THURSDAY, SEPTEMBER 28, 1893.

THE PHYSIOLOGICAL PAPERS OF PROF. SACHS.

Gesammelte Abhandlungen über Pflanzen-physiologie. Von Julius Sachs. 2 vols., with 126 woodcuts and 10 plates. (Leipzig, 1892-3.)

THIS excellent collected edition of Prof. Sachs's chief contributions to the physiology of plants will be welcome to all botanists. The author in his preface explains the very sufficient reasons which have led him to publish this collection, and the principles which have guided him in the choice of papers. He has not thought it necessary to reproduce all his physiological treatises, but has more especially aimed at selecting such as deal with matters of fact rather than theory, while some which he considers to be sufficiently well known already are omitted.

Such a collection is a great help to the reader, and especially so when it is compiled by the author himself. In this case we do not merely obtain a series of isolated papers, but have the further advantage of learning the author's mature view of the relative importance of his own researches.

Many of the papers have been abridged, and some are only given in abstract. In many cases notes have been added, which are not the least interesting part of the work, as they often indicate the author's latest views on the questions at issue.

To review adequately a collection of Prof. Sachs's physiological treatises would be to write the history of vegetable physiology from 1859 onwards. Such an attempt is out of the question; only a very short sketch of the contents of this book can be given here.

The selected papers, 43 in number, are arranged, according to subject, in nine groups; within each group the order observed is chronological. The first volume contains works concerned chiefly with the chemical and physical phenomena of vegetation, while those contained in the second volume are on growth, cell-formation, and irritability.

The first section contains essays on the action of heat on plants. The first, published in 1860, is on the effects of frost. The observations described will be remembered by all readers of Prof. Sachs's text-book. There is much room for further research on the effects of low temperatures on various plants, and the subject is obviously of practical as well as of physiological interest.

Other papers in this group are on the dependence of germination on temperature, on transitory rigidity in irritable organs, on the superior limit of temperature as affecting vegetation, and on the influence of temperature on the formation of chlorophyll. All these investigations are of fundamental importance; the same perhaps can scarcely be said of the last paper in this part, "On Emulsion Figures and the Grouping of Swarm-spores in Water," which is merely concerned with a possible source of error in observations on the movements of unicellular organisms.

The succeeding section, on the action of light on plants, includes some of the best known of the author's researches, the most important perhaps being that on the effect of light of different colours on assimilation and growth. It is a little disappointing, however, to find no reference in the notes to the more recent and exact work of Timiriazeff, Engelmann, and others. The latest published paper in this section, "On the Action of the Ultra-violet Rays on the Formation of Flowers" (1883 and 1886), is probably less familiar to physiologists than the others. In this, Prof. Sachs brings forward evidence to show that when, in the case of a green plant, the ultra-violet rays alone are excluded, the development of flowers is hindered, though otherwise the plant grows normally. The conclusion which he arrives at is that the ultra-violet rays produce, in the green leaves, the "flower-forming substances."

The third group of papers, on chlorophyll and assimilation, is certainly among the most important in the collection, for by means of these researches the author first proved that the chlorophyll corpuscle is the organ of assimilation, a fact which forms the basis of the whole physiology of nutrition in plants. The investigations, dating from 1862, by which Prof. Sachs showed that starch appears in the chlorophyll corpuscles as a result (though, as we now know, not an *immediate* result) of assimilation, are of special interest at the present moment, in view of the new light recently thrown on this whole subject by the work of Messrs. Brown and Morris.

Later papers in the same section are those "On the Activity of Nutrition in Leaves" (1884), and on "The Treatment of Chlorotic Plants" (1888). The former is devoted chiefly to the determination of the energy of assimilation in the leaves of various plants. The latter is the only paper in the collection written with a "purely practical" object, namely to teach the most convenient and effective method of applying iron salts as manure to plants which, from want of iron, fail to develope their chlorophyll.

The fourth section includes the work on the movements of water in plants. Among other researches of importance, we here find the well-known treatises "On the Ascending Current of Sap in Transpiring Plants" (1877-8) and "On the Porosity of Wood" (1877-9). The former contains the author's classical determinations of the rate of ascent of the sap, by means of the Lithium spectroscopic method, while in the latter his famous "imbibition theory," according to which the water rises in the substance of the lignified cell-walls, is developed. This theory is no longer accepted by physiologists, but the author justly points out that the facts given in the paper maintain their value quite independently of the truth of his theoretical conclusions.

The papers of the fifth group, on the behaviour of the constructive materials during growth, are all of early date (1859-63), and the author regards their interest as being mainly historical. To us they seem to be among the most attractive in the collection. Most of them relate to the phenomena of germination, and especially to the changes undergone, during that period, by the reserve food substances, while many facts of morphological and histological interest are also told us.

Going on to the second volume, we find in the sixth section of the work the author's researches on the subject

of growth, which he carried out with the help of the various forms of auxanometer invented by him. His results, which first established the extreme complexity of the conditions on which the rate of growth in plants depends, are familiar to readers of his text-book and lectures.

The seventh section contains the papers on "tropisms," *i.e.* the reactions of growing organs under the stimuli of gravitation, light, and moisture. The last paper in the group, that on orthotropous and plagiotropous organs, seems to us to be of the widest interest, as offering a contribution towards the solution of the most fundamental and most difficult of all biological problems, namely the question of the *causes* of the forms of organisms. This in the author's phrase is the problem of "scientific morphology."

Section VIII., on the relations between cell-formation and growth, includes the two well-known papers on the arrangement of cells (1878–9) in which the form of the network of cell-walls is explained with the help of the law of their rectangular intersection. The author shows how, in organs of similar outline, identical arrangements of the cells arise, whatever may be the morphological nature of the organ, so that the cellular structure of a hair, an antheridium, and an embryo may be the same. He has thus given a useful warning to morphologists, who have often laid too much stress on mere cell-arrangement in discussing embryological and other similar questions.

The last paper in this section is on "Energids and Cells." As it is the most recent of all (1892), and probably the only one in the book which may not yet be familiar to botanical readers, a short account of its contents may be useful.

Under the term *energid*, Prof. Sachs understands a single nucleus, together with the protoplasm governed by it, the two together forming a whole, which is an organic unit, both in the morphological and physiological sense. He has chosen the name energid in order to express the chief property of the organic unit, namely, that it possesses internal or vital energy. The conception of an energid, as distinct from that of a cell, has become necessary, owing to the discovery in recent years of so many multinucleate cells and multinucleate organisms without cellular structure, discoveries which we chiefly owe to the researches of Schmitz. Such a multinucleate cell or organism, though enclosed within the contour of a single cell-wall, is manifestly equivalent not to a single uninucleate cell, but to a multicellular structure. This is proved by the fact that the portions of protoplasm, each surrounding a nucleus, so often subsequently become free as complete and independent cells, as in the formation of the zoospores of *Saprolegnia*, or form a multicellular tissue, as in the endosperm of many Phanerogams.

It is quite evident that the word *cell* has come to be used in many different and inconsistent senses. As Prof. Sachs says: "According to the prevailing terminology, an empty wood fibre is a cell, so is an embryo-sac containing young endosperm, and so also is an Amœba, or a zoospore, or even an entire Caulerpa." Everyone who has had to teach botany will sympathise with the author in his complaints of the confusion thus caused. While other sciences keep their technical language up to date, "the science of living things begins with a word which arose more than 200 years ago in consequence of a mistake." Hence, in his opinion, a radical change in language is demanded; for the true histological unit the word *energid* is proposed, while the old word *cell* can be retained, either for the cell-wall alone (its original sense), or for the cell-wall together with its contents, whatever they may be, and whether including one energid or many.

It appears to us that the change proposed is a real and great improvement; the only difficulty is our firmly fixed habit of connecting the idea of a histological unit with the word *cell*. Whether the new term be adopted or not, Prof. Sachs has done good service in bringing clearly before us the contradictions between our present antiquated phraseology and histological facts as they are now known to us.

The ninth and last section of the work is on the causal relations of the form of plants. It consists mainly of the two essays on "*Stoff und Form*," which have already attracted much attention, and met with much criticism. The fundamental conception on which these essays are based, is the idea that the organs of plants owe their form to their substance, just as a crystal owes its form to the chemical constitution of its molecules. Prof. Sachs, therefore, believes that there must be a special substance concerned in the formation of each kind of organ; there must be a root-forming substance, a shoot-forming substance, a flower-forming substance, and so on. Of course the quantity of the active substance by which form is determined may be extremely small in comparison with the whole material of which the organ consists. Prof. Sachs supposes that these hypothetical formative substances are, in the case of green plants, produced in the assimilating organs, and thence conveyed to the seats of developmental activity. He is inclined to identify the formative substance with the *nucleine*, and is so far in agreement with many modern histologists. He regards the different specific formative substances as being possibly varieties of nucleine, comparable to the isomers of grape-sugar, or of tartaric acid.

The extremely hypothetical character of the whole theory is manifest. There is at present no evidence for the existence of specific formative (*e.g.* "root-forming" or "shoot-forming") substances. Even if we accept nucleine as representing them, we still have no evidence that it is formed in the assimilating organs, or indeed that it exists, as such, anywhere except in the nucleus itself. So far as we know at present it seems that the nucleus forms the nucleine, not the nucleine the nucleus. Until some basis of fact is found for the "*Stoff und Form*" hypothesis, it can only be regarded as a formal, not a real explanation of the phenomena, however valuable it may be as a stimulus to further enquiry.

An addendum to the last paper gives an extract from the Lectures on the Physiology of Plants (1st edition, 1882), on the continuity of the embryonic substance. It certainly seems to us that Prof. Sachs' idea here expressed is essentially the same as the conception of the continuity of the germ-plasm, which has played so important a part in recent biology. The form in which the

doctrine is put by Prof. Sachs is specially applicable to plants, in which the continuity of the germ-plasm can only be traced through the embryonic substance of the growing points.

This collection, containing what are probably the most important contributions of our time to the physiology of plants, is in itself a marvellous record of scientific activity. As Prof. Sachs is still engaged in physiological research, we may hope that a later edition of the work will contain many further invaluable additions to our knowledge.

D. H. S.

OUR BOOK SHELF.

On English Lagoons. By P. H. Emerson. (London: David Nutt, 1893.)

YET another book about the Norfolk Broads, or, as the author prefers to call them, the "English Lagoons." One can hardly credit that anything fresh could be said on this well-worn subject, but Mr. Emerson's book differs from all that have gone before in being a continuous narrative of a twelve months' sojourn on the Broads in his pleasure wherry, the *Maid of the Mist*, and presents to us a graphic picture of these waters under their winter aspect as well as under a summer sky. Much that he has written, more particularly his excellent descriptions of the peculiar scenery of this remarkable admixture of land and water in mid-winter, is highly interesting. The atmospheric effects under various conditions of storm and sunshine, by moonlight and at early dawn, display a keen artistic perception, but the incidents as a rule are trivial in the extreme in fact, and the constant use of the vernacular becomes tiring—whole chapters (*e.g.* Chapter xxi. of six pages) might have been well omitted.

From a naturalist's point of view the reader cannot fail to be pleased with the kindly spirit which pervades the book, the evident delight which the author took in his feathered friends, and his disgust for the wanton destruction which is too frequently committed by thoughtless visitors to these delightful retreats, but having said this we confess we are rather puzzled by Mr. Emerson's ornithology. On page 216, for instance, he mentions watching a pair of desert wheatears on Palling Sand Hills; surely he cannot have met with *Saxicola deserti* in Norfolk. Scarcely less astonishing is the mention of a blue-headed wagtail's nest, and the appearance of the white wagtail on several occasions. The present writer has known the Broads for forty years, but has never had the good fortune to meet with *Motacilla flava* or *M. alba*, both of which are excessively rare in Norfolk, and probably only occasionally appear as passing spring migrants. Many of the observations on birds are interesting, but the following passage is hardly in good taste. Speaking of Surlingham Broad, "which the late Mr. Stevenson, the local naturalist, loved," Mr. Emerson continues, "But this piece of water is to me dull and songless, but then Mr. Stevenson did not know shadows from reflections, nor, I suspect, beauties from commonplaces. As a naturalist, moreover, he was not to be compared to the late Mr. Booth, a true lover of birds and of outdoor life. But in Norfolk every native goose is a swan." Mr. Stevenson's reputation as an ornithologist is too well established to need any defence from my pen, but I can say without hesitation that the best general description of the Broad district ever written is to be found in the introduction to his "Birds of Norfolk," and his chapters descriptive of a summer's night and a summer's day on the very Broad which Mr. Emerson considers so uninteresting, show not only his wonderful powers of observation but his keen perception of the beauty and poetry of nature; even so familiar a bird as the redbreast is invested with fresh interest after reading his charming chapter on this pert little friend of man.

I. S.

The Mechanics of Architecture. By E. Wyndham Tarn, M.A. (Crosby Lockwood and Son, 1892.)

THE modern architect is beginning to perceive that he has allowed the engineer to cover the ground with monstrosities because his immediate predecessors considered that any scientific knowledge would spoil the artistic faculty, regardless of the great architects of the past, Sir Christopher Wren, Leonardo da Vinci, and the designers of our cathedrals.

The theories which the author discusses, as of Pillars, Roofs, Arches, Domes, and Spires, Buttresses and Foundations, are illustrated by numerical applications to well-chosen existing examples; so that the architect will thereby acquire confidence in the formulas, and not lay himself open to disaster in consequence of a mathematical misprint.

Graphical constructions are freely employed, which recommend themselves to the draughtsman, who thinks better on his drawing-board than in symbols and formulas.

G.

LETTERS TO THE EDITOR.

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Telegony.

THIS is a term which Prof. Weismann has recently coined to designate a class of phenomena which have thus far been pretty generally accepted as of unquestionable occurrence in mammals, if not also in birds. I refer to the alleged influence of a previous sire on the progeny of a subsequent one by the same mother. The most notorious instance of this alleged fact is that of Lord Morton's Arabian chestnut mare, which had her first foal to a quagga. Subsequently she produced two colts by a black Arabian horse. These were both partially dun-coloured, and striped on the legs more plainly than the real hybrid had been. One of the colts was also striped on the neck and some other parts of the body; lastly, the mane in both resembled that of the quagga, being short, stiff, and upright. Darwin, from whom this description is taken, records an almost exactly parallel case, on the authority of Mr. James Weir. He also gives a number of references to other cases, not only in horses, but likewise in sheep, swine, dogs, &c. Within the last twelvemonth another seemingly unmistakable case of the same thing took place in the Zoological Gardens, and is recorded by Mr. Tegetmeier in one of the December numbers of the *Field*. Here the first foal was a hybrid between two species of ass, and the second by a male of the same species as the mother. Not a few further apparently well-authenticated instances might be mentioned, but these are enough for present purposes. Indeed, most breeders and fanciers are so persuaded of the truth of "telegony" as to deem a pedigree animal seriously deteriorated in value if she has been covered by an inferior male, while in Darwin's opinion "there can be no doubt" as to the fact of this influence of a previous sire being occasionally exhibited in mammals, although he expresses himself as doubtful with regard to it in the case of birds.

Prof. Weismann, however, has recently challenged the facts. He has also given his explanation of them, supposing them to be facts. Therefore I will consider these two points separately.

Several years ago I undertook an experimental inquiry upon the subject with dogs, which yielded negative results. I then obtained an introduction to Mr. Everet Millais, in order to profit by his large experience and scientific interest in all matters pertaining to dog-breeding. He suggested that the question ought to be put in the journals of fanciers in this country, and also in America, for the purpose of raising discussions upon it. This was done, with the result of letting loose floods of letters to

the journals, and not a few private ones to ourselves. Of course this copious response was for the most part valueless, further than to show a general belief among fanciers and breeders in the facts of telegony, coupled, however, with great differences of opinion touching the frequency of its occurrence. Nevertheless, out of all this medley of unscientific assertion, there were a comparatively few cases where it did not appear that coincidence, pre-formed ideas, mal-observation, atavism, &c., could be reasonably assigned, and these served to indicate the most promising varieties with which to work in future experiments.

The general result of our inquiry thus far has been to corroborate the opinion with which we both started, viz. that although the fact of telegony is of very much rarer occurrence than is generally supposed, it nevertheless does appear to take place occasionally, and especially, as Mr. Herbert Spencer has recently observed, where the first offspring has been a hybrid, as distinguished from a mongrel.

On the other hand, there does not seem to be any good evidence of the phenomenon in the case of mankind. For although I have met with an alleged instance of a white woman who, after having borne children to a negro husband, had a second family to a white one, in which some negro characteristics appeared, I have not been able to meet with any corroboration of this instance. I have made inquiries among medical men in the Southern States of America, where in the days of slavery it was frequently the custom that young negresses should bear their first children to their masters, and their subsequent children to negro husbands; but it never seems to have been observed, according to my correspondents, that these subsequent children were other than pure negroes. Such, however, was not the same case as the one above mentioned, but a reciprocal case; and this may have made a difference.

So much, then, for the facts. As regards their interpretation, Mr. Herbert Spencer says, speaking on behalf of the Lamarckians, "And now, in the presence of these facts, what are we to say? Simply that they are fatal to Weismann's hypothesis. They show that there is none of the alleged independence of the reproductive cells; but that the two sets of cells are in close communion. They prove that while the reproductive cells multiply and arrange themselves during the evolution of the embryo, some of their germ-plasm passes into the mass of somatic-cells constituting the parental body, and becomes a permanent component of it. Further, they necessitate the inference that this introduced germ-plasm, everywhere diffused, is some of it included in the reproductive cells, subsequently formed. And if we thus get a demonstration that the somewhat different units of a foreign germ-plasm permeating the organism, permeate also the subsequently-formed reproductive cells, and affect the structures of the individuals arising from them, the implication is that the like happens with those native units which have been made somewhat different by modified functions: there must be a tendency to inheritance of acquired characters." (*Contemporary Review*, March.)

On the other hand, Prof. Weismann says that, even admitting the facts, they in no way militate against his theory of germ-plasm. For, as he says, "such cases could be accounted for from our point of view by supposing that spermatozoa had reached the ovary after the first sexual union had occurred, and had penetrated into certain ova, which were still immature. The immediate fertilisation of the latter is rendered inconceivable by the fact of this immaturity; but the sperm-cell must have remained in the body of the ovum until the maturation of the latter, with the nucleus of which it then united in the process of amphimixis." ("The Germ-Plasm," pp. 385–6.)

It seems to me that we have here, in principle, a sufficient answer to the Lamarckian interpretation of the facts alleged. I say "in principle," because the obvious objection that mammalian spermatozoa cannot be held capable of delving their way through the stroma of an ovary in order to reach unripe ova, may be obviated by supposing that it is the "ids" and "determinants" of disintegrated spermatozoa which do so. For, if there are any such things as ids and determinants, it is certain (from the facts of atavism) that they can survive the disintegration of their containing spermatozoon, and also that they can then penetrate somatic tissues to any extent.

But I have discussed the whole subject in a lengthy appendix to my recently published "Examination of Weismannism," to which I must refer for all details, both as regards the alleged facts and their rival interpretations. My object in raising the issues in these columns is to ascertain whether further light can be thrown upon the subject by any of your numerous readers. Therefore I will merely add that numerous experiments which during the last eighteen months I have been conducting with birds, have yielded uniformly negative results. Scores of purely bred ducks (white Aylesbury), and dozens of purely bred chickens (Polish) have been hatched; but in no one case has there been the smallest resemblance to their telegonous sires. In some cases a year, and in others only a fortnight was allowed to elapse between the successive impregnations; but in all cases the broods are as purely bred as if their respective mothers had not previously borne offspring to males of widely different breeds.

GEORGE J. ROMANES.

Christ Church, Oxford, September 16.

Quaternions and Vectors.

IN his recent letter (NATURE, August 17, p. 364), which is avowedly a reply to my paper (Proc. R.S.E., 1892–93) on "Recent Innovations in Vector Analysis," Prof. Gibbs does not seem to me to discuss the real point at issue.

At the end of that paper I summarised the arguments in favour of quaternion vector analysis under five heads.

The first of these was: "The quaternion is as fundamental a geometrical conception as any that Prof. Gibbs has named." This argument, which was a direct criticism of Prof. Gibbs's attack on quaternions in his letter to NATURE of two years ago, is not even referred to in his recent letter. It may reasonably be assumed that silence means consent.

The second summarised argument was: "In every vector analysis so far developed, the versorial character of vectors cannot be got rid of." Regarding this, which was a direct criticism of the position of Mr. Heaviside and Prof. Macfarlane, I am glad to find that Prof. Gibbs is virtually at one with me, and brings to my support the great names of Lagrange and Poisson. Now Hamilton's quaternions is admittedly the only vector calculus which takes direct cognisance and makes full consistent use of this principle, the logical consequences of which form the subject of my third and fourth summarised arguments. Thus the quaternion wins all along the line.

The fifth and last summarised argument was: "The invention of new names and new notations has added nothing of importance to what we have already learned from quaternions." This, probably, has most direct connection with Prof. Gibbs's recent letter, which is to a large extent an exposition of his own system. And interesting though this may be in itself, it does not really make out a case against quaternions; and that, be it remembered, is the point at issue. Indeed, Prof. Gibbs himself admits that the quaternion notation has a certain advantage in simplicity. This is plainly so in the case of ∇, of which in its quaternionic form Prof. Gibbs gives a very neat application in an equation whose physical interpretation is the solution of an important problem. But in this very connection, carried away by the exuberance of his humour, he seems to imagine that the *name* Nabla is of the essence of quaternions, and that the quaternionist has no right to use the word potential.

I am not aware that I anywhere expressed a dislike to the notations $[\phi]$, ϕ_s, $\phi_\times$, which represent quantities most emphatically quaternionic, or at least Hamiltonian, in their origin. What I wished to emphasise was that, in getting at the conception of the quantities ϕ_s, $\phi_\times$, Prof. Gibbs makes use of the so-called indeterminate product, which is no vector but is analytically the same kind of thing as the quaternion product, and that consequently his pamphlet and his first letter to NATURE are hardly consistent with each other.

I am accused of an inadvertence in the interpretation of certain integrals. I have not Prof. Gibbs's pamphlet by me at present, but, if I recollect aright, there is no explicit mention in it of the restriction that the operand is to be a constant vector. Nor do I see that such a restriction is necessarily implied in a system in which operators, whether under an integral sign or not, are represented symbolically apart from the operand. The operand is virtually there all the time. The equations are meaningless without it. To introduce the unexpressed operand is therefore a very different thing from the act of introducing an altogether extraneous vector. With the required restriction, however, it appears that Professor Gibbs's integral operators are not of such general applicability as had been hoped.

But even granting that I have been guilty of an inadvertence on this point, that in no way affects the general argument.

Satisfactory reasons have still to be given for deserting the quaternion highway. The asserted weakness of Hamilton's calculus, as contrasted with the implied strength of its rivals, has still to be disclosed.

With a view to bring us all to one mind, Prof. Alfred Lodge suggests (NATURE, June 29) that the quaternion be regarded as the difference of its vector and scalar parts, so that the square of a vector becomes *minus* the scalar product of a vector into itself. It is not easy to see what ultimate advantage this change of sign would bring. The most obvious disadvantage would be that it would to a large extent render Hamilton's and Tait's classical treatises of little service to the student. Moreover, it would bring in the quaternion in a very artificial manner, as a kind of after-thought, so to speak; it would, I think, confuse the beginner by forbidding him to make use of powers of vectors in the way generally familiar in analysis; it would accentuate the importance of the product at the expense of the quotient of vectors; and it would tend to obscure the significance of the versor. I am afraid it is too much to ask of any who have got accustomed to the quaternion method to introduce confusion by such a change of sign. Up to a certain point, and along certain lines, Gibbs's and Heaviside's systems lead to results identical with those obtained by quaternions. It has not been shown that they lead to these results more simply or more directly, or that they are more easily mastered by the student than is the calculus of Hamilton. And the same may be predicted of the modified quaternionic system suggested by Prof. Lodge.

Musselburgh, September 4. C. G. KNOTT.

Grassmann's "Ausdehnungslehre."

SIR ROBERT BALL asks why no one has translated the "Ausdehnungslehre" into English. The answer is as regretable as simple—it would not pay. The number of mathematicians who, after the severe courses of the universities, desire to extend their reading is very small. It is something that a respectable few seek to apply what they have already learnt. The first duty of those who direct the studies of the universities is to provide that students may leave in possession of all the best means of future investigation. That fifty years after publication the principles of the "Ausdehnungslehre" should find no place in English mathematical education is indeed astonishing. Half the time given to such a wearisome subject as Lunar Theory would place a student in possession of many of the delightful surprises of Grassmann's work, and set him thinking for himself. The "Ausdehnungslehre" has won the admiration of too many distinguished mathematicians to remain longer ignored. Clifford said of it: "I may, perhaps, be permitted to express my profound admiration of that extraordinary work, and my conviction that its principles will exercise a vast influence upon the future of mathematical science." Useful or not, the work is "a thing of beauty," and no mathematician of taste should pass it by. It is possible, nay, even likely, that its principles may be taught more simply; but the work should be preserved as a classic.

I should be glad to subscribe £10 towards the expenses of translation. If others will join, perhaps some publisher will take the matter up. Is there no machinery by which the universities could be induced to subscribe?

A good book on the subject, entitled "The Directional Calculus," by Prof. E. W. Hyde, is published by Ginn and Co., Boston; and a valuable and very clever elementary exposition, on a geometrical basis, of important parts of the Calculus, by M. Carvallo, appeared in the *Nouvelles Annales de Mathématiques* of January, 1892. The latter will, in one day, enable a student to comprehend the power and elegance of Grassmann's methods. R. W. GENESE.

Astronomical Photography.

THE nature of chromatic correction adopted for visual telescopes is uniform enough to make it possible to state what kind of photographic plate is desired for use with such telescopes.

A plate which is sensitive to light between C and F in the solar spectrum, with a marked maximum between D and *b*, and insensitive to other light, would be suitable for nearly all visual telescopes, which might in other respects (*e.g.* aperture, focal length, position as affected by climate) be available for taking special photographic records. With existing plates, so far as I have been able to acquaint myself with them, the sensitiveness in the blue and violet is the difficulty.

But whilst such a special plate as I describe would be warmly welcomed, we must not forget that the proved goodness of the photographic star-images of what may be called violet refractors, *i.e.* refractors corrected so that the minimum focus is for violet light, is in great measure to be attributed to the fact that light of short wave length is used. The increase in the diameter of star-images with increased exposures or great brightness of the star, may be, as Scheiner has lately suggested, due to defects in the mode of support of the object-glass or mirror, but doubtless the *goodness* of the images with proper exposures must be connected with the smallness of the scale of the diffraction pattern, and with the concentration of light to the centre of the pattern, which may be got at smaller expense with a violet refractor than with a visual.

Probably few astronomers would have been bold enough, if no photographic plates had been available except plates sensitive only to yellow and green, to urge the preparation of plates sensitive in the violet, on the ground that a violet refractor would give much better results, because short wave lengths were used. And yet a comparison of the results obtained with violet refractors and with reflectors would lead one to the view above expressed, and, I believe, generally accepted.

The increased *range* of sensitiveness of modern photographic plates, with respect not only to the colour, but also to the intensity of the light affecting them, is all in favour of the reflector. A greater and more desirable advance than even the preparation of plates to suit visual telescopes would, I think, be made if the difficulties of supporting, adjusting, and maintaining a mirror were overcome; so that the measurement of star-images may be regarded with as much confidence in the case of plates exposed in reflectors as in refractors. H. F. NEWALL.

Madingley Rise, Cambridge, September 25.

Hering's Theory of Colour Vision.

I AM very much surprised to see that Prof. Ebbinghaus, in the last number of the *Zeitschrift für Psychologie*, announces as new a discovery which has a critical bearing upon Hering's theory of colour-vision—the fact, namely, that two grays composed the one of blue and yellow, and the other of red and green, and made equally bright at one illumination (by admixture of black with whichever of them turns out to be the brighter), do not continue to be equally bright at a different illumination. If two complementary colours were purely antagonistic—that is, if the colour-processes simply destroyed each other, as processes of assimilation and dissimilation must do, and if the resulting white was solely due to the residual white which accompanies every colour and gives it its brightness, then the relative brightness of two grays composed out of different parts of the spectrum could not change with change of illumination. The fact that they do change is therefore completely subversive of the theory of Hering, or of any other theory in which the complementary colour-processes are of a nature to annihilate each other. This consequence of the fact, as well as the fact itself, I stated at the Congress of Psychologists in London in August, 1892, and it was printed in the abstract of my paper, which was distributed at the time, and also in the Proceedings of the Congress.

Prof. Ebbinghaus' discovery is apparently independent of mine, for he supposes that the phenomenon cannot be exhibited upon the colour-wheel. This is not the case; with fittingly-chosen papers (that is, with a red and green which need no addition of blue or yellow to make a pure gray, and with a corresponding blue and yellow) it is perfectly evident upon the colour-wheel. The same paper circles which I used to demonstrate it in Prof. König's laboratory in Berlin are, at the request of Prof. Jastrow, now on exhibition at the World's Fair at Chicago. While Prof. Ebbinghaus' discovery of the fact is therefore doubtless independent of mine, I allow myself to point out that mine is prior to his in point of time.

Baltimore. CHRISTINE LADEL FRANKLIN.

"Megamicros."

IN NATURE of August 24 the following extract from the *Bulletin de l'Académie de Belgique*, No. 6 (1893), is given, viz.:—

"According to Laplace, if the dimensions of all the bodies of the universe, their mutual distances and velocities were to increase or diminish in a constant proportion, these bodies

would describe the same curves as they do now. The appearances presented to observers would be the same, and independent of the dimensions assumed. Hence the only facts we are able to appreciate are ratios. In opposition to this theorem, M. Delbœuf shows that if a system consisting of the sun and earth were to be diminished in linear dimensions to one-half, all densities remaining the same at homologous points, and the orbital velocity of the earth were reduced to one-half its value, there would be certain changes in the relations of an observer to his surroundings which could not escape notice. The velocity of sound propagation would be the same as before, but the distance traversed during a certain number of vibrations will appear larger," &c. (p. 406 of NATURE).

Here it seems to be overlooked that according to the above system of reduction of scale, the molecules of air which propagate sound would have to be conceived as diminished in size correspondingly with the planets, earth, &c., for if not, obviously the constancy of ratio of relative dimensions supposed by Laplace could not persist under this reducing process. For, considering "all the bodies in the universe," we cannot regard the linear dimensions of the earth and larger bodies as reduced to one-half, and neglect the smaller bodies (molecules). If then the dimensions of the molecules of air, and also their normal velocities be supposed reduced to one-half, then (according to what is set forth in a paper of mine in the *Philosophical Magazine*,[1] June 1877, relating to sound), the velocity of sound would be exactly halved, and therefore not remain "the same as before," as M. Delbœuf supposes. But the velocity of sound would *appear* the same as before to us with our halved standards of length on the reduced planet, in accord with what Laplace states. For as indicated in the above paper (*Phil. Mag.*), "The velocity of propagation of a wave—such as a wave of sound—in a gas is solely determined by, and proportional to, the velocity of the molecules of the gas; and the velocity of propagation of the wave is not affected by density, pressure, or by the specific gravity of a gas, or by anything else excepting the velocity of its molecules" (p. 452.)

For, on the Kinetic theory, the molecules of a gas can evidently only act upon each other by direct impact, and they therefore propagate any wave at their encounters at a rate proportional to that at which the molecules are moving in the normal state of the gas. If, we imagine then, the velocities of the smaller bodies (such as the molecules of air) to be halved, just as those of the planets, &c., are supposed halved, then the velocity of sound will be necessarily reduced to one-half, as we have seen.

Hence the above argument based on the Kinetic theory of gases would apparently support Laplace's view; and so the velocity of sound would seem to us precisely the same as before. The distance traversed during a certain number of vibrations would not then (as M. Delbœuf thinks) appear larger; all his conclusions seem to me invalidated by his assumed *unsymmetrical* selective diminution of sizes. Of course one-half the present metre would on the reduced earth be still called a "metre," because it would be a ten-millionth of the earth's quadrant, as now. A man a metre high would still be a metre high in the planet of reduced size, and the metre standard he grasped would still be the same length as himself. So it appears that if the universe known to us were suddenly halved in size by reducing the linear dimensions and velocities of all the bodies to that extent, there would be nothing to allow the change to be detected. This would also seem to harmonise with the Spencerian doctrine of the Relativity of all knowledge.

Hamburg, September 4. S. TOLVER PRESTON.

EARLY ASTERISMS.[2]

II.

AS in Egypt so in Babylonia, for the first references to the constellations we must study the religion and the mythology; Jensen shows that the first notions of the Babylonian constellations are to be got by studying the sun-gods, and especially the mythic war between the later sun-god Marduk and the monster Tiāmat.

So far as I have been able to gather, any myth like the Egyptian myth of Horus involving combats between the sun and circumpolar star-gods is entirely lacking in Babylonia, but a similar myth in relation to some of the ecliptic constellations is among the best known.

In my references to the myth of Horus I have shown that in all probability an astronomical meaning is that the rising sun puts out the northern stars; and there is evidence that we have a reference also to a sun-worshipping race abolishing the cult of Set representing the northern stars. I have also shown that temples built to northern stars have had their axes blocked to prevent the worship, and that the northern temples at On and Denderah were among the first founded for the worship of the Divine dynasty of Set or Anubis.

This being so, it is of importance to discuss the Babylonian myth of the battle between Marduk and Tiāmat from the astronomical point of view, but before we do this it will be well to see if one can trace the history of the sun-god of Eridu, which city is universally conceded to have been the original centre of Babylonian ideas until the descent of the Northmen, and to have been founded by a colony from some other country.

The Sun-god of Eridu.

Let us assume that the earliest sun-god traced at Eridu was the sun-god of those early argonauts who founded the colony.

We are told that this sun-god was the son of Ia and Dam-kina, his wife symbolising the earth, and that his name was Tammuz (Sayce, p. 144).[1]

This Ia was such a great god that to him was assigned the function of Maker of Men; he was also a great potter and art workman (p. 293), a point I shall return to presently. He eventually formed a triad with Anu and Bīl, that is, the poles of the heavens and the equator. This Tammuz (Dumazi) was afterwards identified with Nin-Girsu, and ultimately became "the Nergal of Southern Chaldæa, the sun-god of winter and night, who rules, like Rhadamanthos, in the lower world" (Sayce, p. 245), and as lord of Hades he was made son of Mul-lil (Sayce, p. 197).

This was at first. But what do we find afterwards?

Nergal is changed into the Midsummer Sun! (Jensen, p. 484). And finally he is changed into the Spring Sun Mardukat Babylon (Sayce, p. 144) where he is recognised as the son of Ia and Duazag, that is the Eastern Mountain (Jensen, p. 237).

Now however difficult it may be to follow these changes from the religious point of view, from the astronomical side the changes are not only easily explained, but might have been predicted, provided one hypothesis be permitted, namely, that the colony who founded Eridu were originally inhabitants of some country south of the equator.

Such an hypothesis may at first sight appear strange, but the view that Eridu was colonised from Cush has been supported by no less an authority than Lepsius.[2]

Now the boundaries of Cush are not defined, but they may possibly include the Land of Punt from which certainly part of the Egyptian culture was derived.

Punt was always considered a "Holy Land," and it was acknowledged that several of the Egyptian gods had been thence introduced. Hathor was "Queen of the Holy Land," "Mistress and Ruler of Punt." Amen Rā was "Hak" or "King" of Punt, and Horus was the Holy Morning Star which rose to the west (?) of the land of Punt.[3]

Maspero refers to an ancient tradition that the land of Punt could be reached by going up the Nile, where

[1] "Mode of the Propagation of Sound and the Physical Conditions which determine its Velocity on the Basis of the Kinetic Theory of Gases."

[2] Continued from p. 440.

[1] It would seem also that Isara = Tammuz. This connects the myths of Isis and Osiris, Tammuz and Adonis, and the cult at Byblos (see Sayce p. 228).

[2] Introduction to Nubische Grammatik, 1880.

[3] Rawlinson, ii. 134.

eventually an unknown sea was reached which bathed the land of Punt. Was this one of the great lakes?[1]

Brugsch[2] is of opinion that Punt occupied the south and west coasts of Arabia Felix, but Maspero and Mariette do not agree with him. The two latter authorities identify it with that part of the Somali land which borders on the Gulf of Aden. It is the Cinnamonifera regio or Aromatifera regio of the ancients.[3]

The inscriptions at Dêr el-Bahari make it quite certain that Punt is in Africa. Hottentot Venuses and elephants, to say nothing of the general products of the country referred to as among the freight of the ships on their homeward voyage, distinctly point to Africa, and I think a southern part of it.

The first organised expedition to Punt of which we hear anything is that organised by Se-ānχ-ka-Rā, the last king of the 11th *Theban* dynasty. This was a new traffic by way of the Red Sea. There was then no canal joining the sea with the Nile in existence; the expedition went by land to Coptos.[4]

They further indicate, as Maspero suggests, that the expedition of Hātshepset anchored up a river, and not on the sea-shore, especially since the native huts are shown as built on piles. This again makes Africa much more probable than Arabia.

If we agree that Punt is really in Africa south of Somali-land, there is a great probability that the tradition referred to by Maspero is a true one.

There is distinct evidence that Horus, Hathor, and Amen-Rā are worships coming from the south and dealing with southern stars exclusively. With regard to Horus, it is necessary to discriminate, since there were two distinct gods—Horus in N. and S. Egypt, *and Horus of the south was the elder of the two.* The Hawk God of Edfû, Harhouditi, the southern Horus, had for servants a number of individuals called Masniou or Masnitiou = blacksmiths. The Hawk God of the Delta, the northern Horus, Harsiisit, has for his entourage the Shosou Horou.

Now Maspero has recently pointed out[5] that the southern Horus may have been imported, not from Arabia Felix or Somali-land, but from Central Africa!

Among all early peoples the most important times of the year must necessarily have been those connected with seed time and harvest at each locality. Now the spring equinox and summer solstice south of the equator are represented by the autumnal equinox and the winter solstice to the north of it. If the colonists who came to Eridu came from a region south of the equator, they would naturally have brought not only their southern stars, but their southern seasons with them; but their springtime was the northern autumn, their summer solstice the northern winter. This could have gone on for a time, and we see that their great sun-god was the god of the winter solstice. Tammuz=Nergal.

But it could only have gone on for a time, the climatic facts were against such an unnatural system, and the old condition could have been brought back by calling the new winter summer, or in other words making the winter god into the summer sun-god, in short, changing Nergal into a midsummer sun-god. This it seems they did.

But why the further change from Nergal to Marduk? Because the northern races were always tending southwards, being pushed from behind, while the supply of Eridu culture was not being replenished. The religion and astronomy of the north were continually being strengthened, and among this astronomy was the cult of the sun at the vernal equinox, the springtime of the northern hemisphere, sacred to Marduk. Nergal, therefore, makes another stage onward and is changed into Marduk!

[1] Maspero, "Histoire Anc.," p. 5.
[2] Brugsch, "History of Egypt," 1891, p. 54.
[3] Mariette, "Der el-Bahari," p. 31. Rawlinson, ii. 131.
[5] "L'Antropologie," 1893, No. 4.

It is also interesting to find that in Ninib, another sun god, we have almost the exact counterpart of the Egyptian Horus. He is the eastern morning sun, the son of Isara (? Osiris), and the god of agriculture.[1]

I append one out of many published hymns to the Sun God:—

O Sun (god)! on the horizon of heaven thou dawnest,
The bolt of the pure heaven thou openest,
The door of heaven thou openest.
O Sun (god)! thou liftest up thy head to the world;
O Sun (god)! thou coverest the earth with the majestic brightness of heaven.

Marduk then, the son of Ea, was finally as definite a spring equinox sun-god as Amen Rā in Egyptian mythology was a summer solstice sun-god.

Marduk was more than this, he represented the constellation of the Bull. Here I quote Jensen (p. 315).

"It has already been suggested that the Bull is a symbol of the Spring-Sun *Marduk;* that he was originally complete; that he at one time extended as far as the Fish of *Ia, i.e.* the western Fish; that the Fish of *Ia*, out of which the sun emerged at the end of the year in ancient times to enter Taurus, is to represent *Ia*, the God of the Ocean, out of which his son *Marduk*, the early sun, rises daily; finally, that a series of constellations west of the Fish(es) is intended to represent symbolically this same ocean. *Marduk* is on the one hand, as early sun of the day (and the year), the son of *Ia*, the god of the world-water."

As to the sun-god Marduk, then, he represents the sun at the vernal equinox, when the sunrise was heralded by the stars in the Bull.

But what, then, are the fish of *Ia* and the other constellations referred to? They are all revealed to us by the myth. They are the southern ecliptic constellations. We gather this from Jensen's account of the fight that Marduk—this Egyptian Horus—has with certain monsters inhabiting the world-ocean. The monsters being called generically Tiāmat.

Tiāmat.

Tiāmat, according to Jensen, means initially the Eastern Sea (p. 307). This was expanded to mean the "Weltwasser" (p. 315), which may be taken to mean, I suppose, the origin of the Greek ὠκεανὸς, and possibly the overlying firmament of waters.

These firmamental waters contain the southerly ecliptic constellations, the winter and bad-weather signs—the Scorpion, the Goat-fish, and the Fish among them.

It must be pointed out that these southerly constellations were associated with the winter solstice Sun-God of Eridu *in his first stage.*

The Myth of Marduk and Tiāmat.

But this Horus no longer smites the hippopotamus, that is the northern stars, his quarry is elsewhere; he does battle against this world-ocean in the form of Tiāmat and among the allies of Tiāmat we find a Scorpion-Man (p. 277), a Goat-Fish, and a Fish-Man, and to the west of the vernal equinox, *i.e.* in the 'water-region' of the Heavens, a Fish (Fish of *Ia*), a goat-fish and a scorpion.

We are evidently dealing here with Scorpio, Capricornus and Pisces, the ecliptic constellation of the winter months. Marduk against Tiāmat was the never-ending battle of May against December.

Imprimis then we have the later developed northern spring sun destroying the evil gods or spirits of winter, and chief among them, of course, the goat-fish, which, from its central position, would represent the winter solstice.

But this goat-fish was Ia of Iridu. The primal god of

[1] Jensen, p. 195, 198.

Babylonia! This Jensen, by his wonderful analysis (would that I could completely follow it in its marvellous philological twistings, pp. 73-81) puts beyond question, and clinches the argument by showing that our "tropic of Capricorn" of to-day, the goat still represented on our globes of to-day with a fish's tail! was called by the Babylonians "the path followed by Ia" or in relation to Ia.

The myth, then, has to do with the fact that the winter sun worship of Eridu was conquered by the spring sun worship of the north.

If we accept this we can compare the Egyptian and Babylonian myths from the astronomical point of view in the following manner, and a wonderful difference in the astronomical observations made as well as in the form, though not in the basis, of astronomical mythology in Egypt and Babylonia is before our eyes.

Astronomically in both countries we are dealing with the dawn preceding sunrise on new year's day, and the accompanying extinction of the stars.

But which stars? In Egypt there is no question that the stars thus fading were thought of as being chiefly represented by the stars which never set, that is the circumpolar ones, and among them the Hippopotamus chiefly.

The southern cult had conquered the northern one, the southern Horus had conquered Set.

We now learn that in Babylonia the chief change had been in the sun-god. Here the northern cult had conquered. The exotic worship of the winter constellations had been abolished, and they were pictured as destroyed under the form of Tiāmat,[1] although they were once as prominent as Set in Egypt.

Now I believe that it is generally recognised that Marduk was relatively a late intruder into the Babylonian pantheon. If he were a god brought from the north by a conquering race (whether conquering by craft or kraft does not matter), and his worship replaced that of Ia, have we not *mutatis mutandis* the exact counterpart of the Egyptian myth of Horus? In the one case we have a southern sun-worshipping race ousting north-star worshippers, in the other a northern equinoctial sun-worshipping race ousting the cult of the winter solstitial sun. In the one case we have Horus, the rising sun of every day slaying the Hippopotamus (that is the modern Draco) the regent of night; in the other Marduk, the Spring sun-god slaying the animals of Tiāmat, that is apparently the origins of the Scorpion, Capricornus, and Pisces, the constellations of the winter months which formed a belt across the sky from east to west at the vernal equinox.

J. NORMAN LOCKYER.

(*To be continued.*)

THE BRITISH ASSOCIATION.

NOTTINGHAM, SEPTEMBER 22.

THE bright and pleasant weather universally hoped for, but very generally unexpected, has favoured the meeting of the Association after all; it had been the one uncertain element for which the local committee could make no provision. The fine weather has made the success of the gathering complete. By midday on Monday, the 11th, the reception room was in readiness for the multifarious purposes to which it had been applied, and shortly after that time the booking clerks were kept fully employed for some hours in enrolling local members. The arrival of members was less noticeable on Tuesday, but throughout Wednesday the booking clerks, lodging and hotel clerks, the postal department, and the various excursion, garden party, and recreation counters were constantly besieged. The admirable writing-room also came largely into use, while the ladies found their way to their own special suite of elegantly furnished apartments. Later on the ladies obtained the privilege of entertaining gentlemen to afternoon tea in their capacious drawing-room, a privilege which became rapidly so popular that the accommodation was inadequate to the demand.

Following the strictly business meetings in the early part of the day, came the first general meeting in the Albert Hall, to hear the President's address. The large hall was comfortably filled with an attentive audience, the decorations consisting of little else than the long series of banners bearing the name, coat-of-arms, and year of service of each of the distinguished Presidents who has passed the chair during the sixty-two years of the Association's existence, the banner of this year's President being suspended in front of his reading-desk. The President's address, which was easily heard throughout the hall, was received with applause, the Mayor of Nottingham and the Bishop of Southwell, respectively, proposing and seconding the vote of thanks at its conclusion.

On Thursday (14th) sectional business began in earnest by the delivery of the presidential addresses in the different sections, followed by the reading of papers and reports. The workers of the Association easily found their appointed quarters, and reached them in every case in a few minutes after leaving the reception room, since all the sectional rooms were within easy distance. Five sections met in the University College itself; one in the Poor Law Offices, opposite the College; another in the Central Hall, nearly facing the college; while the geographers had only to pass from the large hall of the Mechanics' Institution (the reception room) to the lecture hall of the same institution. Each of these sectional rooms was completely fitted with all that was requisite to illustrate the papers which were communicated, the equipment ranging from the blackboard and chalk only, to the supply of dark blinds, and lantern supplemented by large diagram frames, electric current, gas, water, compressed gases, and the many other requisites for the experimental sciences. Bearing in mind the difficulty which hard-working members have found at previous meetings in staving off starvation at the luncheon hour, a large luncheon buffet had been provided in the University College; this was accessible to all members, and entailed only a few minutes' absence for luncheon from the business of any section. In the afternoon, Sir John Turner, a local vice-president of the Association, entertained a large party of visitors, with their hosts, in his beautiful grounds at Mapperley; and in the evening the Mayor received the members in the Castle Museum building, where the extensive galleries had been hung with a specially selected series of pictures, and music and refreshments were provided.

Friday (15th) was perhaps specially noticeable for the brilliant demonstration given in Section B by Dr. Meslans, assistant to M. Moissan. The section was crowded, and the audience included a considerable number of the leading British chemists. Dr. Meslans, who had carefully rehearsed his experiments in the laboratory on the previous day, proceeded to prepare gaseous fluorine, and amidst the greatest enthusiasm, both of the experimenter and of his audience, sulphur, phosphorus, silicon, and charcoal were ignited in the stream of the element. Several chemists who entered the room sceptical of the true isolation having been effected, rose and gave their entire assent, and at the suggestion of Sir Henry Roscoe, the President, immediately dispatched a congratulatory telegram to M. Moissan, who had been detained in Paris by indisposition. In the afternoon one party of members

[1] There seems to be no question that Sit, Tiāmat, and the "Great Dragon" of the Apocalypse, represent the same idea. See Sayce, p. 102.

was entertained in the beautiful grounds of Clifton Hall, by Mr. and Mrs. H. R. Clifton; another party was similarly entertained by Mr. and Mrs. Leavers, and inspected the carefully protected rock-dwellings in the grounds. Members met once more in the evening in the Albert Hall, to listen to Prof. Smithell's description of his recent researches on "Flame," and to witness the beautiful experimental demonstration of his views. The audience, at the invitation of Dr. Emerson Reynolds and of Prof. H. B. Dixon, heartily expressed their appreciation of the eloquent discourse, and of the uniformly successful and admirably contrived experiments.

Saturday was in most Sections a *dies non*, as far as scientific work was concerned. Full advantage, however, was taken of the excursions which had been organised for the recreation of the visitors. Sherwood Forest, Haddon Hall, Buxton, Burleigh, Southwell, Minster, Lincoln, Belvoir Castle, and Donington Park were visited in gloriously fine weather; and the list of the places of interest visited was only reduced by one—Wollaton Colliery—this omission being rendered necessary by the strike of the colliers. It may be mentioned that some slight inconvenience had been caused by this lamentable occurrence. Visitors to the town found the military quartered in the neighbourhood of the Guildhall, and learned to their dismay that country houses in which they were to be entertained as guests were filled with billets of police. The railway companies had also been compelled to take off some of their trains; but the inconvenience was scarcely felt—town houses were thrown open to the would-be country guests; trains which would not affect the travelling of members were those selected for removal; and the military parading the streets added a picturesque and entirely peaceful element to the ordinary population of the town. No trouble arose from the miners themselves, although they occasionally solicited alms and food; and it may be stated with truth that visitors to the meeting suffered no more serious loss and inconvenience than that arising from the withdrawal of the permission to descend the colliery. In the evening Prof. Vivian Lewes lectured upon "Spontaneous Combustion," in "The Tabernacle," to an audience of over a thousand working men, who took it into their own hands to accord him a hearty and well-deserved vote of thanks; a similar compliment to the chairman, Dr. Burdon-Sanderson, brought the meeting to a close. Meanwhile a brilliant and crowded audience was listening in the Albert Hall to the concert given by the Sacred Harmonic Society.

"Association Sunday" was marked by the pulpits in many places of worship in the town being occupied by distinguished preachers; amongst these may be mentioned the Bishop of Southwell, Dr. Bonney, Dr. Clifford, Rev. C. Gore, and the Rev. R. F. Horton. By many members the day was, however, spent in the country, or devoted to small social gatherings.

Monday saw the recommencement of serious work in all the sections, relieved later in the day by a garden party at Wollaton Hall, the seat of Lord Middleton, and by an entertainment provided at their Basford Gas Works by the Gas Committee of the Corporation of Nottingham. In the afternoon the General Committee of the Association decided on meeting at Ipswich in 1895. Bournemouth had also applied for the honour of receiving the Association, and announced their intention of renewing their application year by year until they met with success. Application from Toronto was favourably viewed, and it was considered probable that it would be accepted for a future year. The Marquis of Salisbury was elected as President for the meeting at Oxford next year, commencing on August 8, and the other officers of the Association were re-elected. In the evening the Mayor entertained the President, Sectional Presidents, Secretaries, and Treasurer of the Association, together with a few friends, at the Exchange, to dinner; the evening concluded by the lecture given by Prof. Victor Horsley, on "The Discovery of the Physiology of the Nervous System." The lecture was illustrated by a series of original lantern-slides, and was well received by a large and somewhat professional audience, who expressed their thanks, at the suggestion of Prof. Schäfer and Sir Robert Ball.

Tuesday was the only day of the meeting which opened with doubtful weather, inclined to being cold and showery. The unfortunate change culminated in the afternoon at the time of the large garden party in the Arboretum, and had the effect of thinning the attendance to some extent. Those who were present, however, found shelter from slight passing showers in the large tent which covered in the show of the Horticultural Society, and in the capacious refreshment-room; from both of these places the admirable music of the Royal Artillery band could be distinctly heard. The Committee of Recommendations, at their meeting in the afternoon, found it necessary to be economical in the grants made for research; the enrolment of 1661 members had produced only £1653, and this sum was less than that usually received. The list of money grants, however, which were recommended and were finally approved by the General Committee on the following day represent a total of £705. A reception at the Castle Museum brought the day to a close. Mr. Alderman Goldschmidt and Mr. Joseph Bright, as chairman and vice-chairman. respectively, of the Executive Local Committee, received the company. Entertainment was afforded by the string band of the Royal Artillery, and a series of interesting scientific objects were on exhibition. A special feature was the glass-blowing by Herr Zitzmann, of Wiesbaden, who had throughout the week displayed his skill in imitating old Venetian glass-work and in making glass scientific apparatus to large audiences in the chemical theatre of the University College.

The comfort of those attending the *conversazioni* and other general gatherings was secured in great measure by the membership being only an average one, and not unduly large. A larger membership would not only have added to the difficulties of the stewards, but also to the discomfort of those who attended the meetings. It may be safely asserted that the success of the work of the Association in no way suffered by the numbers not being large; whilst those who were playing the part of hosts in the town could the more readily cope with the demand on their kindly services. The number of official and other important members of the Association privately entertained reached nearly 400; and there remained some room both in private houses and in lodgings and hotels, so that the overcrowding frequently complained of in these gatherings was absent.

Of distinguished scientific men from different parts of our own country there was a good attendance; and amongst eminent foreigners who accepted the invitation to attend were the following:—Baron von Reinach; Dr. Meslans, Paris; Prof. Iddings, Chicago; Mons. A. Gobert, Brussels; Prof. Heger, Brussels; Mons. Gilson, Belgium; Dr. Brögger, Norway; Dr. Bock and Dr. Bohr, Copenhagen; Dr. Hertwig, Munich; Dr. Hildebrand, Stockholm; Dr. W. Einthoven, Leyden; Dr. Rothpletz, Munich; Dr. Mandello, Budapest; Dr. Renard, Gand; Mr. Cope Whitehouse, New York; M. de Liegeard, Paris.

On Wednesday little sectional business was transacted, except by the energetic geologists of Section C. In the afternoon the General Committee passed the awards of money towards scientific research, a list of which was given last week.

The business of the meeting was then brought to an end at the concluding meeting by the usual votes of thanks.

In the evening over a thousand members were entertained by the local committee in the Theatre Royal, and witnessed Mr. Wilson Barrett's company in the new play *Pharaoh*.

The concluding day, Thursday, was devoted to whole day excursions to "The Dukeries" (Sherwood Forest, Welbeck, Clumber, Thoresby, &c.), the Midland Railway Works at Derby, Chatsworth and Haddon, Charnwood Forest, Dovedale, Castleton, Matlock and Miller's Dale. The weather was all that could be desired, and the complete organisation led to everything passing off punctually and without a hitch.

The generally expressed opinion of the departing guests was that no meeting was comparable to the present one for enjoyment except that at Montreal. The workers seemed to be generally of opinion that in no direction had the gathering been so useful as in the discussions initiated in several of the sections, to which reference has been made in recent numbers of NATURE. Undoubtedly one of the greatest advantages derived by the annual gathering is the meeting of "researchers" from all parts for the interchange of ideas, and the making and renewal of acquaintance one with another. The impression apparently made on all who have been concerned in the meeting is that the British Association is by no means in a declining condition. It is instinct with life, and those of the inhabitants of Nottingham who have felt the vivifying effect of being brought into contact with many of the scientific pioneers of our time, will wish that the Association, which has stimulated their scientific ardour by its presence, may live to benefit other important centres for many years to come. FRANK CLOWES.

NOTES.

IT is announced that the bust of the late Prof. John Marshall, which has been subscribed for as a memorial to him, will be handed over to the Council of University College on the occasion of the introductory lecture, by Mr. Bilton Pollard, at the opening of the session on Monday, October 2.

M. JANSSEN, writing to M. Bischoffsheim from the summit of Mount Blanc, on September 12, says that the Observatory has been fixed in its place, and all that now remains is to fit up the interior. It is hoped that observations will be commenced this autumn.

WITH much regret we record the death of Mr. Thomas Hawksley, the well-known civil engineer, on Saturday, September 23. Mr. Hawksley had for some years been at the head of that branch of his profession which deals with gas and water supply. It is said that more than 150 waterworks were constructed under his direction, besides a large number of important gasworks. He was born in 1807, and elected a Fellow of the Royal Society in 1878. In 1871 he was chosen as President of the Institution of Civil Engineers, and held that office for two years. The Institution of Mechanical Engineers elected him President in 1876-7, and he was the first President of the Gas Institute. In addition to these distinctions Mr. Hawksley possessed a number of decorations conferred upon him by various Sovereigns for services to science and to themselves. At the ripe old age of eighty-eight he passed away, leaving behind him a name which will be honoured for many years to come.

THE Right Hon. Lord Thring will, on Tuesday, October 3, distribute the prizes to the successful students of the Medical School of St. Thomas's Hospital. The distribution will take place at three o'clock, in the Governors' Hall.

AT a meeting of the Committee of the Sunday Society, at the Prince's Hall, on Tuesday, the date of Museum Sunday this year was fixed for November 26, when, as in November last, addresses are to be delivered in support of the Society's object, viz. the opening of museums, art galleries, and libraries on Sundays.

PROF. H. A. NICHOLSON will commence the Swiney Lectures on Geology on Monday, October 2, at the South Kensington Museum. His subject is "The Bearings of Geology on the Distribution of Animals and Plants."

THE Gilchrist trustees have granted the delivery of a course of science lectures at the Great Assembly Hall, Mile End Road, on alternate Thursdays, beginning this evening, when Prof. V. B. Lewes will discourse on "Our Atmosphere and its Relation to Life." The other lecturers will be Sir Robert Ball, Prof. Fleming, Rev. Dr. Dallinger, Dr. R. D. Roberts, and Dr. Andrew Wilson. The course will be in connection with the Bethnal Green Free Library.

A COURSE of twelve educational lectures on the principles of Commercial Geography applied to the British Empire will be delivered by Dr. H. R. Mill, at the London Institution, on Tuesday evenings, commencing on October 3. At the opening lecture, which is free, the plan of the course will be explained. Mr. H. J. Mackinder will follow Dr. Mill with a course on the relations between History and Geography.

THE following lectures will be delivered at the Royal Victoria Hall, Waterloo Bridge Road, during October:—"The Life and Work of Sir Richard Owen," by A. Smith Woodward; "A Total Eclipse of the Sun," by Prof. Thorpe; "Electrical Fishes," by Dr. W. D. Halliburton; and "The Compass in Iron Ships," by Prof. Reinold.

THE Dublin Water Committee has recently been carrying out experiments in rain-making. On the 20th inst. three dozen distress signals and one dozen rockets were fired into the air, and ten pounds of tonite were exploded on the ground. A copious fall of rain occurred shortly afterwards, especially on that part of the watershed between the Djouce and the Sugar Loaf Mountains. Whether the precipitation was directly caused by the fireworks is, however, a matter of opinion.

THE weather in these islands has recently undergone considerable change, owing principally to a deep depression which for several days lay between the Shetlands and Norway, causing northerly gales in Scotland, and snow in the northern parts of the kingdom. Frosts have occurred at night over Scotland and the central parts of England and Ireland, while in many places the daily maxima have fallen below 50°. Rainfall exceeding an inch in the twenty-four hours has occurred at several stations in Scotland, but in the midland and southern parts of England the weather generally has continued very dry. From the commencement of the year there is a deficiency in the amount of rain in all districts, amounting to nearly seven inches in the midland counties and south-west of England, and to more than nine inches in the west of Scotland.

THE Rev. S. Chevalier, S.J., Director of the Zi-Ka-Wei Observatory, has recently read a paper before the Shanghai Meteorological Society on the *Bokhara* typhoon which occurred in October, 1892. The typhoon originated on the 7th of October to the east of Luzon, and on the 10th passed very near to the south Cape of Formosa and, whilst crossing that island, wrecked in one night the Norwegian steamer *Normand* and the Peninsular and Oriental steamship *Bokhara*. Observations have been collected and collated for the whole area which came under the influence of the storm, and diagrams are given for selected stations to show the action of the

barometer and the position of the typhoon each day from October 8th to 11th. The author considers that the occurrence of a high barometer cannot be taken as a satisfactory indication of a typhoon, as is sometimes asserted, and he gives considerable attention to testing the relation which existed between the occurrence of a high barometer and the typhoon which followed. The first intelligence of the typhoon reached Shanghai on October 8, when a telegram was received from Manila, dated October 7, reporting it to the south-east of Luzon. Mr. Chevalier is of opinion that the typhoon was situated to the north-east, and not to the south-east of Luzon, and he adds that the *Bokhara* left Shanghai with inaccurate information. The storm apparently had its centre about sixty-five miles to the north-east of Appari at 2 p.m. on the 9th, and it must have travelled directly towards the south Cape of Formosa, being about 130 miles distant at 9 p.m. At that time the *Bokhara* was outside the Channel, and had not yet entered into the gale. From the quick fall of the barometer and the veering of the wind from north-east to south-west in a few hours, it is evident both that the centre had passed very near the Cape, and that it had recurved towards the north and north-east, instead of continuing to the north-westward. The barometer on board the *Bokhara* when at its lowest was 29·15 inches, where it remained for several hours. On the evening of the 10th the vessel was quite unmanageable owing to the heavy wind and sea, and was cast on the reef before midnight. The paper contains much valuable data relating to the violent storms which occur from time to time in the China seas.

THE detection of particular pathogenic bacteria in water in the presence of numerous harmless water forms, involves the use of special methods requiring much care and skill in their application. Koch (*Zeitschrift für Hygiene*, vol. xiv. 1893) recently recommended for the isolation of the cholera organism in water the addition of one per cent. of peptone and one per cent. of common salt to 200 c.c. of the water under examination. The latter ingredient is added on account of Dunham's discovery that the cholera bacilli multiply very rapidly when more salt than usual is added to the culture material. The treated water is then incubated at 37° C. for periods of ten, fifteen, and twenty hours, and agar-plates poured at these several intervals, whilst a careful microscopic examination is made of the surface of the liquid. Any colonies resembling those of the cholera organism are isolated from the agar-plates, and are further tested for the indol reaction, as well as for the pathogenic action on guinea-pigs. Koch states that by means of this method he was able to identify the cholera bacillus in a number of waters submitted to him during the recent cholera epidemic in Germany. Quite recently another modification has been published by Arens, "Ueber den Nachweis Weniger Cholerakeime in grösseren Mengen Trinkwassers." (*Münchener med. Wochenschrift*, 1893, No. 10.) The suspected water is first rendered distinctly alkaline by the addition of 1–1·6 c.c. of a ten per cent. solution of caustic potash to 200 c.c. of the water, so that the latter contains ·05–·08 per cent. of KOH. This alkalised water then receives pancreas bouillon in the proportion of one to nine parts of the water. This bouillon is composed of broth obtained from the pancreas to which Witte's peptone is added, and the whole neutralised with carbonate of soda until a highly diluted portion yields a faint red colour with rosolic acid. The treated samples of water are then incubated and examined as described above. Arens claims that by means of this method cholera bacilli can be detected when present in such small numbers as 2 in 5 c.c. of water.

TWO official maps of the geology of parts of Germany have been recently published; one of them, "Geognostische Uebersichtskarte des Königreichs Württemberg," has a scale $\frac{1}{500000}$. The strata are delineated with great minuteness, the subdivisions shown by colour and signs being as follows: 8 Quaternary, 10 Tertiary, 4 Cretaceous, 11 Jurassic, 18 Triassic, 4 Permian, 1 Carboniferous, 1 Devonian (?), 1 Archæan, 6 Igneous. The other map, "Geologische Uebersichtskarte von Elsass-Lothringen," by E. W. Benecke, has a scale $\frac{1}{500000}$. Although on a slightly larger scale, this map shows fewer subdivisions of the sedimentary series than does that of Württemberg; the crystalline rocks of the Vosges, &c., with their associated serpentines and limestones, are, however, carefully drawn. The low price at which these maps are sold is noteworthy—Elsass-Lothringen, 1 mark; Württemberg, 2 marks.

PROFESSOR CHARLES V. RILEY has reprinted, from the Third Annual Report of the Missouri Botanical Garden, the results of his observations, which have now extended over a period of twenty years, on the Pollination of *Yucca*. Every known species of *Yucca* is absolutely dependent, for its fertilisation, on the visits of a single species of insect, in all cases a species of *Pronuba*, a genus of small white moths belonging to the Tineina. The pollen cannot reach the stigmatic tube without artificial aid. The species which has been chiefly observed is *Yucca filamentosa*, which is pollinated by *Pronuba yuccasella*. The process is described in detail by which the female moth pierces the ovary, and deposits the egg in close proximity to an ovule. As soon as the ovipositor is withdrawn the moth runs up to the top of the pistil and thrusts the pollen, which she has gathered from other flowers of the species, into the stigmatic opening, and cross-fertilisation is secured. The larva is developed within the ovary, but the number of ovules destroyed in an ovary is never large, and does not practically affect its fertility. Every other species of *Yucca* has its own special fertilising species of *Pronuba*. *Y. filamentosa* is also abundantly visited by another moth, very similar in appearance to the *Pronuba*, the "bogus *yucca* moth," *Prodoxus decipieus*, which is apparently perfectly useless, and is not dependent on the fertilisation of the ovules for its subsistence. The paper is illustrated by ten plates, and concludes with a monograph of the three known species of *Pronuba* and the ten known species of *Prodoxus*, all named by Prof. Riley.

THE decomposition of any form of energy into two factors, one of which is of a constant magnitude, introduces certain simplifications into the theorems of thermodynamics and chemical physics which appear to merit some attention. Herr W. Meyerhoffer, in the *Comptes Rendus*, points out that the constant factor in the case of heat is not the entropy, as maintained by M. Le Chatelier, but the absolute specific heat, which has the dimensions of an energy divided by degrees of temperature. Entropy, on the other hand, is an energy divided by a number representing the number of degrees possessed by the heat at the time of its passage, and which Herr Meyerhoffer proposes to call the number of the isothermal. The confusion between entropy and absolute specific heat arises from the fact that the dimensions of temperature are at present unknown. Herr Meyerhoffer proposes to call the two factors of energy capacity and potential respectively. Then every transfer of heat will involve a change of two potentials, and the criterion of a reversible process will be the inequality of the two potentials. All the cycles invented since Carnot have always had the same function of transforming the variation of one potential into that of another of different nature. By means of this division of energy, most of the known stœchiometric laws can be reduced to one, thus:—The smallest particles of matter have, in a comparable state, the same capacity of energy. By going through the various forms of energy, Regnault's law concerning the specific heats of gases, and the laws of Dulong and Petit, Faraday, Eötvös, and Dalton may be severally obtained.

MR. JOHN DANIEL has sent us an advance-proof of a paper on "Polarization, using a thin Metal Partition in a Voltameter." The investigation had its starting-point in an observation of Dr. L. Arons', who noticed that ordinary gold leaf, used as a partition in an H_2SO_4 voltameter, allowed a current of ·2 or ·3 ampere to pass without any visible development of gas upon the metal, which was pasted over a hole 1½ c.m. in diameter, bored in a glass plate. The glass plate slid in grooves in a wooden frame, which was placed in the middle of the glass-voltameter. When platinium-foil (0·1 mm. thick) was substituted for the gold-leaf, there was a profuse escape of gas from the metal partition. Mr. Daniel has made similar experiments with partitions of gold, silver, aluminium and platinum of various thicknesses, and with various electrolytes, and has obtained for the different substances, values of the "critical thickness" above which polarization at the partition takes place, as well as some other interesting facts as to "critical current density," &c. He finds, for instance, that the "critical thickness" in good-conducting solutions of H_2SO_4, $CuSO_4$ and NaCl, is greater than ·00009 mm., but less than ·0004 mm., in the case of gold; while ·00015 mm., and ·002 mm. are the corresponding figures for platinum, with a current density of not more than 0·1 ampere per square c.m. of the metallic partition. Between these "critical limits" the polarisation for a given current increases with the thickness. In $CuSO_4$, all the plates except those below the critical thickness were destroyed by oxidation, and a similar effect was noticed in NaCl, in which gold and silver below the critical thickness were quite unaffected, while above it they could not be used on account of the chemical action.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Ascidian *Ascidia mollis*. The tow-nets continue to yield the regular autumn forms, among which the Liphonophore *Muggiæa atlantica* and the larvæ of the Polychæta *Magelona* and *Terebella* have generally been plentiful. An interesting feature of recent tow-nettings has been the presence of numerous minute free-floating colonies of certain Didemnidæ. Young *Echini* and *Asterinæ* of this season's growth are now plentiful at a depth of five fathoms and in coralline tide-pools respectively. The following animals are breeding:—The Hydroid *Sertularella Gayi*, the Nemertine *Amphiporus dissimulans*, the Archiannelid *Histriobdella Homari*, and the parasitic Cirrhipede *Sacculina*.

THE additions to the Zoological Society's Gardens during the past week include a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Miss Mercy Grogan; a Common Quail (*Coturnix communis*) British, presented by Mrs. Mazelin; two Black-pointed Teguexins (*Tupinambis nigropunctatus*) a Crowned Snake (*Scytale coronatum*), a Tree Boa (*Corallus hortulanus*), a —— Snake (*Leptognathus nebulatus*) from Trinidad, W.I., presented by Messrs. Mole and Urich; two Hamsters (*Cricetus frumentarius*, white var.) European, a Black-headed Caique (*Caica melanocephala*) from Demerara, a Corean Sea Eagle (*Haliætus branickii*) from Corea, a Black-pointed Teguexin (*Tupinambis nigro-punctatus*), a Tree Boa (*Corallus hortulanus*), a Boddært's Snake (*Coluber boddærti*) from Trinidad, W.I., deposited; a Golden Plover (*Charadrius pluvialis*) British, purchased.

OUR ASTRONOMICAL COLUMN.

NOVA (T) AURIGÆ SPECTRUM.—In the current number of the *Astronomischen Nachrichten* (No. 3189) Mr. W. W. Campbell communicates his observations of the spectrum of Nova Aurigæ since its reappearance in August. At this time the continuous spectrum was very faint, the spectrum consisted of isolated bright lines, and the three brightest lines had the intensities and positions of the characteristic nebular lines, the result being that the spectrum of this new star was announced to be that of a planetary nebula. That this view has not been universally adopted is shown by Vogel's paper on the same star, and he inclines to the opinion that the bright lines are chromospheric, and that the brightest line is not the nebula line. In the present paper Mr. Campbell has made more visual and long exposure photographic observations of nebular spectra, and finds no less than five other lines which are in the spectrum of the new star. The nebulæ he uses here for comparison are: Orion, G.C. 4390, N.G.C. 7027, G.C. 4964, G.C. 4373, and in the photographs of their spectrum he obtains 12, 12, 7, 10, and 5 lines respectively that appear to him to be new. The tabulated list of lines brings out very clearly, that with the exception of the line 451, the identity of which is uncertain in these nebulæ, the Nova lines are matched perfectly in one or more of them, allowing for the fact that they (the Nova lines) were shifted about five-tenth metres (in August and November, 1892) towards the violet. The Nova spectrum, as Mr. Campbell says, "certainly differs no more from the nebular spectra than the nebular spectra differ from each other." As for the lines, 4857, 4336, 4098, and 396 are the well-known hydrogen lines; 5002, 4953, the first and second nebular lines, while all the others correspond well with the nebular lines. The presence of these four hydrogen lines and the chromospheric line 4472, strengthens, as he says, his argument, and he concludes with the words that "if the spectrum is not conceded to be nebular, I must ask what else we should expect in that spectrum if it were nebular?"

THE FIREBALL OF JANUARY 13, 1893.—In the *American Journal of Science* (vol. xlvi. September, 1893), Prof. H. A. Newton contributes a discussion of all the observations that were made of the large fireball that was observed in America in January last. The great interest attached to this fall lay in the fact, as previously mentioned in this column, that Mr. Lewis, of Ansonia, Conn., happened to obtain a very good picture of the trail as it passed in the line of sight of his instrument while he was photographing the comet Holmes. Prof. Newton seems to have taken great pains to have the information as accurate as possible, and has even had some of the observers cross-examined, so to speak, on many particular points. The plate on which the photograph was taken is 4 by 5 inches, and the meteor went nearly centrally across it, the photographed portion being about 19° long. Several stars of the tenth magnitude in the middle, and some of about the eighth, near the margin of the plate, are shown on the negative, so that some fairly good measurements of the position of the track have been procured. The co-ordinates of seven points of the trail have thus been measured, and a very slight curvature of the path is indicated by the results but not clearly proven, the curvature being caused, as suggested by Prof. Newton, by "the atmosphere's resistance of the irregularly shaped body." An enlarged print of the photograph (about 26 inches long) accompanies the paper. The striking feature of it is the irregularities of light on the path, and also its increase in frequency as the end of the plate is reached. This is due, as supposed, to a rotation of the stony mass, "more rapid at the end than at the beginning, and that the unequal amounts of burned material were thrown off according as a well burned or a raw surface was for the instant in front."

NITRO-METALS, A NEW SERIES OF COMPOUNDS OF METALS WITH NITROGEN PEROXIDE.

A REMARKABLE new series of compounds, formed by the direct union of nitrogen peroxide with certain metals, and of a nature somewhat akin to that of the metallic carbonyls recently discovered and investigated by Mr. Mond and his co-workers, are described by MM. Sabatier and Senderens in the September number of the *Bulletin de la Société Chimique*. It was observed that when vapour of peroxide of nitrogen in a state of tolerable purity was allowed to stream at the ordinary temperature over metallic copper, cobalt, nickel, or iron, these metals being in the finely-divided and pure condition obtained by the recent reduction of their oxides by hydrogen, rapid absorption of the nitrogen peroxide occurred with the formation of definite compounds possessing properties of an

exceptionally interesting kind. These compounds are solid non-volatile substances, unlike the metallic carbonyls in this respect, and are represented by the general formula M_2NO_2, where M represents either of the four metals mentioned. Their discoverers propose the name *metaux nitrés*, which perhaps may be conveniently rendered into English as *nitro-metals*.

When a quantity of copper, recently prepared by the reduction of copper oxide in the usual manner by means of a stream of hydrogen or of carbon monoxide, is exposed at the ordinary summer temperature (about 25° being the average temperature of the laboratory while MM. Sabatier and Senderens were conducting these experiments) to a current of the reddish-brown vapour of nitrogen peroxide, it becomes rapidly attacked and converted into a brown substance, considerable heat being at the same time evolved and a large proportion of the nitrogen peroxide absorbed. The brown solid substance produced is found to react with great energy with water, the reaction being accompanied by a copious evolution of nitric oxide, NO. At 30° reduced copper absorbs no less than a thousand times its volume of nitrogen peroxide. Upon analysis of the product it is found to contain about 74 per cent. of copper. A compound of the composition Cu_2NO_2 would contain 73·4 per cent. The nitrogen present was also determined directly, by heating with excess of copper in a stream of carbon dioxide, the nitrogen being measured over caustic potash in the ordinary manner; its amount was found to correspond closely with that demanded by the above formula.

In preparing nitro-copper care must be taken to free the nitrogen peroxide from traces of the vapour of nitric acid, for this acid decomposes the compound with energy, effervescence occurring and the green nitrate of copper being produced. To prevent the deleterious effects of traces of admixed nitric acid vapour the red fumes are allowed to pass first through a column of litharge and afterwards over phosphoric anhydride.

Nitro-copper is unalterable in dry air at ordinary atmospheric temperatures. When heated in pure nitrogen it is dissociated, a temperature of 90° being ample to effect the change; nitrogen peroxide is evolved together with smaller quantities of nitric oxide and nitrogen, and partially oxidised copper remains. One of the most useful properties of nitro-copper is that it may be used for the purpose of liquefying nitrogen peroxide; if a quantity is placed in one limb of a Faraday V-tube and heated, the other limb being cooled, the nitrogen peroxide liberated by the dissociation rapidly collects in the liquid form in the cold limb. If the tube is removed and allowed to stand a short time, re-absorption of the peroxide by the copper occurs. Water reacts with nitro-copper as above mentioned with considerable violence, pure nitric oxide entirely soluble in solution of ferrous sulphate being briskly evolved. The aqueous solution contains cupric nitrate and nitrite, and a sediment of pure copper remains. In moist air, therefore, nitro-copper rapidly deteriorates, becoming enveloped in red fumes and its surface turning green. Hydrogen is without action upon it in the cold, but when heated to 180° large quantities of ammonium nitrite and free ammonia are produced. Dry ammonia gas reacts at the ordinary temperature with some energy upon nitro-copper. White clouds of ammonium nitrate and nitrite and of moisture first make their appearance, then suddenly the mass becomes incandescent and more copious clouds of ammoniacal salts and steam are produced, the residue consisting of copper mixed with ammoniacal oxide of copper. Sulphuretted hydrogen likewise reacts at the ordinary temperature with nitro-copper, heat being evolved, water, sulphur, and a blue sulphide of copper being the products of the reaction.

It would thus appear that nitro-copper is of a kindred nature to the metallic carbonyls, the nitrogen peroxide being held in a similar manner to the carbon monoxide of the latter compounds, and capable of being liberated in a regular manner by the dissociation of the compound by heat. The substance may, in fact, be employed as a convenient means of storing nitrogen peroxide, with the certainty of being able to liberate it by a comparatively slight rise of temperature whenever it is desired to procure some for experimental purposes.

Metallic cobalt reduced from its oxide by means of hydrogen at a temperature below redness is only difficultly pyrophoric in air, not becoming incandescent on admission into air with anything like the readiness of iron. It burns energetically in the cold, however, in nitrogen peroxide. When the nitrogen peroxide vapour is diluted with nitrogen, the heat of the reaction is modified, and the formation of nitro-cobalt occurs in a regular manner, as in the case of copper. It is necessary in the case of cobalt to conduct the preliminary reduction in hydrogen in the same tube as is afterwards used for the preparation of the nitro-compound, in order to avoid re-oxidation of the metal, and it is advantageous to employ as low a temperature for the reduction as possible.

Nitro-cobalt is a black solid substance. Its reaction with water is very violent, but less nitric oxide is produced than in the case of nitro-copper. The rose-coloured solution contains mainly nitrate of cobalt, and a quantity of basic nitrite is found amongst the residual copper. When nitro-cobalt is heated in an atmosphere of nitrogen, a small quantity of nitrous fumes are first evolved, then almost immediately violent deflagration, accompanied by a flame of great brilliance, occurs. The same explosive deflagration occurs if, at the end of the preparation, the supply of diluting nitrogen is shut off before the nitrogen peroxide. When mixed with a combustible substance nitro-cobalt forms a dangerous explosive. If a small quantity wrapped in paper is introduced into an eprouvette filled with mercury at the top of which is a little water, a violent explosion at once results upon the arrival of the small paper packet at the surface of the mercury, owing presumably to the heat of the reaction of a portion of the nitro-cobalt with water causing sudden dissociation of the whole, the organic matter of the paper burning in the gaseous products of the dissociation.

Nitro-nickel is more difficult to obtain in a pure state, for cold reduced nickel reacts so vigorously with nitrogen peroxide that even when the latter is largely diluted with nitrogen a partial oxidation of the metal occurs. Actual incandescent combustion is, however, avoided, and a regular absorption of the peroxide vapour occurs. In a careful experiment a product containing 20 per cent. of NO_2 instead of the theoretical 28 per cent. was obtained. Nitro-nickel closely resembles nitro-cobalt; it is a black substance which reacts with water with evolution of nitric oxide, and which deflagrates with explosive force when heated in a current of inert gas.

Nitro-iron is still more difficult to isolate. When the peroxide is diluted with a very large excess of nitrogen, it is quickly absorbed by reduced iron up to a certain point, when the passage of more peroxide invariably brings about brilliant deflagration and consequent destruction of the product. There is ample evidence, however, that iron does form a nitro-compound of a similar interesting nature to that of the nitro-compounds of copper, cobalt, and nickel above described.

A. E. TUTTON.

PHYSICS AT THE BRITISH ASSOCIATION.

SECTION A met in the well-appointed lecture theatre of the Nottingham University College. Mr. Glazebrook had only just finished his presidential address when an incident occurred which was of interest as showing that members meant business, and were not disposed to allow the authority of the chair to be questioned. Perhaps the experimental work communicated was not of striking novelty or importance, but some of the informal communications and discussions—notably those on electrical theory, the connection between ether and matter, and the teaching of elementary physics—were of great interest, especially to teachers of physics. This was largely due to the active part taken by Lord Rayleigh, Profs. Fitzgerald, Carey Foster, Oliver Lodge, Rücker, and other leading physicists. The discussion occasionally tended to resolve itself into an exchange of ideas around the lecture-table, but as the ideas were for the most part interesting (and energetically expressed) members did not appear to object. At first there was an occasional grumble against Dr. Lodge's innovation of starting at 10 a.m., but the wisdom of the change was shown by the fact that the Section had generally to sit until 2 p.m.

At the first sitting on Thursday (September 14), after the President's address, the "Report of the Committee on Solar Radiation" was communicated. Observations have been made with a thermometer enclosed in a non-conducting case, an image of the sun being thrown upon the bulb. Simultaneous readings of screened thermometers within the case were also taken, and the excess of temperature noted from minute to minute. The thermometer has since been replaced by a thermo-junction, which works very sharply, the readings becoming steady in about six minutes, whereas with the thermometer twenty

minutes are required. The readings were calibrated by comparison with an iron-copper junction, heated in paraffin oil and balanced against the actinometer couple. 1° F. was found to be equal to about thirty-six divisions. Another Committee gave detailed reports of magnetic work at the Falmouth Observatory. The other Committees submitted formal reports asking for reappointment, in some cases with small grants of money.

Prof. G. F. Fitzgerald gave an interesting communication on "The period of vibration of Disturbances of Electrification of the earth." The period of oscillation of a simple sphere of the size of the earth, supposed charged with opposite charges of electricity at its ends, would be about $\frac{1}{17}$th of a second; but the hypothesis that the earth is a conducting body surrounded by a non-conductor, is not in accordance with the fact. Probably the upper regions of our atmosphere are fairly good conductors. In a Geissler tube air is a good conductor, and we know that when part of a gas is transmitting an electrical disturbance the rest of the gas in its neighbourhood becomes capable of transmitting such as well. Extending the analogy, we may assume that during a thunderstorm the air becomes capable of transmitting small disturbances. If the earth is surrounded by a conducting shell its capacity may be regarded as that of two concentric spheres, and is accordingly greater than that of a simple sphere, which would produce a corresponding change in the rate of oscillation. But at the same time the presence of currents in the outer air would alter the self-induction; and calculation shows that the net result is a comparatively slight change in the period of oscillation. If we assume the height of the region of the aurora to be 60 miles or 100 kilometres, we get a period of oscillation of 0·1 second. Assuming it to be 6 miles (or 10 km.) the period becomes 0·3 second. On the sun we might expect very much greater periods of oscillation, but these oscillations would not give rise to radiations. If alternating currents of the kind referred to really travelled north and south around the earth they would give rise to east and west alternating magnetic forces of periods between $\frac{1}{10}$ and $\frac{3}{10}$ of a second. Dr. Lodge has already looked for evidence of such magnetic forces, but on the assumption that the period would be $\frac{1}{17}$ second. The author has calculated what magnetic disturbances would be produced by given charges. A disturbance equal to $\frac{1}{10}$ part of the horizontal force of the earth would correspond to an electrostatic charge of 80 C.G.S. units per sq. cm. Such a charge would reduce the superficial pressure on the earth by an amount corresponding to a weight of 40 gm. per sq. cm. This does not sound probable, but we must remember that it would correspond to a most fearful magnetic storm. A charge of 8 C.G.S. units per sq. cm. would produce a variation of $\frac{1}{100}$ of H, and would not sensibly affect the barometer. The records of existing magnetic observatories are not sufficiently complete to admit of testing the other suggestions made in the paper. Prof. O. Lodge thought that the detection and observation of such magnetic disturbances was work that could only be done in a National Physical Laboratory. If the sun were a conducting body surrounded by a non-conductor, the period of an electrical oscillation upon it would be 6½ seconds. He had hung up in his laboratory a needle and watched it for hours, but the only disturbances observed were due to trains and traffic. He pointed out that the electric vibrations of a molecule, calculated from its size, were more rapid than those required to produce light. He suggested the addition of a jacket like that which Prof. Fitzgerald assumed to exist around the earth; but would this prevent radiation?

The Moon's Atmosphere and the Kinetic Theory of Gases.—Sir Robert Ball has suggested that the absence of any atmosphere investing the moon is a simple and necessary consequence of the kinetic theory of gases. Prof. Liveing has applied this theory to interplanetary and interstellar space, with reference to the chemical constitution of planetary atmospheres. According to Sir Robert Ball the mean molecular speed of oxygen and nitrogen is less than the speed with which a body would have to be projected in order to leave the moon without ever returning; but in the course of collisions between the molecules they frequently attain speeds sufficiently great to enable them to overcome the moon's attraction, and thus escape from the moon's atmosphere. On the other hand, the speed required to permanently leave the earth is one which "it would seem that the molecules of oxygen and nitrogen do not generally ever reach," and therefore the earth retains a copious atmosphere. Mr. G. H. Bryan, in reading his paper on this subject, stated that no statistical calculations had hitherto been made with the object of testing these questions; he was not aware until his paper had been printed that explanations based on the kinetic theory had been suggested as far back as 1878 by Mr. S. Tolver Preston and Mr. Johnstone Stoney. Mr. Bryan has applied the theory to investigate that effect of varying temperatures upon the relative densities of oxygen and hydrogen in a permanent distribution under various conditions; he has also calculated the average number of molecules of gas to every one whose speed is sufficiently great to overcome the attraction of given bodies in the solar system, and gives tables showing the results. Thus for oxygen at 0° C., rather over one molecule in every *three billion* is moving fast enough to fly off permanently from the moon, and only one in every $2{\cdot}3 \times 10^{329}$ is moving fast enough to escape from the earth's atmosphere; while the sun's attraction, even at the distance of the earth, prevents more than one in every 2×10^{4910} from escaping. In the discussion which followed, Sir Robert Ball stated that the suggestion really did not originate with himself, but were familiar to him as having been discussed many years ago in a paper by Mr. Johnstone Stoney. Among celestial bodies the moon is unique in having no atmosphere. In the earth's atmosphere there is no free hydrogen. Stoney's theory accounts for these effects. On the other hand, in the case of big bodies like Sirius it is hydrogen, and essentially hydrogen alone, which forms their atmosphere.

Grinding and polishing of glass surfaces.—Lord Rayleigh stated that he had been investigating the nature of these processes, and gave a most interesting description of the results. He first pointed out that the process of grinding with emery is not, as is commonly supposed, a scratching process. The normal effect is the production of isolated detached pits—not scratches. The glass gives way under the emery; at the same time the emery gives way under the glass and suffers abrasion. An image seen through glass which has been finely ground (but not yet polished) has perfect definition. And so when the sun is viewed through a cloud the image is sharp as long as there is an image; even when the cloud thickens, the edge appears to be sharp until we lose the image altogether. A glass lens finely ground gives very good definition, but there is great loss of light by irregular reflection. To obviate this the lens is polished, and examination under a microscope shows that in the process of polishing with pitch and rouge the polishing goes on entirely on the surface or plateau, the bottom of each pit being left untouched until the adjoining surface is entirely worked down to it. It appeared interesting to investigate the amount of glass removed during the process of polishing. This was done both by weighing and interference methods, and the amount removed was found to be surprisingly small. A sufficiently good polish was obtained when a thickness corresponding to 2½ wave-lengths of sodium light was removed, and the polishing was complete when a thickness corresponding to 4 wave-lengths was removed. Lord Rayleigh is of opinion that the process of polishing is not continuous with that of grinding, but that it consists in a removal of molecular layers of the surface of the glass. Grinding is easy and rapid, whereas polishing is tedious and difficult. The action of hydrofluoric acid in dissolving glass was also investigated, and was found to be much more regular—that is, has generally been assumed to be by chemists. It was found to be easy to remove a layer corresponding in thickness to half a wave-length of sodium light; and with due precautions as little as one-tenth of a wave-length.

Mr. W. B. Croft exhibited simple apparatus for observing and photographing interference and diffraction phenomena. No bench was used, but the various pieces of apparatus were mounted on the usual stands used for holding lenses, &c. One of these contained a thin aluminium plate with a needle-hole, or the slit of a spectroscope. On this the light of a lamp was focussed by means of a lens. As an observing eye-piece, the eye-piece of a Beck microscope was used and was placed about 2 ft. from the slit or point, the object being introduced between. The stands should be adjusted so that the light proceeds straight into the eye-piece. The whole of the special apparatus required need only cost a few shillings, and with this the usual phenomena of Fresnel's bi-prism, sharp edges, perforated zinc, &c., can be both seen and photographed. Mr. Croft exhibited an admirable series of slides photographed direct with the aid of his apparatus, including interesting examples of the bright central spot in the shadow of a small opaque screen (shot).

On Sun-spots and Solar Envelopes.—The Rev. F. Howlett gave an account of observations and records made by him

during the last thirty years of sun-spots, &c., and stated that he had not on a single occasion been able to verify the assertions made in 1769 by Dr. Wilson with reference to the behaviour (through fore-shortening) of the umbra and penumbra as a sun-spot approaches the limb of the sun.

On Friday a report was submitted "On our Present Knowledge of Electrolysis and Electro-Chemistry." This was part of a report which was being drawn up by Mr. W. N. Shaw and Mr. T. C. Fitzpatrick. Many investigators have been engaged upon electrolytic work, but their observations have been published in scattered papers and expressed in a manner which makes comparison of them difficult. The present instalment of the report is the work of Mr. Fitzpatrick, who has at great pains collected all the available information on the electro-chemical properties of solutions in water and has compiled an exhaustive table showing the different chemical salts in solution. Data are given respecting conductivity, temperature coefficients, migration constants of ions (from which one can calculate the rate at which ions travel through solutions), fluidity (the inverse of viscosity), &c. As with falling objects so it is with ions; they travel more quickly through a limpid fluid than through a viscous one. This is just why acids conduct better than salts.

On the connection between the Ether and Matter:—Prof. O. Lodge made a further report as to experiments made with the same apparatus as that which he had described to the Section at the Cardiff meeting in 1891. Ever since Fresnel's time the question has been debated whether—(1) the earth carries with it the ether in its immediate neighbourhood, thus causing a disturbance, or (2) rushes through it, and it through the earth, each being independent and moving independently. Dr. Lodge has been endeavouring to settle this question by finding out whether a rapidly revolving steel disc (like a circular saw) exercises any drag upon the ether in its immediate neighbourhood. He uses two such discs of tough steel, about a yard in diameter, rotating in parallel planes an inch apart. He is now able to run the discs at the rate of 3000 revolutions per minute; but even at this high speed no effect is observed which can be attributed to any drag of the ether. He has also replaced the discs by an oblate spheroid of wrought iron with a deep channel or groove cut in it and wound with wire; but the rotation of this transversely magnetised mass (weighing about a ton) does not set the ether in motion.

A Mechanical Analogue of Anomalous Dispersion.—Mr. Glazebrook described a mechanical model which he had constructed to illustrate the theory of anomalous dispersion propounded by Sellmeyer, and developed by Helmholtz and Lord Kelvin. The model consisted of rows of balls connected to each other by elastic strings and connected to fixed beams by springs of varying stiffness.

Prof. Fitzgerald communicated a note on Prof. Ebert's method of estimating the radiating power of an atom, and stated that the results show that molecules have a complex structure, otherwise they would radiate very badly. Prof. Fitzgerald holds that the vibration of an atom is the mechanical vibration of a minute bit of the corresponding matter; and that the ionic charges by their corresponding vibrations excite the external radiation.

Lord Rayleigh gave the results of his investigations on the "Theory of Reflection from Corrugated Surfaces," and also, in the absence of the author (Lord Kelvin), read two papers "On the Piezo-Electric Property of Quartz," and "On a Piezo-Electric Pile." These were followed by two interesting communications on electro-magnetic work carried out under the direction of Prof. Hertz in Bonn.

On Electric Interference Phenomena.—Mr. E. H. Barton described experiments on phenomena somewhat similar to Newton's rings, but exhibited by electromagnetic waves in wires. The waves were generated by a Hertzian primary oscillator consisting of two discs of 40cm. diam. each connected by a wire 1m. long to small brass balls between which sparks passed. Opposite these discs, and about 30cm. distant, were two similar ones from which proceeded a pair of parallel copper wires 8 cm. apart and 160 m. long. Along these the waves were propagated and the interference phenomena exhibited. The phenomena in question were produced by hanging sheets of tinfoil on the wires for a certain part of their length. Where the sheets hung the capacity and self-induction of the leads were changed, thus causing a partial reflection of the waves from the *beginning* of this *abnormal* part. But a *second* reflection occurs at the *end* of this part also. Thus interference phenomena were set up, and as the length of the abnormal part was gradually increased the intensity of the transmitted waves was found to periodically increase and diminish. Mr. Barton has recently given (Proc. Roy. Soc.) a theory of these phenomena with which the experiments are in fairly good accord.

On the Passage of Electric Waves through Layers of Electrolyte.—The method and apparatus used in this research were described by Mr. G. H. Yule in a communication to the Royal Society in June last, and an experimental curve was given in the same paper showing that the transmission of trains of electromagnetic waves through a layer of distilled water follows the same law as that of light through a thin plate, *i.e.* that the transmitted intensity varies periodically as the thickness of the plate increases. Similar curves were now given, using dilute solutions of zinc sulphate, alcohol, and a mixture of alcohol and water; in all cases the periodic character of the curve was very well marked. As the transmitted intensity attains its first maximum when the thickness of the layer is half a wave-length, the method may be used to determine dielectric constants. That found for water was 69·5, and for 95 per cent. alcohol 26·7—values agreeing roughly with the high values found by previous investigators.

Mr. J. Larmor referred to a familiar type of caustic curve, produced by reflection from a strip of metal bent into circular form. He pointed out that the source of light need not lie in the plane on which the caustic is thrown—the caustic preserves the same form whether the incidence is direct or indirect.

On Saturday the following papers (mainly of mathematical interest) were communicated:—"On a Spherical Vortex," by Prof. M. J. M. Hill; "Note on the Magnetic Shielding of Two Concentric Spherical Shells," by Prof. Rücker; "The Effect of a Long Tube as a Magnetic Screen," and "The Effect of a Hertzian Oscillation on Points in its Neighbourhood," by Prof. Fitzgerald; "The Magnetic Action of Light," by Mr. J. Larmor (Dr. Lodge characterised this as being perhaps the most suggestive communication made during the meeting, and expressed the hope that it would be further developed and printed); "A Special Class of Generating Functions in the Theory of Numbers," by Major MacMahon; "On Agreeable Numbers," by Lieut.-Col. Cunningham.

On Monday Mr. Horace Darwin exhibited and described the instruments used by the Committee on Earth Tremors. Prof. Milne presented the report of the Committee on the volcanic and seismological phenomena of Japan, and gave a most interesting account of the work done by himself and other observers in Japan.

The greater part of the sitting was taken up by a discussion on the teaching of elementary physics. This was introduced by Prof. Carey Foster, who exhibited and described some simple and cheap apparatus for teaching practical physics. The apparatus shown was well adapted for elementary class-work in heat and electricity. Mr. W. B. Croft followed with a paper in which he described the plan of science teaching at Winchester School, where, by an order of the Privy Council, science is compulsory for almost all the boys. The aim is to arrange for that which may be imposed on all as part of a good education—to supplement thought with the observing faculty. The scheme is also suited for those who may hope to become mathematical physicists and who should in boyhood devote themselves mainly to mathematics. For some boys science forms the best foundation of early education. Public schools are not generally adapted for these cases; but they can well be provided for by a liberal elasticity of system. Prof. O. Lodge read a paper in which Mr. A. E. Hawkins gave the results of his experience of science teaching in public schools, especially in Bedford School. He deprecated the influence of examinations on the teacher's work. Dr. Gladstone considered that apparatus should be not only cheap but simple. To use complicated apparatus was almost as dangerous as to depend upon blackboard work. He agreed with Mr. Buckmaster that too much work was usually expected from a science master. Mr. D. E. Jones emphasised the last point, and stated that instances had come under his notice where science masters had no time to prepare their experiments for class. The idea that science, unlike other subjects, ought to pay for itself, was much to be deprecated; it should not be neglected or abandoned in a school merely because it was costly. The teaching of physics as an educational instrument had not been sufficiently developed; and Continental schools were not

much in advance of English ones in this matter. Mr. Jones gave an account of the system of teaching experimental physics as now carried out under Mr. Rintoul at Clifton School. Referring to the subsidising of science teaching in secondary schools, he pointed out that supervision of some kind must accompany public aid. If the evil effects of examinations were to be avoided, an efficient system of public inspection must be developed, and the inspectors should be men with experience of teaching work. Prof. Fitzgerald agreed with this; and Dr. Lodge expressed his regret that head-masters of schools could not be compelled to attend and listen to discussions such as this. The President, in concluding the discussion, said that an effort should be made to replace examinations by an intelligent system of inspection.

The last sitting was held on Tuesday the 19th. The President, as Secretary, submitted the report of the Electrical Standards Committee. This report defines the unit ohm as being the resistance of a column of mercury 106·3 cm. long, and of 14·4521 grammes mass at 0° C. The B. A. unit is equal to 0·9866 of the ohm thus defined. The French authorities had forwarded through M. Mascart four names which were proposed for the ohm of the 106·3 cm., and of these names the committee on the whole preferred "international." The resolutions respecting the electrical units passed at the Edinburgh meeting have now been accepted in Germany, France, Austria, Italy, and the United States, and throughout the British empire. Prof. Carey Foster said it should be known that the work of the Committee was really the work of the President (Mr. Glazebrook).

On Standards of Low Electrical Resistance.—Principal J. Viriamu Jones described the method of determining the ohm devised by Lorenz and used by Lord Rayleigh and subsequently by himself. The method consists in rapidly rotating a copper disc coaxially in the mean plane of a standard coil, the same current being led through the coil and through the low resistance which is to be measured. By varying the speed of rotation the difference of potential between the centre and the circumference of the disc can be made to counterbalance the difference of potential at the ends of the resistance. Prof. Jones pointed out that it is not only the most accurate method of measuring the ohm, but that it is especially suited for the measurement and production of very low resistances. Errors are necessarily produced in stepping down from a standard ohm, say by the potentiometer method, to a resistance of 1/1000 or 1/10,000 of an ohm. The Lorenz method is sufficiently simple and accurate to be adapted for the direct production of low resistances from a rotating disc and standard coil without going through the circuitous process of stepping up to a standard ohm and down again. The difficulty of making a good contact with the edge of the disc is avoided by using a tube with mercury running through it at constant pressure. Difficulties were encountered in using the electrically driven tuning-fork; for although it vibrated uniformly when once started, it was liable to a small change when stopped and started again. A series of experiments on a resistance of 1/2000 of an ohm was given in which the variation from the mean of the extreme values was only 1 in 12,000. Lord Rayleigh expressed his pleasure at the extraordinary accuracy now obtained by the method. In his own experiments the electrically driven tuning fork, instead of being stopped and started again, was kept on all day, and compared at the beginning with a free fork of the same frequency (128). In a recent paper Dorn has criticised the various methods used in the determination of the ohm, and has raised against Lorenz's method the objection that particles of iron in the disc might affect the result by altering the permeability inside the coil. This assumes that the presence of such particles would introduce a direct factor into the result, which would only be true if the whole space inside the coil were so filled.

Apparatus for Comparing nearly Equal Resistances.—Mr. F. H. Nalder exhibited a modified Wheatstone Bridge for comparing nearly equal resistances. In applying the Carey Foster method only a small portion of the usual metre bridge is brought into actual use, and in Mr. Nalder's modification only the part thus used (about 1 decim. long) is provided. This can be replaced by other wires of the same length but of different diameters and therefore resistances; of course the resistance per unit length in each of these is known. The comparison coils are wound in a single bobbin, so as to avoid temperature errors; these, and errors due to the thermo-electric effects, are materially reduced by the compactness of the whole apparatus. Dr. O. Lodge described a new form of galvanometer for physiological purposes. It was designed by himself and made by Messrs. Nalder Brothers. The nerve currents excited by stimuli are exceedingly feeble and, even with the so-called non-polarisable electrodes, the currents under investigation are frequently masked by other effects. Physiologists require an exceedingly sensitive ballistic galvanometer; but they appear generally to use needles which are far too heavy, and galvanometers which are too highly damped, and which manifestly cannot be so delicate as undamped galvanometers. The best form of galvanometer for their requirements is one which contains a very light needle built up of short pieces of highly magnetised steel wire and in which the coils are small and are wound up as close as possible to the needles. The instrument exhibited had four such coils and four needles, forming an astatic system suspended by a quartz fibre in a very weak field. Compared with the usual galvanometers of the same resistance its sensitiveness was at least twice as great. Prof. Boys has shown that excellent definition can be obtained from a small scrap of reflecting mirror; and Lord Rayleigh has shown that a pointer read by a microscope admits of just the same degree of delicacy as the mirror method. As biologists are accustomed to looking through microscopes, Dr. Lodge suggested that they might prefer to observe through a micrometer eyepiece a needle with a bee-sting as pointer. Prof. Fitzgerald suggested that the damping might be further reduced by hanging up the needle in a vacuous tube; and that the polarisations might be swept out by introducing capacities as in cable work.

A Simple Interference Experiment.—There is a well-known interference arrangement in which the object-glass of a telescope is covered by an opaque diaphragm containing two narrow slits. An observer looking through the telescope at a radiant point or slit parallel to the two narrow slits sees a bright central band of white light bordered by interference-bands. Lord Rayleigh had investigated the part played by the telescope in this arrangement, and found that the interference-bands can be equally well obtained by using a plain brass or cardboard tube, having at one end a single slit and at the other a double slit consisting of two fine scratches on a piece of chemically silvered glass about 1/100th of an inch apart. The President thanked Lord Rayleigh for introducing such a simple form of interference experiment, and said it should be more generally recognised that, inasmuch as the eye contains a lens and screen, we can frequently do without an observing telescope in optical experiments.

On Specula for Reflecting Telescopes.—Dr. A. Shafarik communicated the results of investigations which he has carried on since 1870 with the object of producing specula having greater tenacity than that of the Ross telescope. Silvered-glass mirrors produced by the Foucault method suffer rapid deterioration in the air of large towns. The addition of phosphorus is found to make bronzes harder and closer; and the addition of iron, nickel, or cobalt gives them a surprising degree of tenacity. In general the strongest alloys are those which contain the metals in atomistic proportions; and even a small deviation from this proportion appears to diminish the strength considerably. The process of grinding specula differs from that of grinding glass, for alloys are never homogeneous, they are full of crystals, as can be shown by partially dissolving out with acids. The relative tenacity of the Rosse speculum and of two other alloys is given below:—

R = Cu_4Sn_1	Strength = 1·00
ZN = Cu_5Sn_1Ni	,, = 6·33
D = Cu_4Sn_1 + 4 per cent Zn.	,, = 0·52

Several members pointed out that what was really required was a knowledge of the values of Young's modulus for the various alloys investigated, and that it was doubtful whether this was what the author referred to as "strength," or in what way the measurements had been carried out.

Prof. O. Lodge communicated a supplementary note on the ether. He had been asked how could dust polarise light if there was no mechanical connection between ether and matter? But on the electro-magnetic theory there was no difficulty, for light is not an ethereal oscillation but an electrical oscillation, and if the dust has different values of μ and κ from the ether it may affect the wave. Mr. Trouton stated that dust particles act as reflecting resonators with free periods. The President had to confess that he did not fully understand the sense in which Prof. Lodge used the word "mechanical," but con-

sidered that a modified mechanical theory (*e.g.* that of the quasi-labile ether) could explain all optical phenomena save those of electro-optics.

A discussion on "The Publication of Scientific Papers" was introduced by the reading of Mr. A. B. Basset's paper. Mr. Basset thinks it highly improbable that scientific societies of position and standing would consent to sink their individuality in order that arrangements might be made for the publication of all important papers in a central organ. The only feasible scheme seems to be the publication of a digest of papers by the co-operation of the various scientific societies; and if thought desirable, papers published in foreign countries might also be included. The development of a well-known periodical is an easier matter than the starting of a new one; and as many authors already send abstracts of their papers to NATURE, it might be worth while considering whether an arrangement could not be made with the proprietors of NATURE by which a supplemental number could be issued (say quarterly) containing a digest of the most important papers published during that period. Mr. J. Swinburne characterised the present system of publishing physical papers as being about as bad as it could be. Papers should be printed and circulated beforehand so as to leave time at meetings for useful discussions. He thought the Physical Society was the most hopeful body to look to, and advised the sending of all physical papers to it. Prof. Fitzgerald agreed with Mr. Swinburne that the publication of titles or indexes alone was unsatisfactory; it was like giving a stone to a man who asked for bread. Abstracts were better, for they gave a little bread with the stone, and he advised the translation of Wiedemann's *Beiblätter* into English. The *Philosophical Magazine* was the personal property of Dr. Francis, and even in the interests of science it was unreasonable to try to evict a man from his own property. The discussion was continued by Prof. Rücker, Prof. Carey Foster, and Lord Rayleigh; and the President in summing up said that the general opinion appeared to be that the matter should be considered by a committee of the Royal Society, if possible in conjunction with the Physical Society.

A new form of air-pump by Prof. J. J. Thompson was exhibited, in which two objects had been aimed at:—(1) to use sulphuric acid instead of mercury; (2) to make the pump self-acting and automatic.

Mr. F. T. Trouton made a communication on a peculiar motion assumed by oil bubbles in ascending tubes containing caustic solutions. A long glass tube was exhibited containing a bubble (about 3 inches long) of sweet oil in a very dilute solution of caustic potash. On inverting the tube the bubble begins to rise, and waves develop on its surface like the knots on a bamboo. These are unstable, and presently resolve into spiral waves which are more stable, because they leave spaces along which the solution can stream past the bubble. If the tube is inclined instead of inverted the bubble crawls up with a slow, caterpillar-like motion.

Dr. R. H. Mill gave a most interesting account of the relation between the temperatures of sea water and air in the Clyde sea area, and illustrated his remarks by an excellent series of slides. After a somewhat unintelligible communication by Mr. E. Major "On the disturbance of a fluid consisting of hard particles by a moving body, with special reference to the ether," the meeting closed with a hearty vote of thanks to the President.

CHEMISTRY AT THE BRITISH ASSOCIATION.

AMONG the advantages of the sectional meetings of the British Association are the opportunites they afford for discussions on scientific matters of special interest, and for the exhibition of experiments and specimens to a wider audience than is often available at the meetings of any single scientific society. The meeting of Section B at Nottingham will be chiefly remembered on account of the success of these two features, and it is to them that attention will be specially devoted in the necessarily brief account which follows.

The papers read on the opening day, after the President's address, were chiefly connected with the chemistry of the metals.

Dr. Gladstone gave an account of some tools and ornaments of copper discovered by Dr. Flinders Petrie and Mr. Bliss in Egypt and Palestine. From the chemical examination of some of these it is concluded that their necessary hardness was imparted by the presence of cuprous oxide.

In a paper by H. Harris and T. Turner a furnace used by the natives of Bengal for smelting iron was described. It is a small shaft furnace, about three feet high, and is capable of producing iron of great purity, from magnetic ore and native charcoal, without the addition of flux.

The Report of the Committee for obtaining an International Standard for the Analysis of Iron and Steel was read by T. Turner. The work of the British Committee is complete as far as the first four standards are concerned. A report, subject to slight revision, has been issued by the American Committee. Their results agree very well with those obtained by the English Committee. Standard 5 is held over for later investigation, after the work of all the committees is complete.

G. J. Fowler read a paper on the preparation and properties of Nitride of Iron. His results confirm those obtained by Stahlschmidt, according to which nitride of iron has a definite composition corresponding to the formula Fe_2N. It dissolves in acid according to the following equation:

$$2Fe_2N + 5H_2SO_4 = 4FeSO_4 + (NH_4)_2SO_4 + H_2$$

By means of this reaction the author, in conjunction with Mr. P. J. Hartog, has attempted to determine the heat of formation of the nitride. Agreeing experiments show it to be formed with evolution of about three calories.

Specimens of Cyano-nitride of Titanium obtained from Ferro-manganese were described and exhibited by T. W. Hogg. This substance has been found present, disseminated in microscopic crystals, in every specimen of high percentage ferro-manganese examined by the author. It can be obtained by elutriation of the carbonaceous residue, left after solution of the alloy in dilute hydrochloric acid, cupric chloride, &c., and has been identified by qualitative analysis, and by comparison with cyano-nitride of titanium obtained from the blast furnace.

On Friday the communications dealt chiefly with the chemical action of light, and the chemistry of the halogens.

Prof. Hummel read the Report of the Committee for investigating the action of Light upon Dyed Colours. Reds were the colours chiefly examined; of these the eosins were found to be the most fugitive. The great bulk of the fast reds belong to the azo-colours. It was especially pointed out that certain reds obtained from natural dye-stuffs are more fugitive than many artificial colours.

After the reading of this report, the President called upon M. Meslans, chief assistant to M. Moissan, to demonstrate the Method of Isolation, and the Properties of Fluorine. The experiments, which were followed with great interest by a large audience, were eminently successful, The apparatus used was the same as that already described in NATURE. On passing a current rather exceeding twenty-five amperes through the solution of potassium fluoride in hydrofluoric acid cooled by the evaporation of methyl chloride to $-23°$, fluorine was disengaged at the positive pole, its presence becoming evident by the strong smell of ozone. The combustions of silicon, boron, phosphorus, iodine and carbon in the gas, were shown with great success.

M. Moissan's apparatus for determining the density of fluorine was shown. After the vote of thanks to M. Moissan and to M. Meslans, proposed by Sir Henry Roscoe, and seconded by Prof. Thorpe, had been carried by acclamation, a telegram, at the suggestion of Sir Henry Roscoe, was despatched by the President to M. Moissan, congratulating him on the success of the experiments. A reply was afterwards received from M. Moissan regretting his inability to be present at the meeting.

Specimens of M. Moissan's artificial diamonds, and of the Carbide of Uranium which coruscates brilliantly on shaking the bottle containing it, were shown to the section.

Dr. S. Rideal described the results of hisexperiments to determine the Iodine Value of Sunlight in the high Alps. The experiments were made at St. Moritz in the Engadine, at a height of about 7000 feet, the method being exactly in accordance with that recommended by the Manchester Air Analysis Committee. From comparison of the results with some obtained in Manchester at the same time of year (viz., January), it appears that as much sunshine falls upon St. Moritz in one day as upon Manchester in ten. It is this large amount of sunshine doubtless which renders St. Moritz so favourable a health resort. It appears from some experiments made in the Alps by Prof. Dixon by and Dr. Kohn that above a certain height the amount

of sunlight as determined by the liberation of iodine does not increase.

The Report of the Committee on the Action of Light on the Hydracids of the Halogens in the presence of Oxygen was read by Dr. A. Richardson. The committee have been investigating the conditions necessary to start the decomposition of hydrochloric acid in presence of oxygen. Experiments show that the presence of metallic salts is of great influence in this respect; the action of metallic chlorides is being especially studied.

The Expansion of Chlorine and Bromine under the influence of Light was shown on the screen by Dr. Richardson. For the success of the experiment it is necessary that the surface tension between the liquid, used as indicator of the expansion, and the tube in which it moves, should not be great.

Some interesting experiments made to determine the Rate of Evaporation of bodies into Different Atmospheres were described by Dr. Phookan. From the results obtained with naphthalene, it appears that vapours behave quite differently to gases in the manner in which they affect the rate of evaporation of this substance into them.

At the Monday sitting, Prof. P. Frankland read a paper introducing a Discussion on the Present Position of Bacteriology, more especially in its relation to Chemical Science. Prof. Frankland said that the present science of bacteriology really dated from the discovery, some twelve years ago, of methods for obtaining pure cultures. Since then the changes which have taken place have been chiefly in the methods employed for the recognition of bacteria. Microscopical characteristics, even when they have been brought out by mordant staining, have been found to be insufficient for this purpose. This was illustrated by the case of the cholera spirillum, as much difference existing between the different specimens of this spirillum, as between it and totally different species. Morphological have consequently been obliged to give way to chemical and physiological tests. Chemical tests being as yet few in number are apt to be treacherous, but they are capable of considerable extension. The typhoid bacillus, *e.g.*, will give no reaction with indol, the characteristic of the cholera bacillus, nor will it ferment glucose, but it will coagulate milk. With regard to the chemical products of the action of organisms the following questions suggest themselves:—Does the same substance yield different products with different bacteria? Do the same bacteria give rise to the same products with different substances?

Experiments with pure cultures have shown that one and the same bacillus will give identical products with such chemically related bodies as glycerol, arabinose, mannitol, &c. It appears probable that fermentability is due to the power possessed by a set of substances of yielding the same intermediate body which will give identical end products in all cases. This may explain why only those sugars which contain three carbon atoms or a multiple of three in their molecule appear to be fermentable.

The production of all three varieties of lactic acid by fermentation of glucose by different organisms has been accomplished. The mechanism of their formation was discussed in the light of Emil Fischer's formulæ for the glucoses.

The problems of selective fermentation were next dealt with, the cause of which was to be sought for in the slight differences of solubility &c., shown by active substances, when in combination with optically active isomeric bodies. One isomer is not found always to be quite unfermentable; in some cases both isomers can be destroyed if time be allowed, one, however, always disappearing first.

Of great interest is what may be termed educational culture, by means of which new characteristics may be artificially impressed upon an organism. A species of bacillus, morphologically identical with anthrax, but totally incapable of producing spores, may be obtained by cultivation of true anthrax in broth containing certain salts, such as potassium dichromate, or nitrate. The new characteristics will even persist after passage through the bodies of animals. On the other hand, by various means the virulence of pathogenic organisms can be greatly increased, though it has not been found possible to produce pathogenic from non-pathogenic organisms. It becomes probable, therefore, that naturally occurring bacilli will acquire new characteristics according to alterations in their condition of growth. The occurrence of non-toxic associated with, and morphologically identical with certain toxic organisms, *e.g.* those of diphtheria, anthrax, cholera, and typhus, is suggestive in this connection.

It is possible that ærobic organisms may become so far modified as to be active in absence of air. Much study is wanted in this direction, which affords special opportunities for observing the conditions of evolution among simpler forms of life.

The application of bacteriology to hygienic matters was next dealt with, with special reference to the bacteriological examination of water.

Finally, the disinfecting action of light under different conditions was spoken of. The generation of hydrogen peroxide, from air and moisture, under the influence of light, discovered by Richardson, would seem to play an important part in this action of sunlight, and the problem partly resolves itself into the study of the conditions of formation of this substance. The effect of different salts in modifying the bactericidal effects of sunlight was touched on, and in conclusion the necessity was urged upon chemists of a knowledge of biology and botany, to enable them to carry on bacteriological work, for which the first necessity had now become profound knowledge of chemistry and chemical methods.

In the course of the discussion, which owing to the length and comprehensiveness of the paper was not prolonged, Prof. Burdon-Sanderson advocated the establishment of an institute for research where chemists, biologists, and pathologists could mutually assist one another. It was resolved that, with his permission, Prof. Frankland's paper should be published in full.

The following papers were read in connection with the subject of discussion, viz., "Remarks on the Chemistry of Bacteria," by R. Warington, F.R.S.; "Fermentation in connection with the Leather Industry," by J. T. Wood; and "Some Ferments derived from Diseased Pears," by Dr. G. Tate.

On the Tuesday morning, Prof. H. B. Dixon opened what proved to be a most interesting discussion on Explosions in Mines, with special reference to the Dust Theory.

Opinions on this subject may be grouped under three heads:—

(1) That although it is possible to stir up and ignite a cloud of dust, the flame dies out and is not explosive; *i.e.* that a mixture of coal-dust and air *per se* is not explosive. This is the view held by Mallard and Le Chatelier.

(2) That, although a mixture of coal-dust and air *per se* is not explosive, a very slight addition of fire-damp, insufficient to be recognised by the Davy lamp, will render the mixture explosive. This view is supported by the experiments of Abel.

(3) That a mixture of fine coal-dust and air is *per se* explosive, and that the explosion once started in such a mixture can be propagated as far as the mixture extends.

Prof. Dixon then gave a brief history of the subject, dealing chiefly with the characteristic features presented by certain great mine explosions, and the experiments and results of the committees in different countries who have studied the question. The explosion in the Seaham Colliery in 1880 was specially dealt with. By means of a diagram it was shown that the only portions of the mine untouched by the explosion were those which were damp, and therefore free from dust. It was impossible to explain the method of propagation of this explosion otherwise than by the dust theory. Mr. Hall's experiments in 1891, in which a cannon was fired at the bottom of an old shaft in which coal-dust was suspended, were described, and photographs of some of the explosions shown. In some cases explosions could be brought about by these means, in others not, suggesting that the explosion was largely dependent on the character of the coal-dust. In conclusion, the importance of carefully testing for low percentages of fire-damp was pointed out, and also the possible advisability of using the fuses containing ammonium nitrate, recommended by the French Commission, on account of their low temperature of detonation.

At the conclusion of Prof. Dixon's address, Prof. Clowes exhibited his portable safety lamp, with hydrogen attachment for delicate gas-testing, described in the Proceedings of the Royal Society, vol. lii.

Mr. Galloway followed with a vigorous defence of the coal-dust theory. The dusty mines are always the deep mines which, owing to their greater warmth, are dry. In no mine of a less depth than 600 feet has any great explosion occurred. In damp mines explosions are limited in their area, while in dry mines they may ramify sometimes for a mile or so. In his opinion the experiments which had given rise to the belief that stone

dust could convey explosions should be repeated. It was to be noted in drawing conclusions from laboratory experiments, that the conditions obtaining in the mine were more favourable to the production of explosions, the temperature being higher and the air drier and denser. In conclusion he showed that the anticipated evils resulting from watering the mine do not occur.

Mr. Hall, in the course of his remarks, said the higher the quality of the coal, the greater was the liability to explosion. He hoped that it had been proved to the satisfaction of practical people that coal-dust and air alone were competent to produce explosion.

Prof. Thorpe said that in an explosion caused by flour-dust, which had reduced a mill to a heap of dislocated bricks, he had received an object lesson, which had quite converted him to the coal-dust theory. Experiment had shown him that coal-dusts varied greatly in their capacity of exploding; some will not explode under any conditions, while others he could at any time explode with certainty.

Mr. Stokes declared himself in favour of the second of the three opinions mentioned by Prof. Dixon. It should not be concluded that large amounts of gas could not rapidly accumulate in pits. In one mine, in which for four years no gas had been found, an evolution of gas took place which in twenty-five minutes was sufficient to fill the workings. The lamps being good, no explosion took place; had it done so, all the evidence would have been in favour of its origin being due to coal-dust. He looked for remedial measures in improved explosives and safety-lamps, rather than in watering, which he considered insufficient to more than moisten the surface of the dust, unless carried to an impracticable extent. Others having spoken, mainly in favour of the coal-dust theory, Prof. Dixon, in reply, said that he was glad that all mining engineers now seemed to recognise the dangerous character of coal-dust.

After the above discussion, Prof. Smithells showed by experiment that iodine vapour will glow on heating, supporting his contention that the luminosity of flame may be due to incandescent gas.

The papers on organic chemistry read at Nottingham were very few, viz.—"On the Red Colouration of Phenol," by Dr. C. A. Kohn; "On the Salts of a new Sulphurea Base," and "On Citrazinic Acid," by W. J. Sell and T. H. Easterfield; and "On Ethylbutane Tetracarboxylate and its Derivatives," by Bevan Lean. In the course of the latter investigation two isomeric modifications of di-benzyl adipic acid have been obtained. The Report of the Committee on Isomeric Naphthalene Derivatives was read. The work done has been chiefly in connection with the orientation of mixed nitro and halogen derivatives.

The following pieces of apparatus were described, viz.—An Apparatus for Extraction for Analysis of Gases dissolved in water, by Edgar B. Truman, and a new form of Bunsen and Roscoe's Pendulum Actinometer, by Dr. Richardson and J. Quick.

GEOLOGY AT THE BRITISH ASSOCIATION.

OUT of the sixty papers contributed to this year's meeting of Section C. a considerable number, as might have been expected from the personal influence of the President, Mr. Teall, were on subjects connected with Petrology. Amongst this series, two of the most important were read by the eminent foreigners Prof. Brögger and Prof. Iddings, who had come over especially to attend this meeting. Next in number were the papers on Glacial Geology. The other papers group themselves into those on Local and Triassic Geology, Palæontology, Foreign Geology, and Vulcanology.

"On the Genetic Relations of the Basic Eruptive Rocks of Gran (Christiana region)" by Prof. W. C. Brögger.—This paper dealt with a series of eruptive bosses and laccolites forming a line of hills, of which the chief, in order from north to south, are (1) Brandberget, (2) Sölvsberget, (3) Dignæs. The main rock type in these bosses was called by the author Olivine-gabbro-diabase. It is basic (43 per cent. SiO_2) in 1, rather less basic (47 per cent.) in 2, and somewhat acid (49 per cent.) in 3; the more basic rocks were erupted first, then the less and less basic in order from north to south. From the intimate connection of the minerals in the different types, and the occurrence of all intermediate varieties, it was proved that these rocks had segregated in succession from a magma whose average composition was not unlike tha of the rock of Sölvsberget. The gradation in chemical composition produced a similar gradation in the mineral percentages, the felspar increasing from 12–64 per cent., and the pyroxene diminishing from 67–10 per cent. in a southerly direction. The author briefly stated that the contact metamorphism due to these plutonic rocks was quite different in character from that produced by a neighbouring mass of quartz-syenite on the same group of sedimentary rocks.

The eruptive bosses are accompanied by a great series of dykes and sheets of lamprophyric character, and varying from Camptonite to Bostonite. The author brought forward a quantity of evidence to prove that (1) these two extreme types, with silica percentages ranging from 40–56, had been derived from the same magma; (2) that 9 parts of Camptonite and 2 of Bostonite (about the proportion observed in the field) would give a magma of the composition of the Olivine-gabbro-diabase of Sölvsberget; (3) that these lamprophyric dykes had been derived from the same magma as the plutonic rocks; and (4) that the differentiation had been effected while the magma still remained fluid. It was further shown that the differentiation was probably due to the migration of less soluble constituents to the cooling margin, that the Camptonites had a composition closely allied to that of the brown hornblende of the area, and that while the essential cooling of the plutonic rocks had taken place in the eruptive bosses themselves, the dyke rocks had segregated before extrusion.

A subsidiary differentiation has taken place in some of the plutonic rocks, giving rise in the more basic Brandberget to a pyroxenite (with 95 per cent. of pyroxene) and augite-diorite, and in the less basic Sölvsberget to pyroxenite and Labrador-porphyrite.

Other points of importance to be noted were: (1) That under different physical conditions not only various mineral aggregates, but rocks of varying chemical composition had resulted from the crystallisation of the same magma; (2) that similar products result in this case from the segregation of an Olivine-gabbro-diabase magma, as have elsewhere been derived from a magma that has produced nepheline-syenites; (3) that the direction of segregation according to laws of crystallisation throws considerable light in the order of volcanic eruptions from neighbouring centres.

"On the Dissected Volcano of Crandall Basin, Wyoming," by Prof. J. P. Iddings. This paper was divided into a strictly petrological portion, and one dealing more broadly with the features of the area, and illustrated by slides brought over for the purpose by Prof. Iddings. The palæozoic and mesozoic deposits, almost unbroken up to the Laramic, had been disturbed and eroded before the outbreak of this volcano, now represented by lavas and breccias, penetrated by radiating dykes, and a core of crystalline rock, which is surrounded by a chaotic mass of scoriaceous breccia and massive flows. Erosion has removed at least 10,000 feet from the summit of the volcano, and has cut 4000 feet deeper into the valleys on either side of the centre. The lower breccia contains several varieties of andesite, the upper is chiefly basaltic, which is also the character of the chief massive flows. The dyke rocks are on the whole more crystalline, and contain biotite to the almost total exclusion of the olivine of the lavas and breccias. The core is chiefly of gabbro, which, however, passes into diorite, and even to aplite; these highly acid rocks appear to be amongst the latest of intrusions, but are cut by a few dykes of lamprophyric basic rock, which are also represented in the flows outside the core. The author's investigations show that under different circumstances totally different mineral aggregates arise from the cooling of the same magma. The basalts containing plagioclase, augite, olivine, magnetite, and sometimes hypersthene, the gabbros, plagioclase, augite, hypersthene, and biotite, besides some magnetite, orthoclase, and quartz, with or without hornblende. Further, the coarseness of crystallisation in the core and dykes seems to have been more influenced by the temperature of the surrounding rock than by the pressure to which they were subjected.

"On Structures in Eruptive Bosses which resemble those of ancient Gneisses," by Sir Archibald Geikie. He thought Lehmann's theory of the dynamical origin of foliation might explain granulitic gneisses with thin folia extending uniformly over a large area, but was inadequate to explain coarsely banded masses of irregular composition. These were better compared with the structures visible in the deeper parts of eruptive bosses

in which minerals were segregated into bands, often parallel, and containing one prominent mineral in large crystals. Pegmatite veins, traversing not only massive unfoliated rocks, but the segregated bands, also occurred. These structures were best seen in ancient plutonic masses, but had also been lately observed by the author in the recent volcanic rocks of the Western Isles of Scotland.

On "Berthelot's Principle applied to Magmatic Concentration," by A. Harker. The paper deals with that type of concentration in which an igneous rock-magma, supposed originally homogeneous, has been differentiated by accumulation of the more basic ingredients in the cooler marginal part of the liquid. The author tries to find a physical cause for this action by comparing such a magma with a *saturated* saline solution, and applying Berthelot's "principle of maximum work" or the cognate one of "most rapid degradation." The migration of the least soluble ingredients to the part of the liquid most easily saturated would determine crystallisation, the process which in the case supposed would give the most rapid evolution of heat.

On "The Igneous Rocks of Barnavave, Carlingford," by Prof. W. J. Sollas. The white granophyre of this tract is intrusive into a black gabbro, in dykes of all sizes down to the most minute films and specks amongst the constituents of the latter rock. The result of this intimate intrusion is to convert the gabbro locally into a quartz gabbro, whilst the granophyre is loaded with fragments varying from large masses to crystal dust derived from the fracture of the gabbro, thus becoming a hornblendic granophyre. These intermediate rocks have been made out of a mixture of acid and basic constituents. The same author gave an analysis and microscopical description of an intrusion of Amphibolite at Glendalough, which, at its margin, had been transformed into Quartz-mica-diorite by the action of veins which were filled with potash felspar in the hornblende rock, but with quartz in the adjacent schists. Both these papers were well illustrated by lantern slides. Prof. Sollas also exhibited some pebbles from an ancient consolidated beach at Sandymount, co. Dublin, which had impressed one another on account of the perpetual jarring of the tram-cars running over them. He thought it was likely that earth tremors had had considerable influence in producing the similar pittings in Triassic pebbles. Bearing on this subject Dr. V. Ball showed incised bones and antlers from Irish peat-bogs, the cuts on which were due to pressure and tremors passing through the bog.

There were two papers, by Mr. W. W. Watts, on Irish petrology; one, "On a Hornblende-Pikrite intrusive in Cambrian Rocks at Greystones, co. Wicklow," described a rock consisting mainly of green and colourless hornblende enclosing grains of olivine, now converted into a mineral-like colourless amphibole; and another, "On the Perlitic Quartz Grains in Rhyolite of Sandy Braes Quarry in Antrim," in which the porphyritic quartz grains exhibited a series of concentric cracks, perlitic in character, the bulk of which were confined to the quartz crystals, but some of which traversed quartz and matrix alike.

"On Augen-Structure in Relation to the Origin of Eruptive Rocks and Gneiss," by Mr. J. G. Goodchild. Passing over that type of this structure more properly named phacoidal, the author confined himself to those "eyes" of minerals which have grown *in situ* in the rock where they occur. In cases where the original rock contained the necessary material for the formation of the "eyes," a rise in temperature or relief in pressure sufficient to enable the less refractory minerals to aggregate, but not sufficient to alter the chemical and physical state of the matrix, appears to have been all that is necessary. In other cases the author suggested that the necessary alkalies for the formation of such substances as secondary felspars may have been derived from the inner zones of the earth's crust.

A very useful and well-illustrated paper was read by Mr. Arnold-Bemrose, "On the Derbyshire Toadstone." There are two, at least, and may even be three or four, beds of olivine dolerite associated with tuffs. The rock is columnar and spheroidal, and may frequently be met with in an undecomposed state when the augite occurs in grains or ophitic plates containing felspar or olivine. There appears to be no foundation for the supposition that the toadstone contains no lead ore. All these rocks are surface lava flows.

Messrs. Howard and Small divide the igneous rocks of South Pembrokeshire into a northern group of rhyolites associated with quartz diorites and granites, often gneissose in character, and with epidiorites and hornblende schists, and a southern group at Musclewick Bay, consisting of porphyrites and dolerites in connection with a rock like a soda felsite. The authors are unable to fix the age of the rocks, but think the evidence goes to show that the rocks are, at the earliest, of Post-Silurian date.

Amongst the local papers, one by Prof. Clowes was of considerable interest. In it he showed the rock of which Bramcote and Stapleford hills and the Himlack stone were composed, was cemented by barium sulphate present occasionally in such quantity as to make 50 per cent. of the whole rock. Sometimes the crystalline cement was evenly distributed in minute crystals, but at others it was aggregated into patches which made the rock weather unevenly, so as to produce the so-called "pebble sand-beds." The author had no evidence of the form in which the cement was originally deposited—whether as carbonate or directly as sulphate.

Prof. E. Hull pointed out that the Nottingham water supply was derived from the Bunter sandstone, which was underlaid by the impervious Permian marls. Allowing that 20 out of 30 inches percolated into the sandstone, he calculated that the area of its outcrop from Worksop to Nottingham (120 square miles) must receive 40,000,000 gallons, all of which tends to flow eastwards. From the three stations about 5¼ million gallons were pumped daily. In a note on "The Borings at Netherseal Colliery," Prof. Hull determines the lowest rocks reached under Trias and Coal Measures at a depth of about 770 feet from the surface, as grits, sandstones, and quartzite, and attributes to them a Lower Cambrian age.

A number of more or less local papers relating to the new red sandstones were grouped together. Prof. Lapworth gave a general account of the subdivisions, distribution, and thickness of these rocks in the Midlands. Mr. Irving followed with a *résumé* of his researches for twenty years into the younger red rocks, referring to the classing of the Devonshire igneous and lower stratified red rocks as Permian in the recently published index maps of the Geological Survey. Mr. Metcalfe gave a note on the Gypsum deposits of Notts and Derbyshire. Baron von Reinach and Mr. Ussher recorded the discovery of Upper Magnesian limestone shells at Bulwell, and Messrs. Kendall and Gray showed that the presence of Permian marls at Stockport destroys the supposed evidence of unconformity there between the Permian and Trias.

After a brief discussion on Geological Education, Tuesday was devoted to glacial papers and discussion. Mr. Dugald Bell read an abstract of a most careful and important investigation into the shell-bearing clays of Clava in Nairn. The section in descending order, proved by excavation and boring, is as follows:—

	Feet.
(1) Surface soil and sandy boulder clay	43
(2) Fine sand	20
(3) Shelly blue clay with stones in lower part ...	16
(4) Coarse gravel and sand...	15
(5) Brown clay and stones	21½
(6) Solid rock, Old Red grit	

The highest part of the shelly clay is 503½ feet above sea level, and the deposit appears to be continuous for a distance of 190 yards. It contains far-travelled, well-rounded stones (one must have come at least twelve miles) associated in different proportions from those in the overlying boulder clay or underlying gravel. The shells are mainly littoral, though some may have lived at depths not greater than twenty fathoms; although not intensely arctic, they indicate a colder climate than the present. The shells are well preserved, neither rubbed nor striated, and the deposit is a true marine silt, which if not *in situ* must have been transported in mass. The direction of ice flow being from south, or a little west of south, shows that the ice did not pass over any existing sea-bed before reaching Clava, and if the clay was carried from Loch Ness a submergence is postulated by the marine fauna there. The majority of the committee consider the evidence sufficently strong to prove a submergence to the extent of 500 feet, and they think the passage of ice to form the upper boulder clay would be sufficient to cause the cracking of the shelly clay and the crushing of certain of the shells. Detailed reports and lists of organisms are given, and a "minority report" on the evidence bearing against the view put forward above. Mr. Bell, in a paper, commented on shelly clay and gravel extending along the east coast of Aberdeenshire from the sea level up to about 300 feet, and endeavoured to explain it

by the formation of lakes owing to the blocking of transverse valleys by the passage of ice across their mouths. In another paper the same author connected the granite boulders found in the Clyde Valley about Glasgow and Gourock with the mass of plutonic rocks occurring between the heads of Lochs Fyne and Lomond, and supposes them to have been brought by ice coming through Loch Fyne and Holy Loch, Loch Sloy, Loch Long, and the Gareloch, and in much smaller numbers by Loch Lomond.

Prince Kropotkin summed up his knowledge in the general glaciation of Asia. The Lowlands and Steppes, under 2000 feet in height, do not appear to have been glaciated ; but all the mountain ridges rising over the steppes, the great border ridges like the Tian Shan, and the Alpine tracts fringing the plateau were covered with immense glaciers, which descended to within 1000 feet of the sea level. The Vitim Plateau, the N.W. Mongolia Plateau, the Pamirs, and the Great Khingim were extensively glaciated. The southern portion of the High Plateau, however, yields only indirect and not conclusive evidence of glaciation.

Prof. Sollas exhibited a large map, and gave an account of the Esker Systems of Ireland. Eskers have always been difficult to explain, and the best explanations have called in deposit by rivers ; the difficulty has been to account for the disappearance of their banks. Prof. Sollas suggests that the sustaining walls may have been of ice, and that eskers are practically "casts of a glacial tunnel in gravel and sand." The eskers of Ireland are like rivers in their windings, and in the reception of tributaries at an acute angle. Deducing from the eskers the ancient drainage system of the Irish glaciers we find a smaller set draining from the glaciers of Sligo and Roscommon, and a much more important set, embracing the whole central plain, escaping by the valley of the Liffey

Mr. C. A. Lindvall, of Stockholm, reviewed the principal theories to account for the origin of the glacial period, and proposed to account for it by the partial submergence of Northern Europe to form an archipelago, through which escaped the cold ice-bearing currents from the Arctic Ocean. The author further endeavoured to show that the drifting of pack ice is sufficient to account for the striation, eskers, boulders, and other glacial signs in Scandinavia, Switzerland, and Scotland.

Prof. Bonney read a paper which gave rise to brisk discussion, in which Sir H. Howorth, Mr. Lamplough, Mr. Kendall, and others took part. He denied that there was any proof of considerable ground moraines in connection with existing glaciers, that glaciers were potent encavators, and that there was any evidence to show that ice had the power to scoop loose material from a sea-bed and pile it up from above the water-level ; he suggested that boulder-clays like those of Britain, so different from Swiss moraines, may have had more than one origin.

Messrs. Abbott and Kendall have found shell middens with *Cardium edule*, a sheep's tooth, bird bones, and charcoal, at "The Quinta," on Penmaenmawr, and in the Aber Valley ; they consider them due to human agency. Mr. Cameron described a mass of chalk, about a mile long, embedded in boulder clay at Catworth, in Huntingdonshire. Mr. De Rance concluded that the rock valleys of Lancashire and Cheshire were scooped by fluviatile agency when the land stood 300 feet higher than at present, and many of them are now choked with glacial detritus extending far into the Irish Sea. The so-called inter-glacial gravels do not occur on one horizon, and often several such beds are passed through in succession ; they are regarded as having been partly formed in freshwater lakes and partly under the ice.

In the subject of palæontology three reports were presented. Prof. T. Rupert Jones described two species and two varieties of *Phyllopoda*, and made corrections, suggestions, and criticisms of other work ; Mr. Laurie and Mr. Smith Woodward reported that progress was being made in working out the Eurypterids of the Pentlands, and in the registration of type specimens of fossils respectively. Dr. Traquair recorded *Cephalaspis* (*C. magnifica*) for the first time from the Orcadian area of the Old Red Sandstone ; the cranial shield of this form, the largest known, is not less than 8½ inches in length. Mr. E. T. Newton gave a concise account of the Reptilia of the British Trias, including a notice of two entirely new forms, one related to *Stagonolepis*, the other a form intermediate between the crocodiles and dinosaurs. Mr. R. B. Newton recorded the first known shells from the English Keuper, discovered by Mr. Brodie and Mr. Richards in the marl of the Upper Keuper Sandstone of Shrewley, Warwickshire. They are referable to new species of the genera *Thracia*, *Goniomya*, and *Pholadomya*, and are associated with *Acrodus* and *Estheria*. Prof. Sollas gave a careful and illustrated description of the minute anatomy of *Monograptus priodon*, gathered from exceptionally perfect specimens ; three layers are visible, the middle one being reticulated and thickening out to form the virgula and at the free edges of the thecæ. Mr. Montagu Browne referred several bones and teeth of *Termatosaurus albertii*, and of undetermined species of *Plesiosaurus*, to *P. rostratus* (Owen), from the Rhætic ; he considered that the teeth of several species of *Saurichthys* would have to be divided between fish and labyrinthodonts ; he also recorded the discovery of *Ceratodus* from the Rhætic.

In a clear and well illustrated paper by Mr. Walcot Gibson "On the Geology of Central East Africa" there is a description of the fringing reef bordering the land at Mombasa, succeeded by inland reefs rising up to 100 feet ; the latter rests on a sedimentary series containing ammonites and ichthyosauria, and in turn resting unconformably on a great metamorphic series of gneisses, schists and intrusive granites, which occupy an area of fully two-thirds of Central East Africa. The remainder of the country is formed of recent volcanic rocks, forming great cones like Kilimanjaro, or arranged in lines running north and south. Most of the volcanoes are dormant or extinct, and none appear to be of great geological antiquity. Mr. R. D. Oldham exhibited geological maps of India on the scales of 96 and 32 miles to the inch, showing the recent work of the Geological Survey of that country ; the smaller-scale map is to be published with the "Manual of the Geology of India." Mr. Myres showed that the fundamental rocks at Caria were crystalline, quartzose, and felspathic rocks with obscure foliation, traversed by dykes and necks of two ages, one pre-Cretaceous, which have supplied the volcanic rocks underlying the great mass of Cretaceous limestone, and the other from which the Tertiary volcanoes proceeded. The Cretaceous rocks were eroded before the deposit of the Tertiary shore beds, which pass away laterally into limestones ; these beds are roughly correlated with those of Rhodes and Crete. Galena, pyrolusite, and a cobalt mineral are found in the ancient rocks.

Amongst the other papers it is only necessary to notice the following briefly :—Mr. Fowler described a fault at Cinder Hill, which causes greater displacement in the Carboniferous than in the overlying Permian rocks. Dr. Hicks pointed to the fragment in basal Cambrian rocks as indicating older series in Wales ; Mr. Fox noted the wide extension of radiolarian chert in Cornwall ; Mr. Bolton gave an account of the Skiddaw slates of the north of the Isle of Man, which had yielded rare trilobites and *Dictyonema* ; Mr. Woodward's discovery of a bed of iron-ore on the horizon of the Cleveland iron between the middle and upper Lias of Raasay ; Prof. Herdman's note on a consolidated shelly sand-bed from the bottom of the Irish Sea ; Prof. Milne's illustrated account of volcanic and earthquake phenomena in Japan ; Dr. Johnston Lavis's record of the condition of Vesuvius during the year, and his interesting note on the production of emerald-green augites by the action of enclosed particles of quartz and quartzite on a lava of Stromboli ; Mr. Jeffs' list of geological photographs (140 in number) received during the year ; Mr. De Rance's report on the circulation of underground water ; and Mr. Kendall's report on erratic blocks, including the detailed survey of boulders in some considerable areas of the North of England.

In addition to the papers above reviewed, Section C took part in two discussions with other sections, and held one on its own ground. Mr. Topley, Prof. Bonney, Dr. Ball, Dr. Roberts, and Prof. Lapworth were the chief speakers on the limits of geology and geography ; Prof. Sollas, Prof. Bonney, and Dr. Rothpletz, on the subject of coral reefs. The discussion on geological education was led by Prof. Cole, in a lucid paper on "Geology in Secondary Education," in which he advocated that, as a branch of history, geology should be taught to all secondary students. He advocated practical teaching so far as possible, and especially an acquaintance with the life history of the globe. Prof. Lebour, following, insisted on the careful selection of subjects in professional education and on the importance of making every part of the teaching as practical as possible, and encouraged experiments and field work, which he thought might very well be aided from the County Council's Technical Education Grant. These ideas were enforced by a number of subsequent speakers.

A word must be given to the series of photographs exhibited

by the Photographs Committee, of which, however, only a small selection could be shown, those exhibited by the Scottish Geological Survey, and the specimen slides and maps to illustrate papers and discussions, kindly lent by Prof. Sollas, Messrs. Teall, Topley, Johnston Lavis, Gregory, and many others. This exhibition, if it can be continued with increased facilities at subsequent meetings, promises to become one of the most important features of the section's meeting.

EVOLUTION AND CLASSIFICATION.[1]

AS we have gathered up the scattered masses of botanical knowledge, laboriously wrought out by many isolated workers, and attempted to fit them together into a consistent whole, which should outline the structure of the temple Botany, we have found that the workmen have not always followed the same architectural plan, and have often used different units of measurement. With the increasing specialisation so noticeable year by year there is a corresponding lack of coordination of work. To this lack of coordination, this want of unity of measurement, this misunderstanding of plan, we can no longer close our eyes, and I therefore feel free to invite your attention to the following somewhat summary discussion of the causes of the present unsatisfactory condition, in the hope that we may thereby be enabled to see how we may make some improvement.

All botanical knowledge finally culminates in some kind of classification. The facts of histology, morphology, and physiology are of great biological importance, but the greatest of all biological facts is that the world is peopled with living things. We may group and arrange in orderly sequence the histological facts of the science; we may do likewise with the facts which the morphologist has discovered; we may make a classification of all the known physiological facts; but beyond and above these lies the greatest grouping of all—the grouping in orderly sequence of the organisms themselves whose histology, morphology, and physiology we have studied.

It is now a full third of a century since a great light was first turned upon all biological problems by the formulation of the doctrine of evolution by the master-mind of Darwin. In its light many puzzles have been solved, and many facts hitherto inexplicable have been made plain. We now know what relationship means, and we have given a fuller meaning to the natural system of classification. From the new point of view a natural classification is not merely an orderly arrangement of similar organisms. It is an expression of genetic relationship. Furthermore, in the light of evolution we now see the meaning of many reduced structures whose significance was formerly not at all—or but vaguely—understood. We have become familiar with the fact that degradation is a prominent factor in the vegetable kingdom. Evolution has by no means always involved an advance in structural complexity. Often this catagenesis is a result of parasitism or saprophytism, as is so well illustrated in the "fungi," where the degradation has gone so far that their relationship has to a great degree been obscured.

But there are also many cases of a catagenesis not due to a dependent habit in which we have evidence of a simplification from a more complex structure. Thus in the willows and poplars, where we have a raceme of very simple flowers, each consisting of a single ovary, or one to many stamens, it is readily seen that this simplicity is not primitive. The ovaries are not single carpels, but are composed of two or three united. The flower of the willow is simple by a degeneration from a higher type—probably a tricarpellary or pentacarpellary type—by the loss of its floral envelopes and stamens or pistils.

Every naturalist should be as familiar with these illustrations of evolution by simplification as he is with those of evolution by complication. In the growth of the great tree of life, while the development has been most largely in an upward direction, so that the great body of the tree has risen far above its point of beginning, there are yet multitudes of twigs and branchlets which droop downward.

I need not now, before a body of scientific men, speak of evolution as an hypothesis; for we know it as a great biological fact, about whose existence there is no shadow of doubt. A natural classification will conform strictly to the lines of evolution, it will be in fact a clear exposition of the successive steps in its progress. In such a classification the primitive forms will precede the derived ones, and the relation of the latter will be positively indicated. Moreover, in such a system there will be no confusion between the primitively simple forms and those which are so by derivation.

An examination of our common systems shows them sadly deficient in the essentials of a scientific classification. This is particularly true of the treatment of the flowering plants at the hands of English and American botanists. Nothing could show better the conservatism of botanists than the fact that for a third of a century after the general acceptance of the doctrine of evolution they are still using so crude an arrangement of the group of plants with which they are most familiar.

I may assume that it is well known to nearly all of us that the prevailing arrangement of the Dicotyledons does not represent the later views of any of the systematists. The fact is that the systematic disposition of the higher plants is at present a make-shift, maintained by conservatism, and a reverence for the time-honoured work of the fathers. It is unscientific to let our practice drag behind the present state of our knowledge: it is far more so for us to cling to the opinions of our fathers, through mere reverence, long after we know them to be untenable. It is not to the credit of our science that for a second time she has persistently held to a system through such considerations. For thirty or forty years after a natural system had been constructed by Jussieu, botanists as a body still adhere to the artificial system of Linne. Now, sixty years later, we find ourselves faced with a problem similar to that which Lindley, Torrey, Beck, and Gray met. History repeats itself with such exactness that, with the change of a word here and there, the arguments *pro* and *con* then used may be used to day. The system of Jussieu and DeCandolle is now as much a clog and a hindrance to the systematic botany of the higher plants as was that of Linne sixty years ago, and now as then it is the spirit of conservatism and of veneration for time-honoured usage which maintains the incubus.

Manifestly a system of classification which conforms to and is based upon the doctrine of evolution must begin with those forms which are primitive, or which as nearly as may be represent primitive forms. Since the flower is a shoot in which the phyllomes are modified for reproductive purposes, that flower in which the phyllomes are least modified must be regarded as primitive, while that in which there is most modification must be regarded as departing most widely from the primitive type. The simple pistil, developed from a single phyllome, is primitive and lower, the compound pistil is derived and higher. The several seeded compound ovary must be lower, and the compound ovary with but one seed must be higher. Separate stamens are primitive, united stamens, whether the union be with one another or with other structures, must be derived and consequently higher. So, too, when all parts of the flower are separate it is a primitive condition, and when they are united it is a derived structure.

Applying these principles to the flowering plants it becomes evident that in the Dicotyledons either the Apetalæ or the Polypetalæ must furnish our starting point. The Gamopetalæ are universally admitted to be higher than the groups just mentioned, and certainly do not contain the sought for primitive types. Even a hasty examination of the thirty-six apetalous families shows that they are, at least to a very large extent, derived from the Polypetalæ by the abortion of some parts and the entire omission of others. It will not be difficult to determine that the Ranales must take rank below all other Polypetalæ, in the sense of representing more nearly than any other group the primitive Dicotyledons.

The attempt to make a natural system by linking family to family in a long undulating chain, by concatenation, is unscientific because it absolutely fails to conform to the law of evolution. We must abandon the old classification and attempt one which in the light of evolution is rational. Let us not cling to the old because it is inconvenient to change, let us not cling to it through a mistaken reverence for the practice of the fathers, let us not cling to it as long as a flaw may be found in a new system. Science is ever abandoning the old when the old is no longer the true; it tears down the work of years when that work no longer represents the truth; and it dares to reach

[1] Abstract of Annual Address before Section G (Botany) of the American Association for the Advancement of Science. By C. E. Bessey, President of the Section.

out and frame a rational system even though some parts of it for a time rest upon hypothetical grounds.

A REVISED ARRANGEMENT OF THE BENTHAMIAN "SERIES" OF FLOWERING PLANTS.

Monocotyledons.

Apocarpæ.
Coronarieæ.
Nudifloræ.
Calycinæ.
Glumaceæ.
Hydrales. (Hydrocharideæ).
Epigynæ.
Microspermæ.

Dicotyledons.

Polypetalæ.

Thalamifloræ (including the apetalous Curvembryeæ, Micrembryeæ, and "Ordines Anomali," and the Euphorbiaceæ and Urticaceæ, &c., of the Unisexuales).
Disciflorae (including the apetalous Daphnales and the Juglandaceæ and Cupuliferæ, &c., of the Unisexuales).
Calycifloræ (including the apetalous Aristolochiaceæ and Cytinaceæ).

Gamopetalæ.

Heteromeræ.
Bicarpellatæ.
Inferæ.

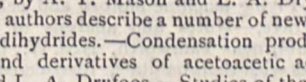
SCIENTIFIC SERIALS.

American Journal of Science, September. — Fireball of January 13, by H. A. Newton (see p. 524).—On a photometric method which is independent of colour, by Ogden N. Rood. This is not based, like most previous methods, upon the comparison of the luminosities of two adjacent surfaces, but upon the shock that is produced upon the retina by a change of intensity of light. If one-half of a rotating disc reflects less light than the other by 1–50th of the whole amount, with appropriate rates of rotation a faint flickering will be noticed. This flickering disappears if the two halves have the same degree of brightness, whatever may be their colours.—On the oscillations of lightning discharges and of the Aurora Borealis, by John Trowbridge. Photographs were obtained of sparks having both great electromotive force and great quantity, produced by an alternating machine giving from 300 to 400 alternations per second, with the aid of a step-up transformer and an oil condenser. The oscillations were investigated by Feddersen's rotating mirror method. The sparks were about 2 cm. long, and the interval between two successive oscillations was one hundred-thousandth of a second. On each of the photographs reproduced some ten or twelve oscillations can be counted. The discharge is seen to follow exactly the same path three times in succession. After that it assumes the character of a brush discharge. By intercalating a non-inductive water resistance and a vacuum tube between the terminals of a suitable transformer it is possible to imitate exactly the phenomena observed when a vacuum tube is held in one hand while the other hand grasps the terminal of the transformer. In observiug the striæ and waving columnar form of the light excited in this manner in tubes filled with rarefied gases, one is led to believe that the stratified form of the Aurora Borealis is produced in a similar manner.—On the estimation of chlorates and nitrates, and of nitrites and nitrates in one operation, by Charlotte F. Roberts. By means of the apparatus for the estimation of nitrates previously described, chlorates and nitrates together may be estimated. They are treated with manganous chloride, and the resulting gases are passed through potassium iodide and then into a Hempel's burette. The amount of nitric oxide, gives the amount of nitrate present, and the chlorate is estimated by deducting from the total chlorine liberated that due to the reduction of the nitrate.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, June 15.—Dr. Armstrong, President, in the chair.—The following papers were read:—Contributions to our knowledge of the aconite alkaloids. Part vi. Conversion of aconitine into isaconitine, by W. R. Dunstan and F. H. Carr. On heating the hydrobromide of the highly poisonous aconitine it is converted into the corresponding salt of its non-poisonous isomeride, isaconitine.—Part vii. Some modifications of aconitine aurichloride, by W. R. Dunstan and H. A. D. Jowett. Aconitine aurichloride may be obtained in three different physically isomeric modifications, melting at 135·5°, 152°, and 176° respectively.—Note on the stereoisomerism of nitrogen compounds, by S. U. Pickering.—A study of the properties of some strong solutions, by S. U. Pickering. The depressions of the freezing points of water, acetic acid, and benzene, by a number of organic non-electrolytes, indicate in all cases the formation of compounds of the solvent with the dissolved substance.—Studies on citrazinic acid, by W. J. Sell and T. W. Easterfield. The authors propose provisional formulæ for citrazinic acid and a number of allied compounds as the result of their work on the subject.—The essential oil of hops. Preliminary notice, by A. C. Chapman. A dextro-rotatory sesquiterpene $C_{15}H_{24}$, is obtained by the steam distillation of hops.—The sulphides and polysulphides of ammonium, by W. P. Bloxam. The author has obtained a number of crystalline double ammonium sulphides of the general formula $(NH_4)_2S$, $xNH_4{\cdot}SH$.—Sarcolactic acid obtained by fermentation of inactive lactic acid, by P. Frankland and J. MacGregor.—Hexanitroanilide, by A. G. Perkin.—The constituents of the Indian dye-stuff kamala, I., by A. G. Perkin. On extraction with ether, kamala yields rottlerin, $C_{11}H_{10}O_3$, isorottlerin, two resins $C_{12}H_{12}O_3$ and $C_{13}H_{12}O_4$ and a small proportion of a yellow colouring matter.—A quantitative method of separating iodine from chlorine and bromine, by D. S. Macnair. The method is based on the fact that, when treated with chromic acid mixture, silver iodide is converted into the iodate whilst silver chloride and bromide are converted into the sulphates.—No e on a form of burette for rapid titration, by L. Garbutt.—The use of sodium peroxide as an analytical agent, by J. Clark. By heating powdered minerals with sodium peroxide, the arsenic and sulphur may be rendered soluble.—Stibiotantalite, a new mineral, by G. A. Goyder.—The colouring matter of *Drosera Whittakeri*, II., by E. Rennie. The author has extended his previously published work on this subject.—Preparation of mono-, di-, and tri-benzylamine, by A. T. Mason. Mono-, di-, and tri-benzylamine respectively may be obtained as the chief products of the interaction of benzyl chloride and ammonia, by varying the quantity of the latter.—Piazine (pyrazine) derivatives, II., by A. T. Mason.—Piazine derivatives, III., by A. T. Mason and L. A. Dryfoos. In these two papers the authors describe a number of new substituted piazines and their dihydrides.—Condensation products from ethylenediamine and derivatives of acetoacetic acid, IV., by A. T. Mason and L. A. Dryfoos.—Studies of the oxidation products of turpentine, by S. B. Schryver. The author assigns to terpenylic acid the formula



—Addendum to note on the nature of depolarisers, by H. E. Armstrong.—The molecular complexity of liquids, by W. Ramsay and J. Shields. The authors deduce the molecular weights of liquids from their surface tensions.—The preparation of active amyl alcohol and active valeric acid from fusel oil, by W. A. C. Rogers. By repeatedly heating fusel oil with fuming hydrochloric acid, pure laevo-rotatory amyl alcohol ($[\alpha]_D = -5{\cdot}2°$) is obtained; by oxidising the alcohol, active valeric acid may then be prepared.—On the occasion of the Rothamstead jubilee, July 29 last, an address was presented to Sir J. Lawes and Dr. Gilbert by the President and Council of the Chemical Society.

PARIS.

Academy of Sciences, September 18.—M. de Lacaze-Duthiers in the chair.—On the teeth of hyperboloidal gearing, by M. H. Resal.—The shooting stars of the month of August, 1893, observed in Italy, by P. Françis Denza. Reports received from members of the Meteorological Association in all parts of Italy show that the August showers were observed under comparatively favourable conditions. The number of meteorites observed grew progessively from the first to the eleventh of the month, and the phenomenon exhibited on the latter date a greater brilliancy than usual. The maximum took place earlier than in previous years, and the greater density of

the shower indicates a corresponding increase in the density of the meteorite swarm. The principal radiant was near η Persei, about R.A. 44°, Decl. + 55°. The steady annual displacement of the Perseid radiant and the unusual brilliancy of the swarm makes an interesting subject for future observation.—Circles or spheres "derived" from an envelope, plane or solid, of any class, by M. Paul Serret.—On the periodical maxima of spectra, by M. Aymonnet. It may be assumed that luminous waves comprising an exact number of molecular ranges are propagated with less friction than waves producing nodes in the molecules themselves. If, between two given limits, the incident radiation is sufficiently complex and intense, and the solid transmits all the maximum waves possible, these will, in the normal spectrum, differ in wave-length by twice the product of the index of refraction into the sum of the molecular diameter at absolute zero, its expansion at the given temperature, and its lengthening or shortening in the direction of propagation under the influence of the wave.—On the development of the pancreas in Ophidia, by M. G. Saint-Remy. The earliest stage observed in the snake, corresponding, as far as the pancreas is concerned, to the fifth day in the development of the chicken, shows distinctly the three markings, one dorsal and two ventral, observed in some other vertebrates. The ventral markings are completely isolated from the intestine, and detach themselves from the hepatic canal, forming two clusters of acini on the two sides. The dorsal marking, which is very voluminous, lies to the right of the duodenum, with which it communicates by a broad canal. It was this that was previously observed. The close connection between the hepatic canal and the pancreas is easily understood by observing the development of the latter from the three markings referred to.—On the coccidia of birds, by M. Alphonse Labbé. In the course of researches on parasites of the blood of birds, conducted at Roscoff, the presence of an intestinal coccidium, probably unknown hitherto, was verified in a large number of aquatic birds. It is a very small tetraspore coccidium with exogenous development. The pyriform capsule is not larger than 16 or 18 μ by 14 or 16 μ. An interesting characteristic is the frequent presence of two bright granules at the micropylar extremity. The presence or absence of polar granules in *Coccidium Roscoviense* appears to be determined by the culture in which the cysts were developed.—Vegetable anatomy of *Ataccia Cristata*, Kunth, by M. C. Queva.

SYDNEY.

Royal Society of New South Wales, June 7.—Prof. T. P. Anderson Stuart, President, in the chair.—The following papers were read:—Flying machine motors and cellular kites, by Lawrence Hargrave.—Notes and analysis of a metallic meteorite from Moonbi, near Tamworth, N.S.W., by John C. H. Mingaye.—Plants with their habitats, discovered to be indigneous to this colony since the publication of the "Handbook of the Flora of New South Wales," by Charles Moore.—On the whipworm of the rat's liver, by T. L. Bancroft.—Small whirlwinds, by H. C. Kiddle.

July 5.—Prof. T. P. Anderson Stuart, President, in the chair.—The following papers were read:—On the languages of the New Hebrides, by Sidney H. Ray.—On an approximate method of finding the forces acting in magnetic circuits, by Prof. Threlfall.—Unrecorded genera of the older tertiary fauna of Australia, including diagnoses of some new genera and species, by Prof. Ralph Tate.

DIARY OF SOCIETIES.

LONDON.

WEDNESDAY, OCTOBER 4.

ENTOMOLOGICAL SOCIETY, at 7.—On the Cost and Value of Insect Collections: Dr. D. Sharp, F.R.S.—On the Ants of the Island of St. Vincent: Prof. Auguste Forel.—Description of a New and Remarkable Sub-family of the Scolytidæ: Walter F. H. Blandford.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—University College, Bristol, Calendar for the Session 1893-94 (Bristol).—The Miner's Handbook: Prof. J. Milne (Lockwood).—Elementary Lessons, with Numerical Examples in Practical Mechanics and Machine Design, new edition: R. G. Blaine (Cassell).—The Orchid Seekers: A. Russan and F. Boyle (Chapman and Hall).—On Sewage Treatment and Disposal: T. Wardle (J. Heywood).—The Cholera Epidemic of 1892 in the Russian Empire: Dr. F. Clemow (Longmans).—Proceedings and Transactions of the Royal Society of Canada, 1892 (Ottawa, Durie).—A B C Five-Figure Logarithms for General Use: C. J. Woodward (Spon).—Our Household Insects: E. A. Butler (Longmans).—The Essentials of Chemical Physiology: Dr. W. D. Halliburton (Longmans).—The Art of Projection and Complete Magic-Lantern Manual: An Expert (Beckett).—Songs in Springtime, 2nd edition; J. C. Grant (E. W. Allen).—Notes on Some of the More Common Diseases in Queensland in Relation to Atmospheric Conditions, 1887-91: Dr. D. Hardie (Brisbane, Beal).—Charts for ditto (Brisbane, Beal).—Manual of the New Zealand Coleoptera, Parts 5, 6, 7: Captain T. Broun (N.Z., Wellington, Costall).—An Examination of Weismannism: Dr. G. J. Romanes (Longmans).—The Science of Mechanics: Dr. E. Mach, translated by T. J. McCormack (Watts).—A Course of Practical Chemistry or Qualitative Chemical Analysis, 8th edition: W. J. Valentin, edited and revised by W. R. Hodgkinson (Churchill).—Drum Armatures and Commutators: F. M. Weymouth (*Electrician* Company).—Handbuch der Palæontologie, I. Abthg., Palæontologie, iv. Band, 2 Lief: K. A. Zittel (Williams and Norgate).—Traité des Gites Minéraux et Métallifères, 2 vols.: E. Fuchs and L. de Launay (Paris, Baudry).—Abnormal Man, being Essays on Education and Crime and Related Subjects: A. MacDonald (Washington).—British Commerce and Colonies: H. de B. Gibbins (Methuen).—The Chemistry of Fire: M. M. P. Muir (Methuen).—A Manual of Electrical Science: G. J. Burch (Methuen).—A Treatise on the Kinetic Theory of Gases, 2nd edition: Dr. H. W. Watson (Oxford, Clarendon Press).—A Handbook of the Destructive Insects of Victoria, Part 2: C. French (Melbourne, Brain).—Glasgow and West of Scotland Technical College Calendar for Session 1893-94 (Glasgow).—Sécheresse, 1893, ses Causes, Principes Généraux de Météorologie, l'Abbé A. Fortin (Paris, Vic et Amat).—Blackie's Junior School Shakespeare; King Henry V.: W. Barry (Blackie).—Blackie's Science Readers, No. VI.: Rev. T. Wood (Blackie).—Hand und Hilfsbuch zur Ausführung Physiko-Chemischer Messungen: Prof. W. Ostwald (Williams and Norgate).—Text-book of Biology; Part 2, Invertebrates and Plants: H. G. Wells (Clive).—Certain Climatic Features of the Two Dakotas: J. P. Finley (Washington).—The Industries of Animals: F. Houssay (W. Scott).—Utility of Quaternions in Physics: A. McAulay (Macmillan).—Pubblicazioni della Specola Vaticana, fasc. 1 and 2 (Roma).

PAMPHLETS.—A Guide to Stereochemistry: A. Eiloart (N.Y., Wilson).—The Caradoc Record of Bare Facts, 1892 (Shrewsbury).—Cremation and Cholera: Sir S. Wells (London).—The Prevention of Preventible Disease: Sir S. Wells (Glasgow).—Abstract of the Proceedings of the Linnæan Society of New York for the Year ending March 1, 1893 (New York).—On the so-called Bugonia of the Ancients, and its Relation to Eristalis Tenax, a Two-winged Insect: C. R. Osten-Sacken (Firenze, Ricci).—Catalogue of the Minerals of Tasmania, with Notes on their Distribution: W. F. Petterd (Hobart, Grahame).—The Glacier Epoch of Australasia: R. M. Johnston.—Abhandlungen zur Landeskunde der Provinz Westpreussen, Heft 5, Die Tucheler Haide, &c.: R. Schütte (Danzig, Bertling).—Notes on Marine Laboratories of Europe: B. Dean.

SERIALS.—Engineering Magazine, September (New York).—Insect Life, Vol. v. No. 5 (Washington).—The American Naturalist, August (Philadelphia).—Verhandlungen des Deutschen Wissenschaftlichen Vereines zu Santiago, Chile, ii. Band, 5 and 6 Heft (Berlin, Friedländer).—American Journal of Science, September (New Haven).—Journal of the Franklin Institute, September (Philadephia).—Quarterly Journal of Microscopical Science, September (Churchill).—Economic Journal, September (Macmillan).—Timehri, June (Stanford).—Proceedings of the Liverpool Geological Society, Session 34, Part 1, Vol. vii. (Liverpool).—Transactions of the Academy of Science, St. Louis, Vol. vi. Nos. 2 to 8 (St. Louis).

CONTENTS.