it contains a statement with reference to tar-macadam which in the interests of engineers should, I think, be verified. Speaking of "Tarmac" the writer says, "the slag is thoroughly impregnated, so that if the pieces are broken further a tarred surface is still found."

I have examined many specimens of tar-macadam, including "Tarmac." I have never found any sign of penetration of tar. I am aware that some believe in this alleged penetration, but it seems to be obvious that any material sufficiently porous to enable tar to saturate it would be totally unfit for road-making.

That tar-macadam, and, of course, "Tarmac," have virtues for motor road-making may be admitted; but this penetration theory is not the reason, and it is a pity that the myth should still exist, as it tends to prevent the trial of other substances far more suitable for roads than furnace slag.

The reason why tarred granites and similar hard stones have not hitherto been found so effective is entirely a matter of surface adhesion. Given a suitable tar mixture, there is no reason why hard, non-porous stone should not be as efficient as slag. Penetration has nothing to do with it. J. VINCENT ELSDEN.

38 St. Stephen's Gardens, Twickenham.

IN reply to Mr. Elsden, I agree that it is of no use to hold mythical views. I think, however, that he is really mistaken in his views that the slag in "Tarmac" is not penetrated by the tar. Possibly it may not be penetrated by the most viscous constituents, but upon examining a broken piece of "Tarmac" I have found that the surface is distinctly darker than that of slag which has not been treated. The difference is very noticeable under the microscope, and if a bit of slag from the interior of a treated portion is heated the tar is readily seen, which fact appears to be conclusive evidence that penetration by the tar takes place. I do not, however, suppose that the penetration is very uniform, as slag is not a very uniform material, and therefore in some parts the effect might not be so evident. W. R. COOPER.

82 Victoria Street, S.W.

THE SOLAR PHYSICS OBSERVATORY ECLIPSE EXPEDITION.

Innsbruck, September 12.

SINCE my last letter, which was dated August 26, I have had so little time for writing that I take the first opportunity to record the events that followed

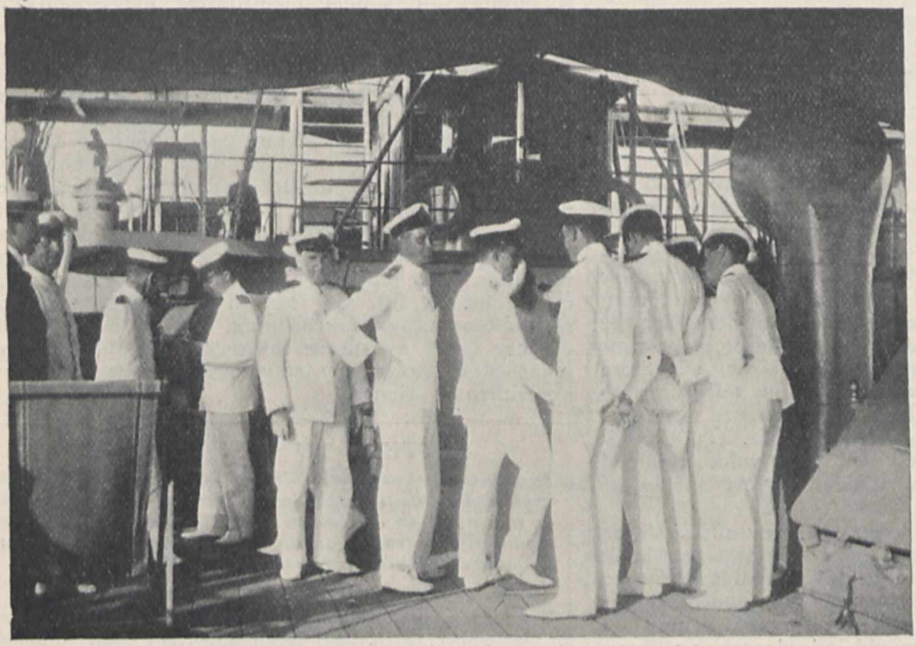


FIG. 1.—The officers of H.M.S. *Venus* volunteering for eclipse work on the quarter-deck.

the last communication. Passing over August 28 and 29, which were spent in giving the final touches to the various instruments, putting in the eclipse mirrors, and in rehearsing, we come to the eclipse day itself. Turning out at 5 a.m. and scanning the sky, a glance showed that clear weather conditions for eclipse time were very doubtful. Heavy black clouds were sailing majestically across the zenith, and still blacker ones were slowly moving nearer the horizon. There were, however, small breaks here and there where blue patches were exposed for brief intervals, but it seemed that the chances for a clear eclipse were very small.

It was not long, however, before many of us reached our camp. Rain had fallen about 4 a.m., and at about 6 a.m. another shower helped still further to lay the dust, which had proved such a menace to the smooth working of the clocks. The previous evening all dark slides had been carefully filled and noted with their particular make of plates, and these now were distributed to the different workers.

Fortunately we were working in an area enclosed by a wall, so that only those who had received special permission could enter. Needless to say, invitations were numerous, and included the majority of those who had helped us in various directions during our preparations.

At the time of first contact, clouds near the region of the sun were very few, and we observed this under excellent conditions. As time progressed, a great bank of clouds was seen gradually working its way along from the west, and it became a race between the clouds and the moment of second contact, *i.e.* the beginning of totality. The diminishing crescent became smaller and smaller at about the same rate as the clouds over the sun became thicker and thicker. The clouds won! The moment of second contact could not be observed! We went, however, through our programmes, knowing that we were photographing nothing. Venus became a brilliant object in the west seen through a break.

6-inch prismatic camera. 16-feet coronagraph tent. The tent of Lieut. Horne (Commandant of Camp) and myself.

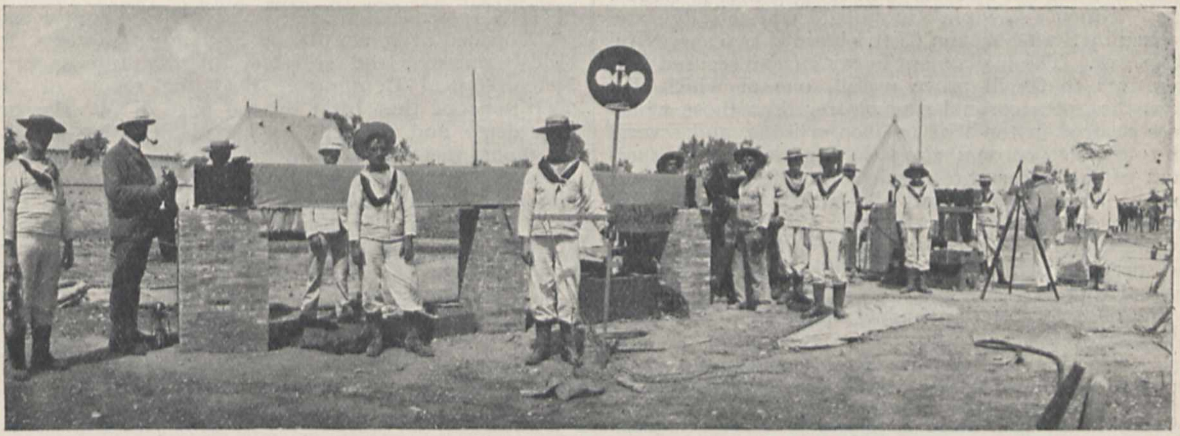
FIG. 2.—Visitors being shown round the camp on the day before the eclipse. Looking west.

Fortunately there were two currents of air at work in the upper regions, one coming from the south and the other from the west. This intermingling of currents was possibly the cause of the thinning of the clouds over the sun, and gave us a view of the corona for brief intervals through, as it were, a thin veil; the clearest intervals were towards the end of totality. The burst of sunlight from the north-west limb of the sun heralded the end of totality, and thus ended the work of the instruments and the greater majority of the different parties.

We were all, however, bitterly disappointed. So much trouble had been taken to make everything work with the maximum of efficiency, but, alas! with so small a result. Prismatic cameras of high dispersive power and prismatic reflectors of long focal length, to say nothing of long-focus lenses for three-colour negatives, are not conducive to good results in a cloudy sky!

During the few moments that were available between the exposures of the different plates in my instrument I saw enough of the corona to know what a magnificent sight it would have been had it been seen in a cloudless sky. The enormously brilliant red prominence in the north-east quadrant was an undoubted feature of this eclipse, and nothing like it was seen by me in either the 1898 or 1900 eclipses. From several accounts the landscape was illuminated by this red radiating object, and sunset effects were recorded by other observers.

The corona itself was of the maximum type, streamers radiating in all directions even very near the poles. At the north pole there was a region displaying the beautiful rifts seen at best during eclipses at a minimum stage, but at the southern pole no such distinctive structure was seen. Unfortunately the eastern and western limb of the sun were shrouded in thicker haze than the north and south region at the time that I had my longest glance. It was therefore about the solar poles that the longest streamers were seen by me, and two in the south-east quadrant extended for at least two solar diameters.



Mr. F. McClean. De la Rue coronagraph behind the men. Grating spectrograph. Mr. Howard Payn.

FIG. 3.—Taken after the beginning of first contact. The tents over the instruments have all been removed. The 16-feet coronagraph, with Mr. F. McClean and his naval staff.

The eclipse being over there was then nothing more to do than to collect all the photographic plates exposed and commence with the packing up of the instruments. It is one thing to set up the instruments and another to take them down. By the evening of the same day about 50 per cent. of the packing up had been completed.

Siderostat. Tube of 6-inch prismatic camera. Packing cases supporting small cameras with gratings. Cusp telescope. Three-colour camera in distance.

FIG. 4.—The 6-inch prismatic camera, showing staff and positions for the small grating cameras and the cusp telescope.

In the cool (?) of the evening the development of the plates was commenced. Those which promised to have some kind of record on them were taken first. To sum up the results, now that the whole set has been developed, it may be said that we have been far more fortunate than was at first anticipated. The prismatic reflector worked by Mr. Butler succeeded in securing an excellent picture of the lower corona, the solar diameter being about $8\frac{1}{8}$ inches. The 16-feet coronagraph operated by Mr. F. McClean obtained a fine photograph of the corona with excessively sharp detail and good extension. The De la Rue coronagraph in charge of Lieut. Trench, R.N., was fortunate enough to secure three negatives, all of which will be very serviceable, as the focus was so well adjusted. Unfortunately the long exposures required for the three-colour camera operated by Lady Lockyer could not be secured in consequence of clouds. The 3½-inch Newton, mounted equatorially and worked by Staff-Surgeon Clift, obtained two successful exposures. The instrument in my charge secured four negatives that will prove useful, one of which displays the green coronal ring clearer than those which were secured in the 1898 or 1900 eclipses, and several other distinct coronal rings in addition. The spectrum of the lower chromosphere at the beginning or end of totality was not obtained. The objective grating spectroscope worked by Mr. Howard Payn produced one out of two exposures made, and shows the spectrum of the larger prominences and the green coronal ring.

The observers of the shadow bands gained a great amount of information as regards their size, rate of motion, and direction. The coronal sketchers obtained very concordant results, and the other parties gleaned much useful information, which will be published later, as the observations have not yet been brought together.

By the evening of Sunday, September 3, the whole of the instruments, tents, dark room, and smaller huts were comfortably on board, and we steamed away to Palermo, leaving our camp as bare as we found it. Two copies of each negative had been made and separately packed to ensure loss against accident.

With the exception of Mr. Butler, who proceeded to Malta in H.M.S. *Venus*, and of Mr. Payn, who remained at Palma, our party bade farewell to the officers and men of H.M.S. *Venus* who had worked so hard, and whom Dame Nature had treated so badly. Crossing to Naples, where we left Mr. F. McClean, we took the train the same morning to Rome, and after a short rest and a little sight-seeing journeyed to Innsbruck, travelling through the beautiful Brenner Pass, to attend the meeting of the Solar Commission of the International Meteorological Committee. Perhaps by the time that the next eclipse occurs we may know a little more about "weather" to enable observers to go to regions where they will not be totally or even partially clouded out!

WILLIAM J. S. LOCKYER.

Officers tent. Lieut. Horne's and my tent. Group packing 6-inch prismatic camera. Dark room. 72 feet prismatic reflector.

Pillars of 16-feet coronagraph. 3½-inch Newton telescope base. Base on which the three-colour camera was located.

FIG. 5.—The camp four hours after the eclipse, showing how quickly the instruments were removed.

INTERNATIONAL METEOROLOGICAL CONFERENCE AT INNSBRUCK.

THIS International Meteorological Conference was opened at Innsbruck on September 9, when Dr. Hildebrandsson, the secretary of the International Meteorological Committee, read the report of the operations of that body on the part of M. Mascart (president) and himself, and explained that at the Southport meeting in September, 1903, Dr. Pernter's proposal that a conference of the directors of meteorological services should be held at Innsbruck this year, similar in character to those at Munich in 1891 and Paris in 1896, was favourably regarded and subsequently adopted.

The vacancies which have occurred on the committee from various causes have been filled by the appointment of Dr. Palazzo and Dr. Shaw in succession to Prof. Tacchini and Dr. Scott. Dr. Hildebrandsson was elected secretary on the retirement of Dr. Scott, who, since the creation of the committee, had performed this function with a zeal and devotion which would be most gratefully remembered. The following changes have also been made:—M. Chaves, director of the Meteorological Service of the Azores, was appointed in place of Admiral de Brito-Capello, Dr. Hellmann in succession to Prof. von Bezold, and M. Lancaster in succession to M. Snellen.

Sir John Eliot, having ceased to be director of the Indian Meteorological Service, tendered his resignation as a member of the committee, but, with the approval of the India Office, communicated through Dr. Shaw, the committee invited him to retain his seat, as representing in Europe the Meteorological Service of India. Thus the committee has the great advantage of counting among its members residing in Europe a man of experience and possessing a thorough knowledge of the meteorology of the tropics.

According to the report presented by M. Wild and Dr. Scott to the conference at Munich, and adopted by it, the principal object of these private conferences of the directors of meteorological services was "the discussion of concrete questions, the arrangements of procedure as to methods of observation and calculation, and the organisation of common investigations." Since that period several investigations have been organised by the subcommittees nominated by the international committee.

The Munich conference nominated a committee for cloud observations, under the presidency of Dr. Hildebrandsson, whose duty it was to publish an international cloud atlas, and to organise and direct observations and measurements of clouds in different countries during a year. The cloud atlas was published in 1896 by MM. Hildebrandsson, Riggenbach, and Teisserenc de Bort. International cloud observations and measurements were made at a great number of stations from May 1, 1896, to the end of 1897, on a plan fixed by the committee at the meeting at Upsala in 1894. The publications, in accordance with instructions laid down by the subcommittee, have appeared, and the principal results have been published by Dr. Hildebrandsson in a report of which the first part was presented to the international committee at the Southport meeting, and the second part is now presented to the conference. The subcommittee has now completed its work.

At the Paris meeting, in 1896, other subcommittees of a similar character were nominated, *e.g.* an aëronautical committee, with Dr. Hergesell as president, for the purpose of organising international scientific aëronautical experiments, especially simultaneous balloon ascents at different stations. A committee was formed under the presidency of Sir Arthur Rücker for the purpose of international researches on terrestrial magnetism and atmospheric electricity.

These subcommittees have had several meetings, and have organised some important investigations. A third subcommittee was constituted at Paris in 1896 for the study of solar radiation. There have been no special meetings, but M. Violle has presented to each sitting of the international committee a report of the principal researches undertaken in different countries. At the St. Petersburg meeting, in 1899, the international committee appointed a telegraphic subcommittee, under the presidency of Dr. Pernter, with the view of suggesting possible improvements in telegrams for weather prediction. Lastly, at the request of Sir Norman Lockyer and Dr. Shaw, the committee appointed a subcommittee for the study of questions relating to simultaneous solar and terrestrial changes, under the presidency of Sir Norman Lockyer.

The reports of these subcommittees show that their labours have been of the greatest utility for the development of meteorological science. By this means it has been possible to organise and carry out successfully investigations which would have been otherwise impracticable. It is very desirable that all persons occupied with the same or analogous problems should meet periodically, in order to fix ideas and coordinate individual efforts, without in any way restricting personal initiative. It may be asserted with satisfaction, added Dr. Hildebrandsson, that the meteorological conferences organised more than thirty years ago have materially contributed to the development of the science, to uniformity of views, and to agreement between the services of different countries. The constitution of the international committee contributes effectively to the maintenance of good relations, and promotes continuity in the labours of the conferences.

Dr. J. Hann was elected honorary president, and Dr. J. M. Pernter president, of the conference. In the course of an address Dr. Hann said:—

As I am not the official president, I shall take advantage of my privilege of passing over in silence most of the questions which form the programme of the present conference, and I shall devote my attention to certain problems of modern meteorology in which I have a special interest, and the solution of which your discussions will assist.

The use of balloons and kites has brought the exploration of the upper regions of the atmosphere to a degree of development of which we had no idea at the time of the first international congresses at Leipzig and Vienna. Even in 1879 the condition of the question had not changed, when at the congress at Rome I was charged with elaborating plans for observations in balloons and on mountains. We had not then the apparatus for raising kites, and had no idea of the important part they were to play in meteorological science. It was reserved for Messrs. Rotch and Clayton, of Blue Hill, to obtain the excellent results with which we are all acquainted.

Further, unmanned balloons were not invented, which since, thanks to M. Teisserenc de Bort, have furnished such surprising data relating to the temperature of the upper regions of the atmosphere. The exploration of the air by means of manned balloons was carried on without any regular plan, and the observations obtained, as we found out later on, were unsuitable for scientific investigations. It was only more recently, after the older experiments by Welsh had been overlooked and forgotten, that Dr. Assmann produced his aspiration-thermometer, which is capable of giving accurate temperature observations during balloon ascents.

Thus I was only able to recommend observations in captive balloons. I directed attention to the superiority of such observations over those made on mountain summits, which were subject to the disturbing influence of the ground, and gave a daily range of temperature quite different from that observed in free air.

But as observations in captive balloons were limited in several respects, I also recommended that observations should be made on mountains. Mountain observations, although subject to local influences, are of great use; they give us information that observations made in balloons or by means of kites cannot do, viz. the continuous registration of meteorological elements (especially barometric pressure) at a definite altitude, and are indispensable in determining the conditions of the weather in the higher regions of the atmosphere.

I now come to another domain of research, which at the present time has attained increased importance, viz. the problem of weather periods and their connection and dependance on the activity of the sun. This is one of the grandest and most beautiful problems of modern meteorology, for the solution of which astronomers, physicists, and meteorologists must give mutual assistance. One of the services which meteorologists can render in furthering this important object is to obtain suitable observations, by means of which the cyclical variations in the atmosphere and their relations to solar activity may be unequivocally determined.

These observations must fulfil two principal conditions; they must be distributed as uniformly as possible over the globe in order to give sufficient data relating to the conditions of the atmosphere at fixed moments, and must be suitable for closely following the variations in time of these conditions during short as well as in very long periods. The meteorological observations at fixed points must give continuous and homogeneous series of mean and extreme values.

Unfortunately, the older observations do not always satisfy these conditions. It often happened that the principal meteorological observatories, while constantly endeavouring to obtain more exact data, omitted at the same time to take steps for obtaining comparisons between the old and the new series of observations. This remark applies above all to certain barometrical observations. Thermometrical observations subject to local influences, as well as barometrical observations affected by large or unknown instrumental errors, may afford valuable means for determining the variations of meteorological elements, provided that the local influences and the corrections are constant. These are even more valuable than absolutely accurate observations that are not homogeneous, because the constant errors do not affect the variations. Accordingly I have for many years urged in the *Meteorologische Zeitschrift* that we should endeavour to continue the homogeneous series of means and extremes of the meteorological elements for as many years as possible, and should collect and critically discuss the older series of observations.

Considered from this point of view, the continuation of meteorological observations on mountains is of special value and most urgently to be recommended. They give us information about the condition of the atmosphere in the higher regions which are less exposed to local influences.

Among the results of recent researches, no other has made so great an impression on me as the observations of the British Antarctic Expedition on the retrograde motion of the glaciers now going on in those regions. The renowned great ice-barrier of James Ross has receded thirty miles; the glaciers of Victoria Land are in full retreat, and no longer reach the sea; while, on the other hand, the Arctic glaciers are receding, and travellers report the same thing about the glaciers of the snow-covered mountains of Ecuador and East Africa.

Comparing these facts with reports and observations of the progressive desiccation of Africa and Central Asia, we are confronted with one of the greatest problems of terrestrial physics. This appears the more difficult of solution since we have similar phenomena on a smaller scale which we can closely observe, both as regards geographical and time distribution, but are unable to explain from a meteorological point of view. I refer to the continual retrograde motion of the glaciers of the Alps, which you have the opportunity of seeing in the vicinity of the place of our present meeting. Although this phenomenon is proceeding in a district where one may suppose sufficient meteorological observations, both as to time and geographical distribution, are available, we are still unable to determine with certainty a direct connection between the variations or periods of the meteorological elements and the movements of the glaciers.

Great results are not attained suddenly, but only after long and carefully prepared efforts. You have met here, gentlemen, to deliberate upon the means by which we may solve, step by step, the most important meteorological problems of the present day.

Dr. Pernter proposed that a certain number of questions should be referred to special subcommittees which would present reports, with the view of simplifying discussions at the general meetings. Subcommittees were nominated for the consideration of (1) an international code and comparison of the standard barometers of different countries; (2) new edition of the cloud atlas, and the classification of clouds; (3) reduction of the barometer to sea-level, and questions relating to weather-telegraphy; (4) international study of squalls.

A vote of thanks was accorded to Dr. Hildebrandsson for his services as secretary to the International Meteorological Committee, and a telegram was dispatched to M. Mascart, president of the committee, expressing regret at his absence owing to ill-health.

An account of the subsequent meetings of the committee will appear in another issue of NATURE.

SCIENCE TEACHING IN ELEMENTARY SCHOOLS.

THE issue by the Board of Education of the Blue-book[1] that lies before us is a promising sign. Intended as a supplement to the necessarily somewhat rigid and mechanical "Code," it indicates the progress which rational ideas upon elementary education have made in the national councils since the days when Robert Lowe's scheme of "payment by results" could claim rank as a piece of wise statesmanship. The opening words of the "Prefatory Memorandum" show the cautious and reasonable spirit in which these suggestions are made:—

"In issuing this volume the Board of Education desire at the outset strongly to emphasise its tentative character, and to invite well-considered criticism designed to make it more useful for its special purpose."

The Blue-book contains an introduction on the objects of elementary schools, organisation, the curriculum, and the methods applicable to children of different ages, followed by chapters on the teaching of particular subjects, viz. English, arithmetic, observation-lessons and nature-study, geography, history, drawing, singing, physical training, needlework and housecraft, handicraft and gardening, and hygiene. Specimen schemes for most of these subjects are given as a series of appendices.

The suggestions made for arithmetic are of a wise and practical kind, as a few extracts will show:—

"The instruction in arithmetic should be made as realistic as possible. . . . The use of sets of objects will make it possible from the very beginning to teach the children to add, rather than count by units. . . . Multiplication tables should not be learnt before they have been constructed and understood. . . . Every school should be provided with (*a*) foot-rulers graduated. . . (*b*) cords with feet, yards and metres marked upon them, . . . (*d*) a pair of common scales with the smaller weights . . . (*e*) measures of capacity . . . (*f*) squared paper or tracing cloth. . . . The commercial applications of arithmetic commonly found in text-books could be advantageously replaced by algebra, practical geometry and the mensuration of the simpler solids and surfaces."

The chapter on observation-lessons and nature-study emphasises the importance of training in accurate observation and accurate description. The distinction made between the two terms is that observation-lessons are for children under ten, while nature-study is for older ones. This seems an artificial distinction, apparently involving the thesis that by the tenth year there is nothing left for observation by the pupils in elementary schools except the outdoor world. The movement of late years for nature-study has, in fact, involved a confusion of thought between subject-matter and method; and it has come to pass that on the one hand didactic teaching of elementary botany, provided it is accompanied by practical verification, and on the other almost any sort of heuristic teaching, are equally covered by that vague and comprehensive term. We see some trace of this confusion of thought in the following remarks:—

"The main factor which marks off nature-study from other school subjects should be that in it the instruction proceeds solely from the actual object, and never from description or reading. In practically every other subject, no matter how successfully the teacher makes the scholar look for the information he requires, the child has to take things for granted, and must depend on the good faith of the teacher or of the printed book; in nature-study comes the opportunity of proceeding by another method and teaching from the thing itself. The teacher should then be very jealous not to waste this unique opportunity" (pp. 48–49).

If this be interpreted as an attempt to use nature-study as an heuristic wedge to be driven into densely didactic school traditions, we may approve of its practical purpose; but with the more idealistic tone of the whole book it is inconsistent. The whole of the chapter on arithmetic is saturated with the notion of "teaching from the thing itself." So far from

[1] "Suggestions for the Consideration of Teachers and others concerned in the Work of Public Elementary Schools." Pp. 156. (1905.)

nature-study affording an unique opportunity for heuristic teaching, the very complexity of the problems which its subject-matter presents puts it at a disadvantage as compared with the simpler problems of elementary physics and chemistry.

Again, how can we reconcile the foregoing quotation with the following, which precedes it by a few pages?

"When a dog has been used as the subject of an observation lesson, the children may read, or be told, about the wolf or the fox. This will lead them to compare and contrast, and will aid in stimulating imagination" (p. 46).

Must we say that the dog is part of "nature" while the wolf and fox are not? or that methods bad for children over ten are allowable below that age? or must we simply explain the difference as due to composite authorship, permissible in a book of suggestions (not instructions), coupled with some confusion of mind on the part of one author between method and subject-matter?

The true idea of the relative positions which heuristic and didactic methods should occupy, which to our mind is well illustrated by the above simple case of the dog and the wolf, is clearly expressed in the chapter on geography:—

"In order that the study of geography may be of real educational value it must not be regarded as a process by which certain facts about the earth . . . are committed to memory. It must be rather regarded as the subject, which above all others brings the youngest child as well as the most advanced student into contact with the outside world. . . . It is true that as we advance in the study of geography we have to rely, to a great extent, upon the investigations of others, but in order that they may understand these investigations we must from the very first teach children to work for themselves and to take nothing for granted."

Nevertheless, it is not suggested that early geographical teaching shall be purely heuristic. On the contrary, the value of stories of strange and distant countries is strongly urged. At first these are scarcely differentiated from fairy-tales, but with each succeeding year they become more exact, until they at length pass into definite geographical teaching for which an observational basis has meanwhile been prepared. Here we see a development of the idea of the relation between didactic and heuristic teaching. It is useless and unnecessary to think, even as a remote ideal, of the exclusion of the former; all that is necessary is to prevent it from being more precise in character than is justified by the stage attained in the latter.

History, in spite of authoritative opinion to the contrary, we must regard as a science, but one in which heuristic teaching is out of the question. Like the one side of geographical teaching, it grows out of fairy-tales, and there need be no scruple in telling young children traditional stories that have not survived modern critical research. But we are glad to see that visits to local places of historical interest are recommended, and that in one at least of the schemes suggested in the appendix the syllabus for the highest class includes "first notions on the materials of history and the use of evidence." Unfortunately, very few teachers will have had any opportunity of acquiring the necessary knowledge on this subject. A book treating in a simple manner of the materials of history—and by no means confined to the documentary portion—is much to be desired.

To sum up the ideas we have so far gathered, we venture to think that in some future edition of these "suggestions" the division into subjects will perhaps be largely abandoned, and in its place we shall have a division by methods which will by no means coincide with groups of the present subjects. Even the official time-tables may come to recognise this. On the one hand we shall have heuristic teaching, aiming primarily at training the mind in scientific habits of thought, and incidentally imparting knowledge; on the other hand, didactic teaching to impart knowledge which is wanted but cannot be obtained at first-hand—its scope being carefully adapted to the stage reached in heuristic training. But, alongside of these two methods, there still remain a number of other subjects, which do not fall under either of these heads, since they consist in training or drilling of some description, *e.g.* the use of the mother tongue, singing, handiwork, and health-training. This last, we agree with the writers of the Bluebook, it is not advisable to teach to young children on a physiological basis. Hygienic habits must be learnt before the age at which physiological laws can really be understood, since some knowledge of physics and chemistry is essential to their real understanding; and to attempt to teach them without such a basis is only to give false knowledge, which is only too likely to prevent the acquisition of true knowledge in later years.

A. M. D.

A NEW ULTRA-VIOLET MERCURY LAMP.

UNDER the name of "The Uviol Lamp," Dr. O. Schott, of Jena, is introducing a modification of the Cooper Hewitt mercury vapour lamp, which appears likely to prove useful. The illuminating power of these lamps is very high, and the arc is very rich in ultra-violet rays, but the glass envelope hitherto prevented the passage of many of these actinic radiations. Dr. Zchimmer has recently produced at Jena glasses which are pervious to the ultra-violet rays, and Dr. Schott has made the envelope of the new lamp of this material.

The Uviol lamps consist of tubes of this special glass of 8 to 30 millimetres diameter and 20 to 130 centimetres length. Platinum wires are fused into the extremities, terminating in carbon heads. In the glass tube there is a charge of mercury of 50 to 150 grs., according to the size. The lamps of various sizes, with their resistance and choking coils, can be connected with electric mains of 220 or 110 volts.

To start the arc, the lamp is tilted to a sufficient degree to allow of the mercury in the tube passing from one pole to the other. At the moment of contact between the pole and the mercury, part of the latter is disintegrated simultaneously with the formation of a column of light. The carbon and heads to the poles permit the passage of the current in either direction without fusing the platinum poles. To get the best results from a current of 220 volts the lamp tube must be 130 centimetres long, but two or three suitable shorter lamps may be arranged side by side or one behind or over the other.

The spectrum of the Uviol lamp is exceedingly rich in lines. The lamp is particularly suitable for taking photographs and for copying processes by artificial light. Experiments have also been made in testing by its means if certain colours used in dyeing and printing have sufficient power to resist the fading effects of the sun. It will thus prove of value in rapidly settling the question of the fastness of colours, which will in future require days instead of months.

The Uviol lamp is also a germicide, and it appears likely that it will prove of value in the treatment of certain diseases of the skin. It is an irritant, and easily sets up inflammations, particularly of the eyes, so that the greatest care must be taken by operators by means of suitable spectacles. With tactful handling it is said that the Uviol lamp can be used for 1000 working hours without loss of efficiency. The cost of a 400- to 800-candle lamp is 1*d.* to 2*d.* per hour. It thus appears to be a very economical method of converting electrical energy into efficient radiating energy of short wave-length.

NOTES.

THE opening of the bridge over the Victoria Falls on September 12, and the visit of the British Association, were celebrated by a banquet, at which Mr. Newton, representing the British South Africa Company, in proposing the health of Prof. Darwin, welcomed the association on the anniversary of the first occupation of Mashonaland by pioneers fifteen years ago, fifty years after Dr. Livingstone first saw the falls. Prof. Darwin proposed the toast of Sir Charles Metcalfe, representing the great enterprise which to-day marks an important step in advance. Reuter's Agency reports that Sir Charles Metcalfe, in the course of his reply, read congratulatory telegrams from Lord Grey and the directors of the British South Africa Company, and a telegram from Mr. Reunert, president of the South African Association of Sciences, conveying his congratulations that more links had been formed in the chain of civilisation. On September 15 the association received a hearty welcome at Salisbury (Rhodesia). The town was decorated, and the trains were met at the station by the local authorities, headed by the Mayor, the Acting Administrator, and the Resident Commissioner. At a subsequent luncheon the Mayor, in welcoming the members of the association to the most northern part of their tour in South Africa, directed attention to the progress made since the occupation of Rhodesia fifteen years ago. When the many diseases which affect the cattle of the country have been conquered, it is hoped that stock-raising will develop very rapidly. In the course of his reply, Prof. Darwin remarked that when the papers and lectures dealing with the special features of South African scientific work are published, it will be seen that serious efforts have been made to grapple with these problems. Sir Thomas Scanlen welcomed the association on behalf of the Chartered Company; and Lord Rosse and Sir William Crookes also spoke. On September 16, at Umtali, a deputation headed by Senhor de Sousa, secretary of the Governor of Mozambique, met the section of the British Association proceeding to Beira. Senhor de Sousa welcomed the members of the association to Portuguese territory in the name of the Governor, the Mozambique Company, and the inhabitants of Beira. On September 17, at Beira, the visitors attended a reception given by the Governor, and were entertained at luncheon. At 4 p.m. on the same day the party left for home on the steamer *Durham Castle.* We regret to learn that Sir William Wharton, a member of the British Association party which is returning home *viâ* Cape Town, is lying ill at the observatory there, having contracted a serious chill.

FOR the past two years cholera has steadily been proceeding westward, and during 1904 had manifested itself in Asiatic Turkey, Persia, and Russia. Since then cases have been recognised in Germany and Austria, and already 179 cases, with 65 deaths, have been recorded in Prussia. A considerable responsibility, therefore, rests on our frontier guards, the port sanitary authorities throughout the kingdom, particularly in view of the number of aliens who reach our shores from the region of the infected districts. If cholera unhappily should reach us, it is not likely to cause any serious epidemic. The last epidemics of note in this country were in 1828, 1848, and 1859.

IT is announced in the *Bulletin de la Société d'Encouragement* that next month a museum of industrial hygiene will be opened in Paris by the President of the Republic. The creation of the museum was authorised by a decree of December 24, 1904. Accommodation for the museum has been found at the Conservatoire des Arts et Métiers, and the sum of 41,000 francs considered necessary for the installation has been collected, as well as subscriptions to cover the annual cost of upkeep. The exhibition will be a permanent one, and, being a loan collection, will be constantly renewed.

THE sixth congress of criminal anthropology will meet at Turin on April 28, 1906, under the presidency of Prof. Lombroso. An exhibition of criminal anthropology will be held in connection with the congress.

DR. OSCAR MAY died at Frankfort-on-the-Main on August 25 at the age of fifty. Dr. May (says the *Electrician*) was one of the founders of the Elektrotechnische Lehr- und Untersuchungs-Anstalt of Frankfort, and was until 1895 instructor in electric lighting at that institution. At the Frankfort Exhibition in 1891 he was a member of the presiding committee and one of the secretaries of the scientific commission.

WE learn from the *Victorian Naturalist* that the estimates recently presented to the council of the University of Melbourne contain, among other proposals of a scientific nature, provision for the erection of a botanical laboratory and the appointment of a professor of botany, who, it is proposed, shall also act as Government botanist. This arrangement, remarks our contemporary, should ensure the best use being made of the valuable collection of Australian plants in the National Herbarium.

A LETTER from Prof. David Todd, dated September 8, informs us that the print of the solar corona of August 30 which was reproduced in last week's NATURE (p. 484) was from an early developed negative done during the heat of the Sahara *gibleh*, and was inferior to others developed after the weather turned cool again. He sends us one of these original negatives, which shows a large amount of detail that did not appear in the print reproduced in NATURE. The automatic machine with which these exposures were made took about seventy-five negatives during totality, of which sixty-three proved to be useful for executing drawings of the corona.

DURING the past few days earthquake shocks have been felt in various parts of Italy. The following is a summary of Reuter messages published in the daily papers:—*September* 13, *Innsbruck.*—Severe shock felt in the Arlberg district at 1.30 a.m. Duration, from six to ten seconds, and direction from south to north. *September* 14.—Shock felt at 10.10 a.m. at Racidena, Messina, Reggio di Calabria, and Mineo; recorded on the seismic instruments at all the observatories in Italy. Another shock felt at Reggio (Calabria) at 12.33. *September* 15.—Mount Vesuvius is becoming increasingly active. During the day frequent undulatory shocks were felt in the region around the volcano. The activity of Stromboli is also very remarkable. *September* 16, *Innsbruck.*—Severe shocks felt in the Arlberg district at 4.3 a.m. and 4.37 a.m. First shock lasted five seconds and the other four. The shocks were accompanied by loud rumblings. *September* 17, *Monteleone.*—Shock felt at 1.40 p.m.

September 18.—Sharp earthquake shocks were felt at 3 a.m. and 11.15 a.m. at Reggio (Calabria). Further damage was done in the provinces of Catanzaro and Cosenza. A severe shock was felt at Monteleone.

THE deaths of two well known explorers were announced in the *Times* of Saturday last. M. de Brazza died at Dakar on September 14 in his fifty-third year, and Captain J. Wiggins at Harrogate on September 13 in his seventy-fourth year. De Brazza was sent in 1875, accompanied by Dr. Ballay and M. March, naturalist, to explore the Ogowe, the great river in Gabun in Equatorial West Africa. During the succeeding eight years he laid the foundations of the French Congo Protectorate. A second visit to West Africa, which lasted for three years, was made in 1879, and during this time de Brazza persuaded King Makoko to place himself under the protection of the French flag. Successive journeys were made to the same regions in 1883 and 1887. After an expedition in 1891–2 from Brazzaville to the Upper Sungha with the view of opening up a route to the Shari and Lake Chad, de Brazza settled down in France. Last April he was sent out as commissioner to inquire into the charges of maladministration in French Congo territory, but the hardships incident to travel in the malarial tropics of Africa this time proved fatal. To Captain Joseph Wiggins belongs the credit of having discovered, or at least rediscovered, thirty years ago a new ocean highway within the Arctic circle by which the trade of European Russia obtained for the first time direct maritime access to the navigable rivers of Siberia. Captain Wiggins was a Fellow of the Royal Geographical Society.

THE thirteenth annual exhibition of the Photographic Salon is now open at the Gallery of the Royal Society of Painters in Water Colours, Pall Mall East. It contains many very fine examples of photography which will interest the scientific student in showing what can be done by means of modern methods. The aim of the promoters of the exhibition is purely pictorial, and although presumably all the works shown are produced by photographic means, it is obvious that there is some, and in a few cases probably a great deal of hand-work in addition. This detracts to a certain extent from the value of the representations of the various phases of nature, of which there are several interesting examples. The methods employed are quite outside the consideration of the society responsible for the show; we can therefore only surmise that the majority of the multi-coloured pictures, and there are about a dozen of them, are made by the gum-bichromate process, applying from two to five coatings of different colours as desired. But the portrait of Frederick Hollyer by Mr. F. T. Hollyer is probably printed on platinum paper, the colours being obtained by modifications in the method of development or by subsequent treatment of the print. A picture so made is obviously not a platinum print, and its permanency and other characteristics must depend entirely upon the nature of the pigmentary materials present. We do not notice any example of "photography in natural colours" as this phrase is commonly understood.

THE greater part of the *Naturwissenschaftliche Wochenschrift* for August 27 is devoted to a review, by Dr. Thesing, of the pathogenic protozoa, dealing particularly with the subject of syphilis.

THE *Popular Science Monthly* for September contains many interesting articles. Messrs. Foulk and Earhart discuss State university salaries, and deplore the meagre remuneration of university teachers. If this be the case in America, how much more so is it in this country?

WITH reference to the article on "The Sterilisation of Water in the Field" (August 31, p. 431), the Lawrence Patent Water Softener and Steriliser Company writes to say that a mistake was made in the records of the official trials of water sterilisers, and that the Lawrence steriliser never consumes more than 1½ pints of kerosine per hour, not 2 pints as stated.

THE *Psychological Bulletin* for August (ii., No. 8) contains an important review by Dr. Meyer of Prof. Wernicke's monograph on aphasia, together with an obituary notice of Prof. Wernicke, who was killed on June 15 in a bicycle accident. We would suggest that the Bulletin be issued with cut pages in future.

THE *Revue de l'École d'Anthropologie de Paris* for August contains an article by MM. Capitan and Papillault on the identification of the body of Paul Jones 113 years after death. This was based partly on general characters, colour of the hair, &c., partly on measurements compared with those of certain contemporary busts, between which there was an extraordinary agreement, and partly on pathological details. There were clear indications of broncho-pneumonia, of tuberculosis, and of renal disease, and from contemporary records it is known that Paul Jones suffered from all of these.

LIEUT. CHRISTOPHERS, I.M.S., records a discovery of considerable interest, viz. the presence of a parasite belonging to the hæmogregarines in blood of the Indian field rat (*Gerbillus indicus*). Hitherto it has been believed that these parasites are confined to cold-blooded vertebrates. The parasite occurs as a motionless vermicule in the red blood cells, and as an actively motile vermicule in the plasma. Infection of the rat was proved to take place through its parasitic louse, a new species of Hæmatopinus, in which a developmental cycle is passed (*Sc. Mem. of the Gov. of India*, No. 18).

WE have received from the director of the Government Zoological Gardens at Giza, near Cairo, a list of a collection of animals obtained by the members of the staff during a collecting trip to the Sudan, which lasted from May 10 until August 10. The list comprises 129 animals referable to 46 species, among which a pair of Senegal storks are perhaps the most notable. It should be added that several of the specimens are the gifts of officials in the Sudan, and that a giraffe was confided to the care of the director by the Khedive.

To the first part of vol. ix. of the *Biological Bulletin* Dr. J. E. Duerden contributes a sixth instalment of his account of the morphology of the Madreporaria, dealing in this instance with the "fossula" of the extinct rugose corals. The fossula (of which there may be several), we may remind our readers, is a very characteristic feature of the Rugosa, and consists of a pit in the calice due to the smaller size of the vertical septa in that particular area. In this communication the author endeavours to explain the structure of this pit from the changes which take place in the corallite during development.

IN the August number of *Naturen* Mr. H. Schetelig describes, with illustrations, certain very interesting remains of buildings of Neolithic age which have recently been opened up in Scandinavia. The building takes the form of a portion of a curved wall situated in a stratum below the peat, which is itself overlain by a considerable thickness of more recent deposits. Alongside the wall were found a number of stone implements, most of which are of the well known Neolithic adze type, although others are chiefly finished by chipping, and appear in some degree transitional between Palæo- and Neo-lithic types.

IN the first article of the August issue of the *American Naturalist* Prof. D. P. Penhallow discusses the ancestry of the poplars and willows (Salicaceæ) as deduced from the woody structure of the fully mature stem. The family appears to be of Old World origin, and while most of its Cretaceous representatives appear to have been suited to a warm climate, the tendency of the later forms appears to have been to adapt themselves to boreal conditions. The other articles include the seventh part of Dr. B. M. Davis's studies on the plant-cell, and a dissertation by Mr. J. A. Cushman on the developmental history of the shelled foraminifera of the group Lagenidæ. For the initial chamber of these lagenoids the author proposes the name "proloculum," on the analogy of "protoconch" in the case of the gastropod shell.

THE trustees of the British Museum have caused to be issued (at the price of 3*d*.) a special guide to an exhibition of old natural history books now placed in the main hall of the Natural History Museum in Cromwell Road. The object of the series is to illustrate the origin and progress of the study of natural history previous to Linnean times. Apart from reproductions of certain prehistoric sketches, which scarcely, it seems to us, come under the designation of "old natural history books," the series commences with Aristotle's natural history, followed by other works collectively assigned to the classical period. Arab philosophers, such as Serapion of the eight or ninth century, come next, and following these, after a brief reference to a few mediæval writers, we are introduced to the works of Leonardo da Vinci and the early "herbalists." With the close of the fifteenth century the legendary period of natural history gave place to an era of first-hand investigation, and special reference is made in the guide to Wotton (1492–1555), the first English physician to make a scientific study of the subject, and to whom belongs the credit of restoring zoology to the rank of a science. For the history of later writers and their works we must refer our readers to the exhibition itself, which, if studied by the aid of the excellent little guide before us, cannot fail to prove both interesting and instructive.

UNDER the conditions which prevail, it is too much to expect any great expansion of forest areas in the British Isles, but there is some consolation in the statement made by Mr. G. Pinchot, the energetic chief of the Bureau of Forestry in the United States, that the Canadian and Cape Colonies have established an efficient forest service, and that Australia and New Zealand are making progress in the same direction. Mr. Pinchot reviews the conditions of forestry in Germany, France, and Switzerland, also in British India and the United States, in the August number of the *National Geographic Magazine*. Among the illustrations are some depicting the employment of elephants in the teak trade of Burma.

AN account of the Erysiphaceæ of Japan in the *Annales Mycologici*, vol. iii., No. 3, by Mr. E. S. Salmon, affords some instances of distribution which are not readily explained. Four species were previously only known from America, one each from Australia and China, and five are endemic. One species, *Uncinula geniculata*, was gathered near Tokio on an endemic plant, *Styrax Obassia*; as recorded from America, the only host-plant is *Morus rubra*. Mr. Salmon suggests that possibly *Morus rubra* will be found to exist in Japan, or that the area of distribution of the two host-plants may have overlapped, or that the fungus, having been introduced to Japan, has spread to a new host-plant.

THE sixteenth annual report of the Missouri Botanical Garden contains three papers on fungal diseases observed on cauliflowers by Dr. H. von Schrenck and Mr. G. G. Hedgcock. Following upon the treatment of the cauliflower leaves with different fungicides, it was noticed that swellings were raised in certain cases; further experiments proved that these were caused by the application of a solution of copper ammonium carbonate which induced extravagant enlargement of the mesophyll cells. Prof. Sorauer, who has treated the subject of intumescences very fully, has referred their formation to the action of an abnormal elevation of temperature, combined with excessive water supply. In the experiments here detailed these conditions did not obtain, and Dr. Schrenck shows definitely that the swellings are the result of chemical stimulation brought about by the copper ammonium salt when applied in a dilute solution, and he compares it with the well known action of poisonous salts, which in weak solutions induce acceleration of growth.

THE August number of the *Fortnightly Review* contains an article by Mr. W. H. Mallock on the two attacks on science. The two attacks are the clerical and the philosophic, and the writer contends that the former of these has failed entirely, because man and the universe, when studied as modern science studies them, neither can have, nor require to have, any other explanation than that which science offers us, the principle, namely, that all phenomena result from a single system of interconnected causes. There are no longer gaps in which the divine interference can be seen, for even the gap between the organic and the mental has been bridged over by the discovery that consciousness and mind are by no means co-extensive and identical, *i.e.* that consciousness is not essential to the existence and operations of mind. As for the philosophic attack, the main problem is that of the origin of ideas, and Mr. Mallock accepts the scientific view that the mind is a highly complex organism, having a long pedigree, and evolved from simpler elements; that the "connection of things" gradually reproduces itself in the "connection of ideas"; that the individual is at no point to be regarded as separated from the cosmic whole, but that even conation, which has sometimes been supposed to differentiate mental from other processes, depends on the universal conation of nature. On these lines science extends indefinitely the borders of what we call self, and breaks down the dividing line between ourselves and the universe; and thus introspective philosophy "instead of disintegrating science as a system of childish materialism, merely hardens and sublimates it into a system of universal mentalism."

WE have received an effective relief map of the Dominion of Canada, on a scale of 100 miles to an inch, published by the Department of the Interior.

A RECENT Bulletin (No. 15) of the Geological Commission of Finland contains a series of chemical analyses of ninety-one igneous rocks from Finland and the Kola peninsula. The analyses are set out and the rocks classified according to the elaborate new method of the American petrographers (Whitman Cross, Iddings, Pirsson, and Washington), in whose work many of these analyses have already appeared. Thirty-eight, however, are new, being mostly the work of Miss N. Sahlbom.

THE Geological Survey continues its work of unravelling the complex structure of the Highlands, and has lately published a memoir on the region of the Upper Tay and Tummel valleys (Sheet 55, Blair Atholl, Pitlochry, and Aberfeldy), a region where the newest and the oldest of geological formations alone are found. Most of the memoir is occupied with the field relations and petrography of the crystalline schists and igneous intrusions, but glacial and alluvial deposits are also described. Chief among the illustrations are seven very fine photographic plates. One of the most interesting is a view of the rocky bed of the Garry, with the curious "water-pipe" structure, due to unsymmetrical folds in the Moine gneiss. An example of the practical utility of the survey is given in the fact that the basalt quarries near Aberfeldy, which supply the best road-metal in the district, were started at the suggestion of a survey officer.

THE Geological Survey of Ireland has recently been transferred from the charge of the Board of Education to the Department of Agriculture and Technical Instruction, and in connection with the transference an interesting article describing the survey's history and work has been contributed by Prof. Grenville A. J. Cole to the department's journal. In this article mention is made of the fact that so long ago as 1837 a laboratory for the examination of soils was established in Belfast, and a soil survey was projected. Unfortunately, however, the authorities were unsympathetic, and Ireland has not the credit of the first soil survey. "It was left," writes Prof. Cole, "for Germany, the United States, Japan and other countries to develop agricultural geology as a branch of organised research." Under the care of Sir Horace Plunket's vigorous department, it is safe to predict that the survey will now make amends to Irish agriculture for the neglect of 1837.

WE have received the report of the United States Geological Survey on the results of primary triangulation and primary traverse for the fiscal year 1903-4, by Mr. S. S. Gannett. Prefixed to this is a valuable chart showing the "condition of astronomic location and primary control" in the United States up to April 30, 1904.

THE new number (vol. xviii., part i.) of the *Mitteilungen aus den deutschen Schutzgebieten* contains a paper of interest to surveyors on a method of measuring a base-line, in sections of about 40 metres, by means of a 4-metre subtense rod and theodolite, by Herr H. Böhler. The reduction of the observations is dealt with in detail, and Captain Kurtz contributes a separate note on a special method. The general result points to an error of about $\pm 7{\cdot}4$ mm. per kilometre.

WE have received No. 8 of the "Current Papers" presented to the Royal Society of New South Wales. Nearly two years have elapsed since the last of these papers was communicated by Mr. H. C. Russell, F.R.S., and on account of his illness the present number has been drawn up by Mr. H. A. Lenehan, the acting Government astronomer for the State. The Federal postal regulations having done away with the system of "franks" for Government documents, the number of observation records received diminished by about 60 per cent. in 1904 as compared with the average for the period 1899 to 1903. Several records are, however, of great interest, notably that of a float cast adrift off the coast of California, and picked up on the island of Boillon in the Java Sea, after a journey of 11,350 miles.

STANDARD sections for rolled iron were used first in Germany in 1879 and in the United States in 1897. In Great Britain the Engineering Standards Committee was appointed in April, 1901, by the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Iron and Steel Institute, and the Institution of Naval Architects to inquire into the advisability of standardising rolled iron and steel sections for structural purposes; and although the time has not yet been sufficient for the standard sections to be adopted as widely as they are in Germany, the committee has done admirable work, and with the support of the Institution of Electrical Engineers important developments are being made in other fields. The latest reports received, namely, No. 16, "British Standard Specifications and Tables for Telegraph Material" (London: Crosby Lockwood and Son, 1905, price 10*s*. 6*d*. net), and No. 23, "British Standards for Trolley Groove and Wire" (London: Crosby Lockwood and Son, 1905, price 1*s*. net.), are striking examples of the wisdom displayed by the committee in not going too far in the direction of standardisation. In the case of telegraph material it is not considered necessary to issue a specification for copper wire. No attempt has been made to standardise submarine or underground tables, nor telegraphic or telephonic apparatus; and in the case of trolley wire it has not been deemed advisable to go further in the direction of standardisation than the recommendation of certain figures for the minimum tensile breaking strength for the gauges of wire in general use. No attempt is made to standardise any particular design of trolley wheel, the committee having confined itself to recommending a groove of a certain section. In short, these standard specifications are so reasonable that they cannot fail to meet with general adoption, as economy in production is ensured without any revolutionary change or any restraint on originality of design.

AT the last meeting of the Faraday Society (held on July 3) a paper was presented by Prof. E. Wilson upon "Alternate Current Electrolysis." The author has carried out a long series of experiments with alternating currents, using various metals as electrodes, and various metal salt solutions as electrolytes. The loss or gain in weight of the electrodes during the experiments was recorded, and accurate measurements of the potential difference and of the current intensity were also made. The exact potential difference between the electrodes was obtained by use of an exploring electrode placed between the plates and a quadrant electrometer. The following metals were experimented with:—lead, zinc, iron, copper, tin, and aluminium. The frequency of the alternating period, the density and character of the electrolyte, and the current intensity were varied during the experiments with each metal. The results obtained are gathered together in tabular form in the original paper, and these show that the loss of weight was greatest in the case of lead in a dilute sulphuric acid solution, and least in the case of copper. The discussion on this paper has been adjourned until the meetings of the society are resumed in November next.

THE Cambridge University Press has just published an index to the volume containing Lord Kelvin's "Baltimore Lectures on Molecular Dynamics and the Wave Theory of Light," reviewed in NATURE of May 5, 1904.

A FOURTEENTH edition of "Mineralogy," by the late Mr. Frank Rutley, has been published by Messrs. Thomas Murby and Co. The book has been revised and corrected, and a brief notice of the radio-active elements, contributed by Mr. Ernest H. Adye, has been added.

COPIES of two booklets, which have been published privately by Mr. F. W. Armstrong, of the Blue School, Wells, Somerset, have been received. They deal respectively with elementary inductive chemistry and inductive physics.

A NEW catalogue of physical and electrical instruments, balances, &c., has been issued by Messrs. W. G. Pye and Co., of the "Granta" Works, Cambridge. The excellent illustrations, drawn to a larger scale than is usual in similar publications, should greatly assist customers ordering instruments from a distance, since with the accompanying concise explanations little room is left for misapprehension.

OUR ASTRONOMICAL COLUMN.

THE VARIABLE ASTEROID 1905 Q.Y.—From a telegram from Dr. Palisa to the Kiel Centralstelle, it appears that the asteroid which, on the supposition that it was a newly discovered one, was designated 1905 Q.Y., is identical with that known previously as (167) Urda. The identity is confirmed by Prof. Berberich, who writes that on August 28 the magnitude of Urda was from 0·5m. to 1·0m. brighter than shown by the value given in the Jahrbuch (*Astronomische Nachrichten,* No. 4046).

NOVA AQUILÆ No. 2.—From a note in No. 4046 of the *Astronomische Nachrichten,* we learn that the position first given for Nova Aquilæ was 1m. wrong in R.A. It should have read R.A. = 284° 17′ (= 18h. 57m. 8s.) instead of 284° 2′ as given, the mistake occurring in the first telegram received at Kiel.

Observing this object on September 5, Prof. Hartwig determined the position, referred to the equinox of 1905·0, as R.A. = 284° 16′ 16″ (= 18h. 57m. 5·06s.), dec. = −4° 34′ 50″, and found the magnitude to be 10.

FRENCH OBSERVATIONS OF THE TOTAL SOLAR ECLIPSE.—No. 10 (September 4) of the *Comptes rendus* contains the brief reports received from various French eclipse expeditions by the Académie des Sciences.

Prof. Janssen, M. Bigourdan, and MM. Stephan and Trépied, observing at Alcosebre, Sfax, and Guelma respectively, report satisfactory meteorological conditions and successful observations. At the last named place M. Bourget obtained fourteen negatives of the corona, using coloured screens. The parties at Cistierna, Burgos, and Tortosa were less fortunate, clouds interfering with, or totally preventing, observations. The measures of the ionisation of the electric field were, however, carried out throughout the eclipse by the observers at Tortosa. Similar observations were carried out, entirely according to programme and under perfect conditions, at Philippeville, and M. Nordmann, from a preliminary examination of the curves obtained, expects that some very interesting results will accrue when these are finally compared with those obtained on previous occasions. M. Salet, from the same station, reports that the polarisation of the corona was well observed, the deviation of the plane of feeble polarisation being 3°. Ten coronal radiations were photographed with a "Nicol" in front of the slit, and fifteen ultra-violet coronal radiations were photographed with the spectroscope.

From the eclipse station at Alcalá de Chisbert (Spain) M. M. Moye writes that the eclipse was observed under good conditions, and that the corona was very brilliant, the longest streamers occurring in the south and the north-east. The green line was very apparent. Shadow bands were well observed both before and after, but were invisible during totality.

Observations of the partial phase were made in Paris, where the times of the contacts and of the occultations of spots were recorded by several observers. Unfavourable meteorological conditions prevented the actinometric observations, which it was proposed to carry out at Trappes, Bordeaux, and the Pic du Midi, from being made, but a series of good observations was obtained at Bagnères.

EYE-ESTIMATES OF THE TRANSITS OF JUPITER'S SPOTS.—In order to determine whether his own eye-estimates of the transits of Jupiter's spots were subject to any error similar to that suspected by Schmidt, the Rev. T. E. R. Phillips has analysed his observations, which number about 140, and cover the period of seven apparitions. As a result he has arrived at the conclusion that at the beginning of each apparition, when the planet's hour-angle is east, he observes the transit a little too early. Similarly, at the end of each apparition, when the hour-angle is west, the transits are recorded a little too late. The explanation of this error is that it is due to the varying slant of the belts as the planet is removed from the meridian, and the consequent failure of the eye to determine correctly the position of the line which bisects the disc and is normal to the planet's equator. If this explanation is correct, the error should be of the opposite sense in the two hemispheres, but the evanescent character of the spots in the northern hemisphere has prevented Mr. Phillips from making this test. Again, if the cause suggested is the true one, this error should disappear if care be taken to keep the line joining the eyes parallel to the belts.

In No. 361 of the *Observatory* Mr. Phillips gives the details of his observations during each opposition since 1898, and a diagram which shows the effect of the error referred to above on the observed drift in longitude of the Great Red Spot "Hollow." The hope is expressed that this may lead other observers to elucidate the matter further from their own experiences.

THE SOLAR ACTIVITY, JANUARY–JUNE.—No. 7, vol. xxxiv., of the *Memorie della Società degli Spettroscopisti Italiani* contains Prof. Mascari's usual summary of the solar observations made at the Catania Observatory during the first six months of the current year. A comparison of the "frequencies" observed with those recorded for the latter semestre of 1904 shows that the solar activity was much greater during the later period, but the increase was much more marked during the first quarter of this year than during the second. The daily frequencies of spots, faculæ, and prominences during the six months under discussion were 7·18, 7·12, and 3·29 respectively.

Two plates which accompany this publication show, diagrammatically, the sizes and positions of the prominences observed on the sun's limb at the observatories of Catania, Kalocsa, Odessa, Rome, and Zurich during the last quarter of 1902 and the first two months of 1903.

INSTITUTION OF MINING ENGINEERS.

THE sixteenth annual general meeting of the Institution of Mining Engineers was held at Manchester on September 13, 14, 15, and 16 under the presidency of Sir Lees Knowles, M.P. The report of the council contained an expression of deep regret at the loss sustained by the death of the president, Sir Lowthian Bell. The Institution of Mining Engineers is a federation of seven local mining societies—the Manchester Geological and Mining Society; the Midland Counties Institution of Engineers; the Midland Institute of Mining, Civil and Mechanical Engineers; the Mining Institute of Scotland; the North of England Institute of Mining and Mechanical Engineers; the North Staffordshire Institute of Mining and Mechanical Engineers; and the South Staffordshire and East Worcestershire Institute of Mining Engineers. Since the formation of the institution in 1889, the membership has increased from 1239 to 2901 in 1905.

The first paper read was on the leading features of the Lancashire coalfield by Mr. Joseph Dickinson, formerly H.M. Chief Inspector of Mines. This paper gave a concise summary of the recent developments of the geological investigation of the coalfield. Electric power distribution was dealt with in a paper by Mr. R. L. Gamlen, in which he showed the advantages possessed by the power companies as providers of power. Mr. B. H. Thwaite submitted a paper on colliery explosions in which he suggested, as a method of dealing with explosions, the installation of a series of pipes conveying a supply of oxygen and a pneumatic method of coal-dust removal. The former proposal met with much adverse criticism in the discussion. Mr. Sydney F. Walker read a paper on earth in collieries, in which he pointed out some of the difficulties in carrying out the special rules drawn up by the departmental committee for the installation and use of electricity in mines. If earth was to be admitted into the system, the only method of carrying out the wishes of the committee was to use an uninsulated return completely enclosing the live conductor. The last paper read was by Mr. John T. Stobbs on the value of fossil Mollusca in Coal-measure stratigraphy. He expressed the opinion that Mollusca afforded the best means of correlating Coal-measures, and considered that their neglect was due to inadequate collections in public museums, and to the fact that teachers failed to impress upon students the utility of the Mollusca as zonal indices. The Coal-measures were, he thought, comparatively neglected by the geologist, the knowledge of the Ordovician, Silurian, and Chalk systems being much more exact than that of the 3000 feet of Coal-measures. The remaining days of the meeting were devoted to excursions to Chanters Colliery, to New Moss Colliery, to the Manchester Museum, to the works of the British Westinghouse Company and the Manchester Ship Canal, to Pendleton Colliery, and to other places of interest.

THE BRITISH ASSOCIATION.

SECTION K.

BOTANY.

OPENING ADDRESS[1] BY HAROLD WAGER, F.R.S., H.M.I., PRESIDENT OF THE SECTION.

ON SOME PROBLEMS OF CELL STRUCTURE AND PHYSIOLOGY.

Introduction.

WHEN Robert Hooke, in the early part of the seventeenth century, discovered, with the aid of his improved compound microscope, the cell structure of plants, he little thought that our ultimate knowledge of the physical and chemical processes in the living organism, of its growth and reproduction, of the problems of heredity and of the factors underlying the origin of life itself, would be in the main dependent upon a clear understanding of the structure and physiology of the cell.

Hooke's researches did not, in fact, carry him very far, and we must turn to the nearly contemporaneous works of Malpighi and Grew on the anatomy of plants for the first clear indication of the important part which cells take in the constitution of the various tissues of plants. The account they give of them is extremely interesting in the light of our present knowledge. Grew, for example, in speaking of the structure of the root, compares the parenchyma to a sponge, "being a body porous, dilative, and pliable . . . a most exquisitely fine wrought sponge." The pores are spherical and consist of "an infinite mass of little cells or bladders. The sides of none of these are visibly pervious from one into another; but each is bounded within itself. . . . They are the receptacles of liquor, which is ever lucid, and . . . always more thin or watery." There is no indication either in Grew's or Malpighi's works that they understood the significance of this cell structure, and it was not until the beginning of the nineteenth century, after a lapse of some 150 years, that any insight into the real nature of the cell and its functions was obtained. But then began a period of activity—associated with the names of Turpin, Meyen, Robert Brown, Purkinje, J. Müller, Henle, Valentin, and Dutrochet—which culminated in the cell theory of Schleiden and Schwann that the common basis of all animal and plant tissues is the cell, and that it is upon this elementary vital unit that all growth and development depends.

The nucleus was discovered in 1831 by Robert Brown in various tissues of the Orchideæ and in some other families of the monocotyledons, as well as in some dicotyledons. He described it as a "single circular areola, generally somewhat more opaque than the membrane of the cell," and more or less granular. It is very distinct and regular in form, and its granular matter is held together by a coagulated pulp not visibly granular, or, which may be considered equally probable, by an enveloping membrane. Although Robert Brown was the first to recognise the importance of the nucleus, and to give it a name, it had been seen by previous observers, and he himself mentions that he had met with indications of its presence in the works of Meyen and Purkinje, chiefly in some figures of the epidermis; in a memoir by Brogniart on the structure of leaves, and that Mr. Bauer had particularly noticed it in the cells of the stigma of *Bletia tankervilliae*, but had associated it with the impregnation by pollen. There are some figures by Leeuwenhoek, published in 1719, to which Prof. L. C. Miall has directed my attention, of blood-corpuscles of a fish, human epidermal cells, and the connective tissue of a lamb, in which nuclei are shown, and they had been seen by Fontana (1781) in epithelial cells, and by Cavolini (1787) in some fishes' eggs.

To Schleiden and Schwann the cell was essentially a membranous vesicle enclosing a fluid sap and a solid nucleus. They thought that it arose in contact with the nucleus as a delicate transparent vesicle which gradually increased in size and became filled with the watery sap. As soon as it was completely formed, the nucleus, having done its work, was either absorbed or cast off as a "useless member," or in some cases was "found enclosed in the cell-wall, in which situation it passes through the entire vital process of the cell which it has formed." So far from being the most important organ of the cell, as we now consider it to be, they saw in the nucleus merely a centre of cell formation which is no longer required when the cell is formed. It was left for Hugo von Mohl to show that the mucus-like contents of the cell which he called protoplasm (1846) is the real living matter in which reside those activities which call into play the phenomena of life, and that the origin of nuclei by division from a nucleus already existing in the parent cell would possibly be found to occur very widely. Von Mohl, Nägeli, and Hofmeister all appear to have had some idea of the importance of the nucleus in cell division. Von Mohl says that the "process is preceded in almost all cases by a formation of as many nuclei as there are to be compartments in the mother-cell." Hofmeister's description of it is interesting: "The membrane of the nucleus dissolves, but its substance remains in the midst of the cell; a mass of granular mucilage accumulates around it: this parts, without being invested by a membrane, into two masses, and these afterwards become clothed with membranes and appear as two daughter-nuclei."

It is, however, mainly to the researches of the last thirty years that we owe our knowledge of the many complex cell-activities at work in living organisms, and we are still only just on the fringe of the great problems which cytology has to solve. Some of the most important of these are the origin and evolution of the nucleus, the meaning of the complex mode in which the nucleus divides, the origin and nature of the spindle figure and centrosomes, the part played by the chromosomes in the transmission of hereditary characteristics, the meaning of the phenomena accompanying fertilisation, the significance of the longitudinal division of the chromosomes and of their reduction in number in the sexual cells, and the evolution of the living substance. The satisfactory solution of these problems depends upon a clear understanding of the structure of protoplasm and its various differentiations. How far we have succeeded in obtaining this I will endeavour to show.

The Differentiation of Structure in the Cell.

The essential constituent of a cell is the protoplasm. This is differentiated into two constituents, the cytoplasm and the nucleus. It is usually held that this differentiation is an essential one, and that these two constituents are present in all cells; but, as we shall see later, there is some evidence that not only are there cells with very rudimentary nuclei, but cells in which no trace of a nuclear structure can be found at all.

In addition to this primary differentiation of the cell, secondary differentiations occur, resulting in the production of organs such as chloroplasts, chromoplasts, leucoplasts, pyrenoids, and pigment spots, which have special

[1] Slightly abridged.

functions to perform. All these are permanent organs of the cell, produced in the first instance as a result of the cell activity, but now capable of an independent existence in the cell, in that they reproduce themselves by division, and are in this way carried on from cell to cell.

In many cells there are formed at certain stages other organs which appear to be transitory, and are only produced when they are required. Such are the spindle figure, the centrosome, the blepharoplast, and the cœnocentrum.

So far as we know, the cell is the smallest vital unit that can have a separate existence. But it is only among the unicellular organisms and under certain conditions in the earlier stages of development of the more highly organised multicellular organisms that cells have a perfectly independent life. Schwann's hypothesis that the multicellular body is a colony of independent vital activities governing the nutrition, growth, and reproduction of the whole is not tenable. The cell cannot be regarded as an independent unity working merely in association with other cells. Its life and existence depend upon these. It is an integral part of an individual organisation, and cannot exist apart from it. But this absolute dependence of individual cells upon the organisation as a whole is only realised in the more highly developed forms. In the lower types of plants (and animals) it is possible, during the early stages of development, to separate a single cell from the whole, which will still continue to live and grow. Each cell is no doubt dependent upon the others to some extent, even at this early stage, but it still retains the power to develop independently if placed under suitable conditions. As cell division continues each cell becomes more and more dependent upon its fellows, until the stage is reached when it no longer has the power to exist by itself. The various functions performed by a cell reside within it as an individual unit, but the exercise of these functions is governed by the organism as a whole. Just as the organism seeks for a state of equilibrium in relation to various external stimuli, so a cell in an organism has to adapt itself to and come into a state of equilibrium with the various cells around it.

The Nucleus.

The nucleus is the centre of activity, and governs the vital functions of the cell. All investigations show that in its absence the cell soon ceases to perform its vital functions and dies.

In all cells, from the algæ and fungi upwards, the nucleus is more or less clearly delimited from the cytoplasm by a membrane or limiting layer. The important substance which is thus separated off from the rest of the cell is the chromatin, probably the most complex and most highly differentiated chemical compound or collection of compounds in the cell. It exists in the form of a more or less granular network, and is characterised chemically by the presence of phosphorus, which is in organic connection with it. We may look upon the chromatin as the highest point in the development of living substance, upon which the activities of the cell in great measure depend, and as the seat of origin of all those complicated changes which have for their ultimate aim the division of the cell.

The division of the nucleus begins by a series of transformations in the chromatin network which lead to the differentiation in it of chromosomes. We know very little of what actually takes place during these changes, and practically nothing of the forces at work to bring them about. But the visible result is that the chromatin granules gradually fuse together, or become restricted to certain areas by the increased vacuolation of the ground substance of the nucleus to form a thick, more or less regular thread, in which can be observed at certain stages a differentiation into alternate regions of stainable and unstainable substance—chromatin and achromatin—which finally breaks up into equal or unequal lengths to form the chromosomes. In some cases the chromatin granules or network become aggregated into a definite number of irregular masses which form the chromosomes directly without the production of a distinct chromatin thread.

This nuclear differentiation is usually accompanied by changes in the cytoplasm which lead to the appearance of a fibrillar structure in the form of a more or less regular spindle, the threads of which come into contact with the chromosomes through the breaking down of the nuclear wall. The chromosomes then, by the action of a force or forces of which we as yet know very little, arrange themselves in regular order in the equatorial plane of the spindle figure, and some of the spindle fibres become attached to them. The chromosomes become divided longitudinally into two apparently exactly equal halves; and then, probably by the exertion of some sort of contractile force or pull on the part of the spindle fibres, the separate halves are caused to move to opposite poles of the spindle. Here a series of transformations take place, which lead to the constitution of two new nuclei. Such are the essential features in this complex process of nuclear division, and it is a striking fact that they occur with more or less regularity in all nuclei from the algæ and fungi up to the highest plants.

The Structure of Cytoplasm.

In the elucidation of cell structure we owe much to the beautiful methods of staining and fixing which are due especially to Flemming and Heidenhain, to the improved micro-chemical methods which we owe especially to Zacharias and Macallum, and to the investigations of such observers as Fischer and Mann, who have shown us the effects of various reagents upon the living substance, and have thus taught us to be very cautious in our interpretations of the structures seen in dead fixed cells.

The investigations of oil-foams and colloids by Butschli, Hardy, and others have given us a clue to possible explanations of the various appearances seen both in the living and dead fixed and stained cells, and the introduction of the ribbon section cutting microtome into the domain of vegetable histology has enabled us to make the best use of the beautiful apochromatic object-glasses which we owe to the researches of the late Prof. Abbe.

It is unfortunate that, so far, very little progress has been made in the examination of the structure of the living cell. We may hope that, with the improved methods of illumination now available, combined with experimental investigation, it will be possible to make some progress in this direction. It is of the greatest importance that we should be able to satisfy ourselves to what extent the various appearances seen in the fixed and stained cell are due to the action of the reagents employed. In this respect a recent discovery by Köhler, which indicates the possibility of making use of the ultra-violet rays in such investigations, is of interest. Köhler (*Phys. Zeit.*, 1904) finds that if the ultra-violet rays from the electric spark between cadmium or magnesium terminals are separated out by means of quartz prisms, objects illuminated by them, when examined by means of lenses made of quartz, show differentiations of structure which otherwise require staining to make them visible. The chromatin of the nucleus and such substances as cuticle and cork are almost opaque to the ultra-violet rays, and can be made visible on a fluorescent screen or can be photographed. The resolving power of the microscope is doubled, and Lummer considers that the principle employed is the only one by which further progress in resolving power can be made. If the method is found by cytologists to be a workable one, it may open up an entirely new field of microscopic investigation by which the protoplasmic differentiation in living cells may be more clearly revealed.

Many attempts have been made to show that the cytoplasm possesses a definite morphological structure of its own, which is related to the various functions it performs, and that it is not a formless semi-viscid fluid in which various physical and chemical forces are at work, and upon which the various structures observed depend; in other words, that it possesses a morphological constitution as opposed to a merely chemical one.

Fromman and Heitzmann in 1875 described the structure of cytoplasm as consisting of fine threads or fibres in the form of a net with fluid between and forming a sponge-like structure. Flemming in 1882 described it as composed of two substances, one in the form of fibrils (filar substance) embedded in the other, a more or less homogeneous interfilar substance. In 1890 Altmans propounded his interesting hypothesis that all living substance is made up of minute granules or bioblasts, which are the real vital units or elementary organism, embedded in a homogeneous substance, the non-living matter. Cells are formed by a combination of these units of a lower order, and are therefore individuals or units of the second order.

At about the same time Butschli brought forward his celebrated hypothesis of the froth or alveolar structure of cytoplasm. This was based upon an extensive series of observations upon both living and dead cells as well as upon froths or foams made by mixing salts of various kinds with oil and then placing small particles of the oily mixtures so obtained in water.

Butschli compares the structure of cytoplasm to that of a fine froth, and considers that much of the granular, and network or fibrillar structure can be referred to the optical appearances presented by such a froth. That such structures are visible cannot be doubted by anyone who has examined these froths attentively with the microscope. But that all the fibrillar structures described by Fromman and Flemming, whose observations have often been confirmed since by competent cytologists, can be referred to a froth structure, cannot, I think, be accepted by anyone who has carefully examined plant cells.

From the fact that cytoplasm appears homogeneous under certain conditions, and that the foam structure can be so readily produced in it by various means, and further that, as Hardy has shown, the action of certain reagents upon colloids results in the separation of solid particles which become linked together to form a comparatively coarse, solid framework in the form of an open net which holds fluid in its meshes, it is probable that we shall find the foam-structure theory of protoplasm is not tenable. It seems far more in accordance with what we know that we should regard protoplasm as fundamentally a semi-fluid, homogeneous mass, in which, by its own activity, granules, vacuoles, fibrils, &c., can be produced as secondary structures; and that any special morphological structure which it may possess is beyond the limits of the present resolving powers of the microscope.

The Structure of the Nucleus.

From the recent observations of Gregoire and Wygaerts, Berghs, Allen, Mano, and others, it is difficult to arrive at any definite conclusions as to the structure of the nucleus, or as to the changes which take place in it leading to the production of the chromosomes. The resting nucleus seems to possess a very simple organisation. In the living condition it appears to consist merely of a homogeneous ground substance in which is contained a mass of chromatin granules which do not appear to have any particular shape, and one larger granule of a spherical shape, the nucleolus. Sometimes a network or foam structure is visible, but not always; but here, as in the cytoplasm, it is difficult to be certain of this. It may be that the chromatin is always in the form of an irregular network embedded in the colourless ground substance, and that the granular appearance is due to an optical effect similar to that observed in finely meshed oil-foams. According to Strasburger, Miss Sargant, Farmer and Moore, Mottier, and others, the nucleus contains an achromatic network—the linin—in which the chromatin granules are embedded. Mano, Moll, and Sypkens deny the existence of these two substances, and state that the network consists of chromatin only; while Gregoire and Wygaerts, Allen and Berghs, are inclined to the view that there is a fundamental basis of linin which is impregnated by chromatin ordinarily diffused through its whole substance, but capable of being collected into certain definite regions under certain conditions by which the granular appearance is produced. The evidence brought forward in many of the more recent investigations certainly goes to show that the chromatin is not in the form of such definite granules as was at one time supposed; that they are not so regular in size or outline; and that it is not easy to differentiate between the chromatin and achromatin contents of the nucleus. Staining reactions do not afford a sound clue to their differentiation, for, as Fischer and, more recently, Allen have shown, the differences in staining reactions of the different parts of the nucleus vary according to the strength of the stain, the time it is allowed to act, and the size or thickness of the granules or threads stained.

Strasburger has suggested that the chromosomes are formed by the fusion of gamosomes (chromatin granules) around gamo-centres into zygosomes (chromosomes), but the changes which take place are probably not so clearly defined as this. What seems clear from the facts we know is that the substance forming the homogeneous chromosomes—the chromatin or nuclein—becomes broken up in the reconstitution of the daughter-nuclei, by vacuolation or otherwise, into an irregular network which presents a granular appearance. In this all trace of the original individual chromosomes is in most cases lost, and at the same time one or more deeply staining bodies of a spherical, or nearly spherical shape—the nucleoli—appear in contact with it.

The Nucleolus and its Function.

The evidence is steadily accumulating that the nucleolus is intimately concerned in the formation of the chromosomes, although probably not exclusively concerned in this function. In most cases it appears to form a part of the chromatin network, being connected to it by threads, and generally gives similar reactions to the chromosomes. In some few cases it is described as completely separated from the network by a clear area which is visible both in the living and in the stained condition. The evidence that the nucleolus is concerned in chromosome formation may be summed up as follows: the nucleoli are closely connected or associated with the nuclear network; as the nuclear network becomes more deeply stained the nucleoli become smaller or lose their capacity for stains; at the time the chromosomes are being differentiated they are connected to the nucleoli by delicate threads; the chromosomes resemble nucleoli in their behaviour towards reagents and stains; during the period of sinapsis the nucleoli come into very close relations with the nuclear thread, and as the nucleus gradually passes out of the sinaptic stage the thread stains more deeply; in the reconstitution of the daughter-nuclei the chromosomes can be seen to fuse together into a more or less irregular mass, out of which the delicate nuclear network and the prominent nucleolus are evolved; in certain cases all the chromatin appears to be stored up in the nucleolus.

It has been suggested that the nucleolar substance is a product of excretion of the nucleolus, but there is very little evidence for this view. On the other hand it is very likely, as suggested by Mottier, that the nucleolus contains a store of nutritive material which can be used up for various purposes, both in the nucleus and in the cytoplasm. In some cells a portion of the nucleolar substance is thrown out into the cytoplasm during the division stages, and it is very probable that this may have some important connection with the metabolic activity of the cell at this period.

Division of the Nucleus in the Spore Mother-cells.

The divisions of the nucleus which lead immediately to the formation of the spores possess some features which are not found in ordinary vegetative mitosis, and which have an important bearing upon the facts of heredity. The first of these is known as the heterotype, the second as the homotype division. The essential features of the heterotypical division are as follows:—The chromatin net becomes gradually resolved into a more or less continuous spireme. This thread (or threads) contracts into an irregular mass around the nucleolus, a phenomenon which was first discovered by Moore, and to which he gave the name of "sinapsis." Some observers regard this contraction as caused by reagents; but since it has been observed in the living condition by Miss Sargant and others, it is probably a definite and normal stage in the division. It is concerned with some very pronounced changes which take place at this time in the nucleus. The nuclear thread becomes more prominent, stains more deeply and exhibits a double row of granules which gives it the appearance of a double thread. This has been variously interpreted by different investigators: Miss Sargant, Farmer and Moore, and many others consider that it is due to a longitudinal splitting of the thread; Dixon, Gregoire, Berghs, and Allen consider it as indicating a close approximation of separate loops of the thread. Whichever of these explanations is the correct one, the doubling gradually disappears and the thread becomes distributed through the nuclear cavity and again appears single; it becomes shorter and thicker and once more becomes aggregated around the nucleolus. This may be, as Miss Sargant suggests, a second sinapsis. At this stage the chromosomes appear, but reduced to half the number of those which appeared in the previous divisions, so that they may be regarded as bivalent or double chromosomes. They become shorter and thicker, and gradually become grouped in the equatorial plane of the nucleus, where they become attached to the spindle fibres. Each chromosome now divides into two halves, which pass to the respective poles of the spindle, to form, without the intervention of a complete resting stage, the division figures of the daughter-nuclei.

The exact mode in which the division of the chromosomes into two halves takes place is the subject of much controversy. The studies of Weissman on the phenomena of heredity led him to the conclusion that the chromosomes consist of more than one complete ancestral germ-plasm, and that consequently these must be reduced in number in the sexual cells to escape the extraordinary complexity which would arise if the ancestral germ-plasms were doubled at each sexual fusion. As the longitudinal division of the chromosomes divides them into two equal halves it is obvious that this will not reduce the number of ancestral germ-plasms, and therefore Weissman predicted that a transverse division of the chromosomes would be found to take place by which the reduction would be brought about. This was soon discovered to be the case for many animal cells, the reducing division taking place during the formation of the sexual cells, but in plants this was not so easily determined. Belajeff, Dixon, Atkinson, and others maintained that a true reduction division took place in the cases examined by them; but the majority of observers, Miss Ethel Sargant, Strasburger, Farmer, Mottier, and many others, maintained that there was no transverse division, but that all the divisions were longitudinal. Recently, however, Farmer and Moore have re-investigated the whole sequence of events in both animals and plants, with the result that a true reduction division is found to occur in the heterotype stage. In many investigations which have recently appeared this transverse division is confirmed, but the exact details of the process are not yet agreed upon. Farmer and Moore state that the spireme thread first becomes longitudinally split, the two longitudinal halves then fuse again, and subsequently bivalent chromosome loops are formed which divide transversely in the middle, and so produce two monovalent chromosomes which pass to opposite poles of the spindle, as already described. Gregoire, on the other hand, states that the threads at the first sinapsis become approximated together and then fuse; the double thread thus produced breaks up into chromosomes, which are thus bivalent in a different sense from those of Farmer and Moore, the monovalent chromosomes being produced by a longitudinal splitting of the thread, which divides it into the two original halves which fused together.

Which of these two methods will ultimately be found to be the correct one remains to be seen, but Allen has recently published an account of the process as it occurs in *Lilium canadense,* in which he agrees substantially with Gregoire, and states definitely that the first appearance of the double nature of the thread is not due to a longitudinal splitting of a single thread, but to an approximation of two threads, which ultimately fuse together to form a single continuous thread in the nuclear cavity. This thread at a later stage undergoes a longitudinal splitting, possibly into those which formerly united; but this is not certain. The double thread then divides up into segments, the chromosomes, and in the subsequent series of events the longitudinal halves of these chromosomes become distributed to the opposite poles of the spindle. Each chromosome is thus seen to be bivalent; but whether each half of the chromosome is to be regarded as a monovalent chromosome is doubtful, as the fusion of the original threads was complete, and there is no means of deciding as to how far the subsequent longitudinal division of the completely fused thread separated it into its two original parts.

Sinapsis.

The term "sinapsis" was first given by Moore to that stage in the prophases of the nuclear division of the sexual cells in which the contraction of the nuclear thread around the nucleolus at one side of the cavity of the nucleus takes place. If this phenomenon is not a result of the action of the fixing reagents, then it indicates some striking change in the metabolic activity of the nucleus. This activity is seen in the increased staining capacity of the chromatin thread and in the changes which take place in the nucleolus, by which it becomes very irregular in shape and closely connected by threads to the chromatin network. In many cases the nucleolar substance appears as if being drawn out into the threadwork, and the nucleolus appears as if some active change were taking place in it.

It is very difficult to escape the conclusion that we are here dealing with a series of changes in the chromatin thread which are intimately bound up with the activity of the nucleolus, and it is probable that the increased stainability of the chromatin is due to an actual transference of a portion of the nucleolar substance into the thread.

Experimental Observations on the Activities of the Nucleus.

So far as I know no experimental investigations into the causes which bring about the changes in the prophases of nuclear division have been made, but it is not difficult to imitate artificially some of the phenomena observed. Olive oil is shaken up in a mixture of methylated spirit and water of such a strength as will allow the oil globules to float. A shallow Petrie dish, three or four inches in diameter, is then taken; the mixture of oil and dilute methylated spirit is well shaken until the oil is broken up into very fine globules, and the mixture is at once poured gently into it. The appearance of the mixture is that of a homogeneous mass of small oil globules distributed through the solution, and can be compared to the granular appearance of a nucleus in a resting stage. The spirit at once begins to evaporate, and currents are at once set up in the solution in such a way that the globules of oil gradually become restricted to certain areas only, and a coarse granular network is formed somewhat like the early stages in the aggregation of the chromatin granules into a spireme in the nucleus. The network gradually becomes more and more clearly defined, and then, just as is the case in the nuclear network, it begins to show a double row of granules, which finally becomes very clear and distinct. The threads become shorter and thicker and break up into irregular lengths, which gradually mass themselves together into an irregular heap or heaps of fusing-oil globules either in the middle or at the periphery of the petrie dish. We have, in fact, a good imitation of the earlier stages in the prophases of division of the nucleus, and it seems not unlikely that the aggregation of oil globules in our petrie dish may afford some clue as to the possible means by which the aggregation is brought about in the nucleus.

I do not suggest that the complex phenomena which take place in nuclear division are to be explained as due simply to such phenomena as diffusion, surface tension, and the like, or any other physico-chemical processes. We must be very careful not to attempt to force merely physico-chemical explanations upon such phenomena as these. Without admitting the necessity of anything akin to a special vital force, we are compelled to admit that vital phenomena do not at present admit of a merely mechanical explanation. But it does seem to me possible that the metabolic activity of the nuclear material at this stage may be accompanied by phenomena referable in part to these agencies. If, for example, active metabolic activities are set up between the nucleus and cytoplasm through the nuclear membrane, as seems probable, it is quite conceivable that this would bring about diffusion currents which might be taken advantage of in producing the aggregation of the more solid parts of the nuclear substance into a more or less definite thread-like structure and its aggregation into chromosomes. In any case such possibilities must be taken into account in considering the significance of such nuclear re-arrangements, and if any of them can be definitely explained in this way the final solution of the problem may be much simplified.

Validity of Cell Structure as seen in Fixed and Stained Preparations.

Our knowledge of the minute details of cell structure and nuclear differentiation depends upon the appearances presented by cells which have been fixed in various reagents and subsequently stained, and it is not an easy matter to determine in how far these are artificial and in how far they are actual structures existing in the living cell. The researches of Fischer, Hardy, Mann, and others have shown that on the precipitation of proteids by reagents structures are produced which were certainly not present originally, and which resemble those often observed in fixed cells. From a consideration of such facts it has been suggested that many of the details revealed in fixed cells, such as centrosomes and centrospheres, with their fibrillar radiations, are produced artificially and have no real existence. It is unfortunate that so little attention has been paid to the examination of living cells, for the structures which can be seen in them are, so far as they can be revealed by the microscope, always like those seen in fixed preparations.

Differentiation of Structure Visible in the Living Cell.

The amount of differentiation visible in the living cell in favourable objects is very considerable. Not only can chloroplasts, starch-grains, nucleus, leucoplasts, pyrenoids, &c., be clearly seen, but also a very considerable amount of detailed structure. Chromosomes have been seen in the living cell by many observers—Treub, Strasburger, Behrens, Zacharias, and others. The series of figures published by Strasburger of nuclear division in the staminal hairs of Tradescantia show the whole process of chromosome formation and separation into two daughter-groups, except the longitudinal division.

In the same object Demoor and de Wildeman have also been able to detect the spindle fibres and connecting fibres. These were not seen by Strasburger; and Zacharias, who has more recently made observations on staminal hairs, was also not able to detect them. Nevertheless Strasburger mentions that in some cases connecting threads were visible at a late stage in the division between the daughter-nuclei, and Treub also describes a similar phenomenon in some cases during the nuclear division in the ovules of an orchid.

In Spirogyra, Strasburger has given a full account of nuclear division in the living cell. Large species of this alga are very favourable objects for this work, and he has shown that in such species the spindle figure as well as the connecting fibres can be seen in the living cell. Wildeman has also seen and figured them; but Behrens states that spindle fibres and connecting threads are not visible in Spirogyra during life.

My own observations upon a large species of Spirogyra which I have had an opportunity of investigating entirely support the view that these structures are visible in the living condition.

The Structure of the Chloroplast.

In view of its extreme importance in the function of assimilation a knowledge of the structure of the chloroplast is important. Owing to its small size a satisfactory demonstration of its finer structure is very difficult. That it consists of a colourless ground substance, in which the chlorophyll is embedded, is clear; but how these two substances are united and the relations between them structurally are not known. Pringsheim concluded that the ground substance of the chloroplast is a sponge-like network with the oil-like solution of chlorophyll in its meshes.

Schmitz thought that the fine granular appearance of the chloroplast was due to a fine net-like structure in which the chlorophyll was diffused. Fromman also describes it as a green granular network. Schwartz, on the other hand, describes it as composed of a ground substance containing a number of green fibrillæ side by side, which are coloured green throughout, but show also an accumulation of the green colouring matter in the form of granules along these threads.

Meyer thought it was composed of a homogeneous ground substance with various-sized granules of the green substance embedded in it. To these granules he gave the name of "grana." Schimper stated that it was composed of a colourless stroma containing numerous vacuoles filled with the green semi-fluid chlorophyll, identical with the "grana" of Meyer.

Some observers consider that the chloroplast is surrounded by a distinct membrane; whilst others consider that the substance of the chloroplast is directly connected by colourless strands to the cytoplasm.

According to some observations which I have made recently, the chloroplast, when examined under high powers in the living condition, appears to be filled with a mass of green granules with a colourless substance between them. But in certain cases a distinct fibrillar arrangement of the chlorophyll is observed. This is very easily seen in the chloroplasts of Euglena, both in the living condition, and, more easily, when the cells are burst and the chlorophyll grains are extruded into the water. But it may be seen also in the chloroplasts of the higher plants when these are large enough to be examined easily. In these cases the green colouring matter appears granular when the chloroplast is in the epistrophe or shade position, fibrillar when it is in the apostrophe or intense light position. This difference in the appearance of the chlorophyll accompanies a difference in the shape of the chloroplast. As is well known, the chloroplast in the epistrophe position presents an oval or more or less circular form; in the apostrophe position a flattened and lenticular form. The fibrillar structure appears to be that of fine fibrils lying more or less parallel, but a closer examination shows that they are connected together here and there so as to give the impression of an elongate network. In the epistrophe condition the chlorophyll corpuscle appears greener than in the apostrophe condition. The granules are in fact so arranged and so numerous as to present a practically continuous surface of chlorophyll to the action of the light rays. The fibrillar arrangement, on the contrary, has numerous light spaces between the fibrils, so that less surface of chlorophyll is exposed to the rays of light. The difference in the amount of chlorophyll surface exposed to the light appears therefore to be bound up with the difference in the intensity of light which causes the different positions of epistrophe and apostrophe to be assumed by the chloroplast. Just as in diffuse light the chloroplasts themselves are more fully exposed to the light than in intense light, so in the individual chloroplast we appear to have such an arrangement of the chlorophyll that in diffuse light a larger surface of it is exposed to the light rays than in a more intense light. The interesting conclusion is therefore arrived at, that the chloroplast is able, not only by its position but also by its structure, to guard itself against the effects of a too intense light.

A careful examination of the chloroplast in the epistrophe position renders it probable that the granular appearance is not due to the existence of separate granules of chlorophyll. It resembles more nearly an optical effect, due to the superposition of alveoli upon one another, such as appears in fine oil-foams. By focusing carefully above and below the granules we get a distinct appearance as of a green alveolar network. If the chlorophyll corpuscle is extruded into water it begins to swell up and becomes vacuolar; the granules disappear and the chlorophyll then appears to be distinctly diffused through the ground substance of the chloroplast. I am therefore inclined to the view that the chlorophyll corpuscle consists of a ground substance in the form of a delicate alveolate structure, in which the chlorophyll is more or less uniformly diffused. The diameter of the threads of this network is greater in the epistrophe than in the apostrophe position, and this affords a means by which the chloroplast can accommodate itself to varying intensities of light.

The chloroplast must be regarded as performing at least two functions. It brings about the dissociation of CO_2 and it is a starch-forming organ. In the algæ and some other plants these two functions appear to be differentiated, and starch is formed directly by the pyrenoid. How far these two functions are independent in the ordinary chloroplast is not known; but that starch can be formed, independently of chlorophyll, in the leucoplasts and in the ordinary chloroplasts directly from sugar and other organic solutions in the dark seems to indicate that the two are not necessarily connected.

The colourless stroma of the chloroplast gives a distinct and pronounced reaction for phosphorus when treated according to Macallum's method. It resembles, therefore, in this respect the nuclein constituent of the nucleus. What the exact significance of the presence of phosphorus in the chloroplast may be I do not know, but it is extremely interesting to find that in an organ in which a high degree of metabolic activity is always found a substance should be present which is akin to the highly organised nuclear constituents. It suggests an interesting comparison with those plants in which a special starch-forming organ, the pyrenoid, is differentiated.

The Centrosomes and Centrospheres.

A vast literature has grown up in connection with the structure and function of these bodies because of the special importance which has been attached to them as the originators of the process of nuclear division and of the formation of the spindle, and because of the important part which it is assumed they play in the phenomena of fertilisation.

Their very general occurrence in animal cells and their prominence in the reproductive processes led plant cytologists to predict that they would be found to occur also in plant cells. But their prediction has not been fulfilled. They are frequently found among the Thallophytes and Bryophytes, but in the higher plants the evidence is steadily accumulating against them, and such structures as have been described by Guignard and others are held to be based upon a misinterpretation of the facts observed.

Where the centrosome exists it consists of a deeply stained granule or group of granules surrounded by radiating fibres. In some cases, as in the Basidiomycetes, the centrosomes only become definitely visible as minute dots at the poles of the spindle, and are not visible until this is completely or nearly completely formed. In other cases, as in Dictyota (Mottier), Ascomycetes (Harper), the centrosomes with their radiations are clearly visible at two opposite sides of the nucleus in the resting stage, and are in close contact with the nuclear membrane. In the Ascus, Harper has shown that the centrosome is in close contact, not only with the nuclear membrane, but also with the chromatin net, and it seems probable that there may be a connection between them. The spindle fibres are formed both in Dictyota and in the Ascus in the nuclear cavity before the nuclear wall breaks down. In the division of the daughter-nuclei the centrosome which is carried over with each daughter-nucleus appears to divide—but this is not certain—to give two new centrosomes for the formation of the new spindle figure.

Experiments on the Production of Artificial Asters.

There are two main views as to the nature of the spindle and astral fibres: (1) that they represent a definite morphological differentiation of the cytoplasm which possesses in itself the power of forming these fibres; (2) that they are formed out of the cytoplasm by some modification of its structure or arrangement of its parts, or by the precipitation or condensation of some of its constituents.

The aggregation of granules into radiating fibrils can be imitated artificially by allowing a drop of alcohol or turpentine to fall upon smoked glass. If the drop is allowed to fall from a good height, we get the artificial centrosomes with radiations first described by Henking; these are due mainly to the splash of the drop and its breaking-up into small particles which radiate outwards, carrying portions of the smoke film with them. If the drop is allowed to fall more gently, so that it does not splash, its first effect is to produce a clearly circumscribed circular ring, and then, by slowly spreading outwards, to produce an aggregation of the smoke particles into fibrils which more nearly represent the appearances produced in cytoplasm than do Henking's splashes.

By careful manipulation we can get in this way representations of the centrosome or centrosphere, or even the radiations around the nucleus. If the edge of the alcohol or turpentine be carefully examined under the microscope as it is slowly spreading outwards, a violent motion of the smoke particles will be observed as soon as the liquid comes into contact with them, and as the liquid passes on these particles settle down into definite continuous fibrils, which go on growing as the liquid continues to spread.

Fischer has described the formation of artificial asters by two methods: (1) If pith is injected with proteid and then fixed, asters are found around small particles of foreign matter in the proteid. (2) If a small granule of corrosive sublimate or a drop of osmic acid be brought into a proteid solution radiating striæ are formed in it by precipitation. He suggests that the centrosome is formed by the precipitation of albuminous substances in living cells by the excretion of nucleic acid from the nucleus, and that, as in (1), artificial radiations are formed around it by the action of the fixing reagents; or possibly by the fixative action of the nucleic acid itself. Or the centrosome itself may produce them, as in (2), by acting as the precipitating agent, just as corrosive sublimate or osmic acid. Mr. Jenkinson has recently described some interesting experiments on the artificial production of asters, and comes to the conclusion that osmotic pressure and surface tension are probably concerned in the formation of these structures in the living cell. The centrosome may be a body capable of withdrawing water from the cytoplasm, of swelling up and dissolving in the water so absorbed, and then giving off radial outgrowths which precipitate the proteids of the cell, and so form astral rays; or the centrosome may undergo decomposition, or may secrete a ferment which would have the same effect upon the cytoplasm.

The Blepharoplast.

The blepharoplast is a special organ associated with the formation of the cilia in motile spermatozoids and zoospores. It consists of a centrosome-like granule, often surrounded by radiations. It appears inside the cell in close relation to the nucleus, or sometimes at the periphery of the cell. In Polytoma the two cilia thus arise from a granule (blepharoplast) at the extremity of the cell. In Ædogonium the blepharoplast arises, according to Strasburger, in the plasma membrane. Strasburger considers them as kinoplasmic in nature, and thus brings them into relation with his other kinoplasmic structures, the centrosome and spindle.

Some authors consider that the blepharoplast is a true centrosome, or homologous with a centrosome. It has not, however, been conclusively shown that it at any period in its history performs the function of a centrosome, or that it is derived from one. Further, in many of these plants, if not all, there are no centrosomes at any stage in their life-history.

On the whole the evidence is distinctly against the view that the blepharoplast is genetically connected with the centrosome. It is more in accordance with the present state of our knowledge to consider the blepharoplasts as special structures which arise *de novo* in the cell for the special function of cilia formation.

The Coenocentrum and its Function.

In the oögonia of some fungi there appears at an early stage in the development of the oösphere a dense granular, deeply stainable substance, the function of which is unknown. It appears in the centre of the cell, and was first discovered in the oösphere of *Cystopus* (*Albugo*) *candida*. It is probably formed by an accumulation of stainable granules or microsomes. It disappears soon after fertilisation takes place, and is therefore not a permanent organ of the cell. Shortly after its appearance one of the nuclei out of the large number irregularly scattered through the oögonium comes into contact with it, and gradually becomes more or less embedded in it. All the other nuclei pass to the periplasm, leaving this single nucleus as the nucleus of the ovum. The fertilising tube which contains the male nucleus also grows towards it, and comes close to it to discharge the male nucleus upon it. This indicates that it may exert in some way or other an attraction, first upon the female nucleus, and secondly upon the fertilising tube, thus helping to bring the sexual nuclei together. Stevens suggests that it may be of the nature of a dynamic centre, and he gave it the name *coenocentrum*. It may be nutritive in function, and may exert a chemotactic stimulus upon the sexual nuclei.

It does not appear to be actually concerned in the fusion of the sexual nuclei. In *Peronospora parasitica*, for example, it completely disappears before the fusion of the nuclei takes place. So far all the views as to its function are purely hypothetical. It may be a mere coincidence that it should become associated with the sexual nuclei at the time they come together in the oösphere. Its function may be totally unconnected with these. From the fact that it stains so deeply in nuclear stains, the substance of which it is composed may be of the nature of nuclein, and it is possible that it may be due to a substance secreted by the nuclei of the oögonium for some special purpose connected with the maturation of the oöspore. It is possible that it may have something to do with the formation of oil, which appears in such abundance in the ripe oöspores. It begins to disappear just at the time the oil begins to form.

It seems more likely that the function of the cœnocentrum is connected with those metabolic activities of the zygote, which must at this stage in its development be very considerable, than with the exertion of an attractive influence upon the sexual nuclei. It is difficult to see how such a selective chemotactic stimulus could be exerted as to act upon one nucleus only out of the large number in the oögonium. But the evidence before us does not admit of any definite solution of the problem at present. The subject demands further investigation of such a kind that a comparative study of the formation and disappearance of the cœnocentrum, the formation of the oil reserves, and the changes in the nuclei, should be carried on side by side.

The Nuclei of the Lower Plants.

The presence of nuclei in the algæ and fungi had already been recorded by Nägeli and many other observers shortly after the discovery of the nucleus by Robert Brown, but it is doubtful whether all the structures described as nuclei by these early observers were really so. It is only in comparatively recent times that it has been possible to determine with any degree of certainty that the minute deeply stainable bodies described more especially by Schmitz (1879) could be regarded as nuclei. This determination was easily made for many of the algæ, especially by the researches of Strasburger, who described both the structure and mode of division. But among the fungi the structure and mode of division of the nuclei were practically unknown twenty years ago, and we have the opinion expressed by De Bary in 1887 that the satisfactory discrimination of true nuclei from other small bodies contained in the protoplasm can only be obtained after renewed investigation.

Previous to 1887 cases of karyokinetic division in fungi had been described by Sadebeck (1883), Strasburger (1884), Fisch (1885), and Eidam (1887). Hartog (1889) described a process akin to karyokinesis in the Saprolegnieæ, and at the end of that year a true process of karyokinesis was shown to occur in Peronospora. Since that time our knowledge of the process of nuclear division in the fungi has been largely extended, and the phenomenon has now been found to be of general occurrence in the group, and many of the forms are unusually favourable objects for the study of the process.

The only groups of plants in which true nuclei have not been found are, so far as I know, the bacteria, Cyanophyceæ, and the yeast fungi. In the yeast plant there is a large homogeneous spherical body which gives the reactions of chromatin similar to the chromatin of true nuclei. With this is associated a prominent vacuole which contains a more or less amorphous substance of a chromatin nature. The two appear to be very closely related and undergo division simultaneously.

The Cell Structure of the Cyanophyceae.

It is easy to demonstrate in the living cell of the Cyanophyceæ that the contents are differentiated into two distinct regions: (1) an outer layer containing the colouring matter; and (2) a central colourless portion which is known as the central body. The central body is considered by many investigators to be a true nucleus. It contains a deeply staining granular substance which to some extent resists the action of digestive fluids, and is therefore similar to the chromatin in the nuclei of the higher plants. In 1887 Scott was able to demonstrate a reticulate structure in this body, and also saw some indications during its division of a process akin to karyokinesis. Zacharias also in the same year, largely on micro-chemical grounds, concluded that it was a nucleus. The problem has been the subject of investigation by numerous observers since that date with very varying results. These results may be shortly summarised as follows:—The central body is not a nucleus (Macallum, Fischer, Massart, Chodat). It is a nucleus of a simple or rudimentary type (Hieronymus, Nadson, Butschli). It is a true nucleus similar to that found in the higher plants, and forms both chromosomes and spindle (Hegler, Kohl, Olive, Phillips).

The facts of the structure of this body, so far as I have been able to ascertain them by the examination of the cell both in the living and fixed conditions, are that it possesses a vacuolate structure, associated with granules which stain deeply in nuclear stains, resist the action of digestive fluids, give a strong reaction for phosphorus and masked iron, and, further, according to the recent researches of Macallum, do not contain potassium. These qualities are characteristic of nuclein, and there can be, I think, no reasonable doubt that these granules are comparable to the chromatin of a true nucleus.

From a consideration of the facts we at present know concerning the central body we cannot, I think, escape the conclusion that it is of the nature of a nucleus, but one of a simple or rudimentary type. It is not sharply delimited from the surrounding cytoplasm, although it sometimes appears as a vacuolar cavity in the centre of the cell, with a vacuolar membrane around it. It seems to me that we might very well regard it simply as a specialised region of the cytoplasm which possesses a pronounced vacuolation associated with granules of chromatin or with a chromatin network.

The Function of the Nucleus of the Cyanophyceae.

The nucleus of the Cyanophyceæ is very large, much larger proportionally than the nuclei of the higher algæ. It gives also a proportionally stronger reaction for phosphorus. Some observers have considered the large size and prominence of the central body as an argument against its nuclear nature. In the algæ the nuclei are much smaller in proportion to the cell, and in many forms are very difficult to make out. On the other hand the pyrenoids which are present in the cells of Algæ stain more deeply in the nuclear stains, and give a much stronger reaction for phosphorus than the nuclei. In *Prassiola parietina* the pyrenoid is in the centre of the cell, and both in the living condition and in stained preparations is much more prominent than the slightly stained nucleus on one side of it. So, also, in Zygnema there are two star-shaped chromatophores, each with a large pyrenoid in the middle, and between them a small very inconspicuous nucleus.

My view is that the large size of the central body in the Cyanophyceæ may be connected with the development of the chlorophyll assimilation; that it may be held to function both as a pyrenoid as well as a nucleus, and that this receives support from what is observed in the coloured bacteria, in which the cytoplasm contains a more abundant supply of chromatin granules than do the colourless bacteria.

Structure of the Bacterial Cell.

Owing to the small size of the bacterial cells it is very difficult to arrive at a correct interpretation of the structures observed. The examination of the larger forms, such as the various species of Beggiatoa, Chromatium, *Bacillus anthracis, Bacillus subtilis*, &c., has, however, revealed a certain differentiation, which enables us to come to some conclusions as to their actual structure. Ernst has shown that the contents of these cells are not homogeneous, as was formerly thought to be the case, but show a differentiation into a less stainable substance, and embedded in it one or more deeply stained granules.

Butschli has shown that the central portion of the contents of the cell exhibit a foam structure in which granules of a chromatin nature are embedded: this is surrounded by a thin layer of a less deeply stained substance, which sometimes accumulates more prominently at the ends of the cell. The central, more deeply stained, froth-like structure with its granules is the nucleus; the delicate peripheral layer is the cytoplasm. From a recent examination which I have made of *Beggiatoa alba, Beggiatoa roseo-persicina, Bacillus subtilis,* and other smaller species, I cannot agree with Butschli that there is a differentiation into a central body or nucleus, and peripheral cytoplasm. In the various species of Beggiatoa and Spirilla which I have examined the cell contents exhibit a reticulate or foam structure of the cytoplasm in which one or more deeply stained granules may be embedded. As these granules stain deeply in nuclear stains, and also give a reaction for phosphorus, they are probably similar to chromatin. They are distributed throughout the whole cell, and are not specially confined to one place.

We must conclude that the bacteria do not contain anything which can be individualised as a nucleus, but that the nuclein constituent of the cell when present is contained in granules distributed throughout the cytoplasm.

The Evolution of the Nucleus.

All plant nuclei, from the algæ and fungi upwards, present a striking similarity both in structure and mode of division. The same appears to be true of the animal kingdom, from the protozoa upwards. But among the protozoa on the animal side, and the yeast fungi, bacteria, and Cyanophyceæ on the plant side, there is a kind of border kingdom in which occur structures which appear to represent the nuclei of the higher organisms, but are so different from them in many respects that it is very difficult to say whether they should be regarded as nuclei or not. As we have already seen, the central body of the Cyanophyceæ and the chromatin granules of the yeast plant and bacteria may represent simple or rudimentary forms of nuclei. It is, therefore, possible that we may obtain from them a clue or indication of some kind as to the origin of the nucleus and the process of its evolution.

It is among the protozoa that we find the greatest variation both in form and structure of these rudimentary nuclei. All the various parts of the nuclei of the higher animals can be recognised in them, but, as Calkins points out, are rarely present in one and the same nucleus. From a consideration of the various types Calkins considers that the most primitive nucleus is probably a single mass of chromatin without membrane or reticulum. By the division of this into granules, their association into lines forming primitive chromosomes, the development of a linin network, and the formation of a definite nuclear membrane was gradually brought about the development of the typical nucleus.

In the three groups of plants the Cyanophyceæ, bacteria, and yeast fungi it is not possible to recognise all the various parts of typical nuclei as in the protozoa. In none of them do we find a nuclear membrane, nucleolus, chromosomes, or spindle figure, or centrosome. We have nothing very tangible, therefore, to compare with the typical nucleus of the higher plants, and it is no doubt very largely due to this that we have so many contradictory accounts of the nuclear structures in these forms.

At the same time the nuclei of the higher plants pass through stages in their division which more nearly approach in their structure the simple forms with which we are now concerned. Thus the nuclear membrane and nucleolus disappear, and the chromatin network becomes condensed into a number of homogeneous rods or granules, the chromosomes, which lie free in the cytoplasm. There seems to be no reason why we should not consider the simpler chromatin structures in the lower plants in the light of these ontogenetic changes, as we may term them, of typical nuclei, in order to obtain some indication of the origin and phylogenetic development of the nucleus.

We may take the colourless Beggiatoa as a starting-point; not that this form is the lowest, but because its structure is, on account of its size, more easily examined, and because it is connected possibly with the Cyanophyceæ on the one hand and with the ordinary bacteria on the other. From a careful examination and comparison of its structure with that of other low forms we obtain the following diagram, showing their possible relationships as indicated by their cytological structure:—

?

Beggiatoa alba.

(Chromatin granules may or may not be present.)

Beggiatoa roseo-persicina, Chromatium okenii, &c.

Many chromatin granules often condensed in the centre of the cell. Cytoplasm coloured.

Cyanophyceae.

Central body with chromatin granules surrounded by a peripheral coloured protoplasm.

?

Algæ.

Larger Spirilla with colourless cytoplasm. (Few small chromatin granules).

Forms like *Cholera vibrio, B. lineola, B. anthracis, Typhus bacillus,* &c. Colourless. (One or two chromatin granules.)

Yeast Fungi.

With one or two chromatin granules associated with a nutritive vacuole.

Fungi.

In the simplest case the cell of Beggiatoa contains only cytoplasm without, so far as I can see by careful examination with the highest powers available, any differentiation of chromatin grains or structures of a like nature. Neither do I think that we can regard the protoplast as representing a nucleus. As Fischer points out, the idea that the protoplast of the bacteria stains like a nucleus is not correct, and, as I have been able to show, it certainly does not give a phosphorus reaction like a nucleus. It is, in fact, a simple undifferentiated mass of cytoplasm, either homogeneous or at times exhibiting a foam structure. In this cytoplasm a few granules of chromatin may become differentiated, and this is the first indication of the separation of nuclear substance. Whether there are any species of Beggiatoa or other bacteria which are permanently without nuclear granules I do not know, and it will be very difficult to prove it: but the fact that under certain conditions these cells exist without them seems to point to the conclusion that this may be the primary cell structure, as has been surmised by Haeckel and others.

At an early stage in the evolutionary history of the protoplasm, before a typical nucleus was evolved, we appear to have had the development of colouring matter for the function of assimilation, and a bifurcation into the two distinct lines of descent of the fungi and the algæ. This appears to have been accompanied by two distinct lines of nuclear evolution leading respectively to the development of the central body of the Cyanophyceæ and the nuclear apparatus of the yeast plant. The possible lines of development of the nucleus up to the yeast fungi on the one side and to the Cyanophyceæ on the other are clearly indicated in the diagram; but between the yeast fungi and the true fungi, and between the Cyanophyceæ and the Algæ, there are gaps which we cannot bridge at present. It is possible that the evolution of the typical nucleus may have been brought about in the fungi by the more definite association of the nuclear vacuole with the homogeneous nuclear body, possibly accompanied by a vacuolation of the latter, or that the nuclear body itself may have become the nucleus direct by a process of vacuolation and differentiation within itself.

In the case of the Cyanophyceæ I have already shown that the central body is a vacuolar structure associated with granules of chromatin, and that sometimes this vacuolation becomes so pronounced in resting cells that we get an appearance as of a limiting membrane between it and the cytoplasm. The granules run together and become associated in such a way as to simulate the spireme thread of an ordinary nucleus. Further, we have in some Cyanophyceæ a differentiation of a nuclein-like substance in the form of the red granules of Butschli at the periphery of the central body, which may be an early stage in the separation of a portion of its substance to perform the special functions of the pyrenoid. The complete separation of this into a definite pyrenoid and the formation around the remainder of a nuclear membrane would give us a differentiation comparable to some extent to what we find in *Euglena viridis*, where we have a reticulate nucleus which divides by a rudimentary process of karyokinesis, in which, so far as we know, there is no definite formation of chromosomes and no longitudinal splitting.

As to when or how the higher differentiation of the nucleus, with its chromosomes, longitudinal division, and spindle figure, arose we do not know. Possibly a careful investigation of the lower forms of the fungi and algæ and such organisms as Euglena, and especially the protozoa, may throw light upon this difficult problem.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

SIR DONALD CURRIE has promised to give 20,000*l.* to the equipment fund of Queen's College, Belfast, provided an equal sum is raised from other sources. It is understood that a considerable portion of this amount has already been promised.

MR. E. TOWYN JONES, demonstrator in chemistry at University College, Bangor, has been appointed assistant lecturer and senior demonstrator in the department of chemistry and physics of the Pharmaceutical Society of Great Britain.

IT is announced that Mr. Bazil McCrea has given 6000*l.* to found a chair of experimental physics in Magee College, Londonderry, and to provide two scholarships in connection therewith. The gift is conditional upon funds being provided by subscription within six weeks for the erection of a suitable physical laboratory.

WE have received the year-book of the Michigan School of Mines for 1904–5, and an album of views showing the facilities for instruction afforded by the immediate surroundings of the college. Established in 1885, the college is situated at Houghton, in the heart of the great copper mining region of Lake Superior, with the deepest shafts in the world and the most powerful machinery ever employed in mining. The students also have access to the docks, railways, dressing plants, and smelting works. The special facilities for practical training largely account for the success which the institution has attained. There are at the present time 223 students, their average age being 22½ years.

THE metropolitan medical schools will re-open for the winter session on October 2 and October 3, and in many of them inaugural addresses will be delivered. At University College the address will be given on October 2, at 4 p.m., by Prof. Kenwood on "Preventive Medicine: Past and Present"; at King's College on October 3, at 3 p.m., by Prof. Clifford Allbutt, F.R.S., on "Medical Education in London," and an opening lecture on October 4, at 4 p.m., by Prof. Dendy on "The Study of Zoology"; at Charing Cross Hospital on October 2, at 4 p.m., by Sir James Crichton-Browne, F.R.S.; at St. George's Hospital on October 2, at 3 p.m., by Mr. Brudenell Carter; at the Middlesex Hospital on October 2, at 3 p.m., by Dr. R. A. Young; at St. Mary's Hospital on October 2, at 3.30 p.m., by Dr. Wilfred Harris; at the London (Royal Free Hospital) School of Medicine for Women on October 2, at 4 p.m., by Mrs. Bryant, D.Sc.; at the London School of Tropical Medicine on October 10, at 4 p.m., by Dr. Nuttall; at the School of Pharmacy, Pharmaceutical Society, on October 2, at 3 p.m., by Sir Boverton Redwood; and at the Royal Veterinary College on October 2, at 4 p.m., by Mr. W. Hunter. At Guy's, the London, St. Thomas's, and Westminster hospitals there will be no inaugural addresses, but at the first named Prof. Osler, F.R.S., will open the session of the Pupils' Physical Society with an address on "Some Reminiscences of Sir Thomas Browne" on October 12, at 8 p.m.

THE second volume of the report of the Commissioner of Education for the year 1903 has now been received from Washington. The bulky volume of some 1300 pages is largely concerned with statistics, full data being provided concerning every grade of educational institution. Dealing with the income of colleges and universities, the report shows that in the United States the State and municipal aid to higher education during 1903 amounted to 1,591,000*l.*, of which 1,034,000*l.* was granted for current expenses and 557,000*l.* for buildings and other special purposes. The total value of all gifts and bequests reported during the year to the commissioner by universities and colleges amounted to 2,950,000*l.* The three institutions receiving the largest sums for the year under consideration were:—University of Chicago, 487,500*l.*; Harvard University, 351,300*l.*; and Barnard College, 225,600*l.* The universities and colleges in the States of the North Atlantic and North Central divisions continue to receive the greater portion of benefactions, more than 90 per cent. of the total amount being reported by them in 1903. Dr. John Eaton, who was formerly United States Commissioner of Education, contributes biographical sketches of American educational benefactors and of American citizens whose lives were devoted to educational work, and this brightly written section of the volume affords another indication of the way in which the men of wealth in the United States are encouraged by those in authority to interest themselves in educational progress.

THE polytechnics and technical institutes of London will open shortly for the winter session, and the issue of new calendars and syllabuses has begun already. The session of Birkbeck College will commence, we learn from its new year-book, on October 2, when Sir Edward Fry will deliver the inaugural address. Afterwards the class-rooms and laboratories will be opened for inspection, and an exhibition of work will be held in the school of art. The work of Birkbeck College is conducted in close relation with the University of London, courses of study for examinations of the university being provided under recognised teachers of the university. In addition to evening classes in almost every department of learning, there are day courses of work which give instruction in practical and theoretical science, in classics, in modern languages, in commercial subjects, and in English literature. The moderate fees will enable students of limited means to take advantage of the lectures and laboratory work which have been arranged at this central institution. The syllabus of classes at the Sir John Cass Technical Institute has also been received, and supplies gratifying evidence of the excellent provision of scientific and technical instruction which is available in Aldgate. It is satisfactory to find that in addition to systematic courses of lectures, special attention is given to laboratory work with a view to bring home to students the general and fundamental principles of science in association with the work and products with which they are more immediately concerned in their daily life.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, July 20.—"A New Formation of Diamond." By Sir William **Crookes,** F.R.S.

Assuming the following data for carbon—boiling point 3870° ab., melting point 4400°, critical temperature 5800°, critical pressure 2320 ats.—the Rankine or Van der Waals formula calculated from the boiling point and critical data gives for a temperature of 4400° ab. a pressure of 16·6 ats. as the melting-point pressure.

Making similar estimates for other temperatures, it appears that above a temperature of 5800° ab. no amount of pressure will cause carbon vapour to assume liquid form, whilst at 4400° ab. a pressure of above 17 atmospheres would suffice to liquefy some of it. Between these extremes the curve of vapour pressure is assumed to be logarithmic.

In their researches on the gases from fired gunpowder and cordite, Sir Frederick Abel and Sir Andrew Noble obtained in closed steel cylinders pressures as great as 95 tons to the square inch, and temperatures as high as 4000° C. According to a paper recently communicated to the Royal Society, Sir Andrew Noble, exploding cordite in closed vessels, has obtained a pressure of 8000 atmospheres, or 50 tons per square inch, with a temperature reaching in all probability 5400° ab.

By the kindness of Sir Andrew Noble, the author has been enabled to work upon some of the residues obtained in closed vessels after explosions, and he has submitted them to the same treatment that Moissan's granulated iron had gone through. After several weeks he removed the amorphous carbon, the graphite, the silica, and other constituents of the ash of cordite, and obtained a residue among which, under the microscope, crystalline particles could be distinguished. Some of these particles, from their crystalline appearance and double refraction, were silicon carbide; others were probably diamonds. The whole residue was dried and fused at a good red heat in an excess of potassium bifluoride, to which was added during fusion 5 per cent. of nitre. The residue, after thorough washing and then heating in fuming sulphuric acid, was washed, dried, and the largest crystalline particles picked out and mounted.

From the treatment these crystals have undergone, chemists will agree that diamonds only could stand such an ordeal; on submitting them to skilled crystallographic authorities the author's opinion is confirmed.

PARIS.

Aacdemy of Sciences, September 11.—M. Troost in the chair.—Remarks on the present condition of solar researches and on the means of improving them: H. **Deslandres.** The author proposed in 1893 that automatic apparatus should be established at suitable spots capable of registering the surface of the sun and the successive layers of its atmosphere. As this has so far not been realisable, on account of the expense, suggestions are now put forward for the correlation of the work of the observers actually engaged in solar research, and these suggestions will be submitted to the International Union at the meeting to be held at Oxford.—On a differential equation of the fourth order: Gaston **Darboux.**—On some properties of the α rays of radium: Henri **Becquerel.** The author showed, two years ago, that the bundle of α rays behaves as homogeneous in the magnetic field, and also that the trajectory of the particles in a plane normal to the field, instead of being a circle, is a curve the radius of curvature of which goes on increasing with the length of the trajectory. The recent work of Bragg and Kleeman and of Rutherford is discussed, especially the hypothesis of the slowing down of the particles used by the latter to explain the experimental results obtained when a series of aluminium screens is interposed in the path of the rays. The author has repeated his original experiments with the addition of aluminium screens, and the results confirm his views. On this account M. Becquerel thinks that the hypothesis of Rutherford regarding the loss of velocity of the particles must be rejected.—On the total eclipse of the sun of August 30: G. **Rayet.** An account of the results obtained by the expedition from the Observatory of Bordeaux at Burgos, Spain. The weather was bad, and interfered with the work of several of the observers. In spite of this, however, two good images of the corona were obtained by M. Courty with the photographic equatorial. M. Esclangon was able to follow the variations in the polarisation during the eclipse.—On the method of using captive and pilot balloons at sea: **Prince of Monaco.** Details are given of the mode of launching the balloons and of maintaining them at heights fixed on beforehand. The observations were carried out in the Mediterranean and in the trade winds region of the Atlantic, the maximum height attained being 14,000 metres.—On the eclipse of August 30, and on the polarisation of the solar corona: Georges **Meslin.** The proportion of polarised light is sensibly the same in the polar and equatorial regions—it is about 50 per cent. Elliptical polarisation could not be detected.—On two particular cyclic systems: A. **Demoulin.**—On the generalisation of algebraical continued fractions: M. **Auric.**—On Monge's problem: M. **Zervos.**—On the physical units of albuminoid material and on the part played by lime in its coagulation: G. **Malfitano.** By repeated coagulation it was found to be impossible to free the albumin entirely from inorganic substances, and the author regards the precipitate as aggregates of molecules, associated with electrolytes. It is probable that the mechanism of peptonisation consists essentially in a change in the nature of the salts which are associated with these aggregates.—The influence of the eclipse of August 30 on some plants: Ed. **Bureau.** *Acacia dealbata* proved to be the most sensitive to light, and during the eclipse executed the nocturnal movements, whilst other species of "sleeping" plants were unaffected.—On the evolution of the liver: Camille **Spiess.**—The vibration of the eyelids in renal affections: G. **Ullmann.** This has proved a valuable sign in affections of the kidney, and is present at the earliest stages.—The direct solution of the silicates from arable earth and the experiments of Daubrée: L. **Cayeux.** The author controverts the views of Delage and Lagatu on this subject, and holds that the experiments of Daubrée have been wrongly interpreted by these authors.—The waterspout of August 28 at Saint-Maur and at Champigny (Seine): Th. **Moureaux.**—On the meteorological observations made at Constantine during the eclipse of August 30: Henry **de la Vaulx** and Joseph **Jaubert.**—On the phenomenon of moving shadows: Lucien **Libert.**—An earthquake shock registered at Grenoble, September 8: MM. **Kilian** and **Paulin.**

NEW SOUTH WALES.

Linnean Society, June 28.—Mr. T. Steel, president, in the chair.—Description of a new species of Actinotus from eastern Australia: R. T. **Baker.**—Revision of the Australian Curculionidæ belonging to the subfamily Cryptorhynchides, part vii.: A. M. **Lea.**—Descriptions of five new species of Cicindela from tropical Australia: T. G. **Sloane.**

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