THURSDAY, FEBRUARY 24, 1898.

THE MAGNETIC CIRCUIT.

The Magnetic Circuit. By H. du Bois, Ph.D. Translated by E. Atkinson, Ph.D. Pp. xviii + 362. (London: Longmans, Green, and Co., 1896.)

NO one is better fitted than Dr. du Bois to write a treatise on the magnetic circuit. He is well known for his experimental investigations in magnetism, and abstract magnetic theory is clearer and more comprehensive for his restatement of its main propositions. His German treatise, "Die Magnetische Kreise," published some five years ago, attracted considerable attention in this country. It gave in reasonable compass an excellent account of magnetic theory, methods of magnetic measurement, and of recent magnetic research, in which Dr. du Bois' own contributions to knowledge formed an important part, not merely on account of their intrinsic value, but of their clear and first-hand and withal modest statement.

A translation of this book, made by Dr. Atkinson with the assistance and revision of the author, and one or two other experts in the subject, was published in 1896, and was thoroughly welcomed by the already considerable and continually increasing number of experimentalists in electricity and magnetism. Some apology for so late a review of so important a work is necessary, and this is now offered by the reviewer, whose fault it has been that an account of it has not long before now appeared in NATURE. Still "good wine needs no bush," and the work of Dr. du Bois carries its own guarantee of excellence on the face of it.

The book begins with a very valuable summary of magnetic quantities and conceptions, in which the fundamental ideas of magnetic force, magnetic induction, intensity of magnetisation, permeability and susceptibility, &c., are fully explained, and the graphical representation of their values for actual cases is fully illustrated by curves of induction and magnetisation obtained for actual specimens of iron and steel.

The question of the effects of the ends of a bar of magnetised iron or steel, or of a narrow crevasse or joint between two parts of a bar or ring, is taken up towards the end of Chapter i., and is continued in Chapter ii. Ewing's representation of the effect of the cut, by a shearing of the curve of magnetisation for the uncut bar or ring, is given, and illustrated, as before, by the results of actual investigations—mostly those of Ewing himself. The effect of a cut leads to a further discussion of that of an end, and thence to a discussion of Coulomb's law for the distance action of a magnetic pole, and of the field at a point due to a pair of equal and opposite "point-charges" of magnetic matter.

Of course this action at a distance is what is actually observed, and there is an advantage in starting with what are the immediate results of experience. Still, if the book, as no doubt it will, should pass soon to a new edition, we should like to see some account of a more "mediumistic" view of the matter included. It is possible, and in connection with the electromagnetic theory of light it is very desirable, to consider magnetic force and magnetic induction not only as both existing as directed quantities at every point of a magnetised body, but at every point of the electromagnetic field, in ether or other "interferric" material, as well as in iron itself. With electric induction and electric intensity also introduced as the analogues of the magnetic quantities, with k for the electric inductivity, and μ for the magnetic inductivity of the medium, whatever it may be, all difficulties as to units disappear if k and μ are regarded as depending upon real physical properties of the medium which, if fully known, would determine the dimensions of these quantities, and $1/k\mu$ is seen in a natural way to be the square of the velocity of propagation. The serious difficulties which students feel with respect to this matter, and which are only apparently overcome by an unsatisfactory process, are entirely avoided.

In Chapters iii. and iv. we have an Outline of the Theory of Rigid Magnets, and a discussion of Magnetic Intensity and Magnetic Induction. The account of rigid magnetism and of induction here given is based in the main on that source of all theory on the subject, Lord Kelvin's Mathematical Theory of Magnetism, and on the digest of this part of the subject given in Maxwell's great treatise, and includes most of the more valuable results obtained by Kirchhoff, and by later writers who have commented on or developed the theoretical principles laid down by these masters. Here Dr. du Bois has himself done good service. He has given solutions of important problems of induction, and generally, as stated above, in certain points improved the presentment of theory; work of which English readers now reap the full advantage.

A chapter on the Magnetisation of Closed and of Radially Divided Toroids, which is divided into two parts—(*a*) Theoretical; (*b*) Experimental—closes the first part of the treatise. This chapter is exceedingly important. Kirchhoff's theory of the magnetisation of a solid of revolution is given, and its results for rings of rectangular and circular section are deduced. This investigation of Kirchhoff's gave rise to the experimental investigations of Stoletow and Rowland, the results of which have only confirmed its correctness.

Results are next deduced for a radially divided ring, which are fully illustrated in the experimental investigations described later. Thus we have the subject of leakage of magnetic induction introduced and clearly discussed and illustrated. The great practical importance of this part of the subject will be obvious when its application to dynamo machines is considered, and a large part of the experimental investigations which have been carried out have had to do with the question of the distribution of tubes of induction in or near more or less narrow gaps in what may be regarded as closed circuits or rings of iron.

The great importance of having a magnetic circuit nearly closed was recognised by Faraday, and was more or less present to the minds of makers of magnets, both permanent and electro, down to the beginning of the present active manufacture, on a large commercial scale, of dynamo machines.

Then it was that Hopkinson came forward with his explicit statement of the laws of the magnetic circuit, and their application to the construction of the field magnets of dynamos, a piece of work for which practical

science owes him a heavy debt. The magnetic circuit, and the mode of testing the performance of dynamo machines by means of characteristic curves, which themselves give valuable information regarding the magnetisation of the circuit, really did for the dynamo machine very much what practical thermodynamics and the indicator did for the steam-engine.

After an account of the General Properties of Magnetic Circuits, Dr. du Bois proceeds in his Chapter vii. to a discussion of the Analogy of the Magnetic Circuit with other Circuits. Here the author, as we think very properly, condemns the use of the term "Ohm's Law" to express the fact that magneto-motive force in the circuit divided by the magnetic reluctance is equal to the flux of induction in the circuit. This, it has always appeared to us, is using the term "Ohm's Law" to describe what is a mere result of definition. The equality of the magneto-motive force multiplied by the permeance (permeance = 1/reluctance) of the circuit to the flux of induction is a result of definitions of induction and field intensity, and to thus use it is to introduce into magnetics the confusion which many have fallen into with regard to the law of Ohm in voltaic circuits. In the latter case, the law, properly speaking, expresses the proportionality of the current in a conductor to the difference of potential between two points in the conductor near its ends when the conductor is not the seat of any internal electromotive force. This result has no counterpart in magnetic circuits, and no "Ohm's Law" holds there.

In Chapter viii. the Magnetic Circuits of Dynamos or Electromotors is dealt with, the work of the brothers Hopkinson, the empirical formulæ for the magnetisation curves of such machines given by Frölich and others are all described, and the application of all this thoroughly practical theoretical discussion is focussed on the construction and arrangement of the field-magnets and armature of the machine.

We are immediately carried on in a natural sequence to magnetic cycles and hysteresis, and the immensely important researches on the magnetic properties of iron carried out by Ewing and others. The results in this field are, however, before all our readers specially interested in the subject, and the subject is so large and so full of detail, that we cannot with any advantage continue our sketch of the contents of the book.

The magnetic circuits of electromagnets, containing an account of the devices used by Ewing and the author to obtain very intense fields, and of methods of measuring such fields, is given in Chapters ix. and x. Up to about fifteen years ago determinations of field intensities had been confined to measurements of the earth's field-intensity or intensities of like magnitude, and a paper (*Philosophical Magazine*, 1882) by the present writer, describing methods which were in use in the Glasgow University Physical Laboratory, contained perhaps the first published statement of how the field between the poles of a powerful electromagnet could be quickly and accurately measured.

In this connection also we have one of the author's notable contributions to magnetics, in his account of the researches which he carried out at Berlin on the magneto-optical method of measuring intense fields.

Here we must conclude our review of a most fascinating book. It cannot be praised too highly as a piece of work sound from every point of view, and tending to the advancement of knowledge. Dr. Atkinson and his colleagues have performed their work of rendering the book into English very carefully indeed, and on the whole the version reads like a book originally written, and well written, in English. Only in one or two places have we found, in a fairly extensive comparison of the German and English, that the sense has not been exactly caught. For example, at p. 340 a method of investigation there referred to is rather hardly treated by being described as "circuitous." The German "umständlich" ought here to be rendered by "circumstantial."

A. GRAY.

AUDUBON.

Audubon and his Journals. By Maria R. Audubon. With zoological and other notes by Elliott Coues. 8vo. Two vols. Vol. I., pp. xiv + 532; Vol. II., pp. viii + 554. Portraits, copies of diplomas, photogravures, &c. (New York: Charles Scribner's Sons, 1897.)

NATURALISTS and many who are not naturalists will find this an entertaining book. It gives in great detail the incidents of certain years of Audubon's life, years in which he was carrying on his work in the field, or else meeting every day men who are still noteworthy. The book is founded upon unpublished journals and letters, of which parts are given at length. All has been corrected by recollections handed down in the family, and the zoological information has been revised by Dr. Elliott Coues. A summary of the naturalist's life is prefixed. We have now a full and lively account of what is most memorable in the life of Audubon.

Some readers who are not naturalists will turn with curiosity to the passages in which mention is made of places which are now populous American cities, but which, when Audubon dwelt there, or passed through, were backwoods settlements. Others will be glad to note small particulars concerning the naturalists, merchants, and men of letters whom Audubon saw during his visit to Europe in 1826–29—Cuvier, Bewick, Jameson, Selby, Jardine, Rathbone and Roscoe. Others again will study the character and methods of a man, who partly by real merit, and partly by the good-luck of becoming known to men who could write, has been widely accepted as a typical naturalist. Some of us can hardly remember the time when we had not heard of Audubon as the man who faced all dangers and fatigues, caring nothing for comfort or profit, if only he could learn more and more of the wild creatures which fly from the face of man. There is matter here for readers of very different kinds, and all should thank those who have rescued so many old papers, and arranged them so carefully.

Audubon was a real naturalist, if ever there was one. He had the passion for observing and drawing birds almost as a gift of nature. As a boy and young man he was fit for nothing else, but the responsibility which a family brings made him in middle life a sensible man of business. He was never a man of science. He never received from others, nor gave himself any kind of training in scientific method; he never studied the anatomy of

birds or systems of classification ; above all, he never put questions of the slightest scientific interest. It was enough for him to draw his birds as they looked when alive, and now and then to note some curious detail in their mode of life. His less famous helper, MacGillivray, was far better furnished and far more productive. Audubon's "Birds of America" has great artistic merit, but less scientific value than a good series of photographs from life.

Audubon's career is now revealed to us more fully and more pleasantly than in any earlier account. He was born of French parents at Mandeville, on Lake Ponchartrain, somewhere about 1780. His first seventeen years were spent almost altogether in France, and he showed his turn of mind by making 200 drawings of the birds of France. Then he was sent out to Philadelphia, where his father had landed property. After another two years in France he came back to America, which henceforth he always claimed as his fatherland. At first young Audubon lived like a young gentleman of property, hunting, fishing, shooting, skating, but drawing birds too. He was a bit of a dandy in those days, and a favourite with young ladies. He went into business, married, and should according to all expectation have settled down as a money-making American. But he was intent upon birds and not upon money. He was easily diverted from a business-journey by a glimpse of a new bird, and was regularly cheated by his partners, agents, employers and customers. He complained that one of his partners cared only for money; the partner on his side complained that Audubon had no turn for commerce, and was continually in the forest. The advantages with which he started were soon lost, and in a few years we find him roving about in America, giving drawing-lessons, music-lessons, dancing-lessons, drawing portraits, but always adding to his portfolio of birds, and always studying how to make his delineations more life-like. The hope of publishing his great collection gradually became more definite. In 1826, being then near fifty years old, he came over to Europe to get subscriptions and engage draughtsmen. His diary shows him to us as sobered down by this time to a modest, careful man, minding his chances, and thoughtful for his wife and children. His success in publishing the "Birds of America," his later ventures, his expeditions to Labrador, Florida and the Missouri River, as well as his charming family life, are all described in the book before us. In 1847 his faculties began to give way, and he died in 1851.

The "Birds of America" has maintained its reputation, in spite of its enormous bulk, its costliness, and its want of scientific utility. It is now a luxury, only to be possessed by the wealthy, and very seldom enjoyed even by them, an unprofitable jewel in comparison with the homely tools which the working ornithologist requires. To have published a book which very few men can afford to buy, gives a certain kind of distinction. Audubon has better claims upon our attention than this, but the ever-rising price of his "Birds of America" has helped his fame.

One thing in the journals moves our indignation, but it will hardly excite remark among the naturalists of to-day; we mean the profuse and needless slaughter of wild animals, which fills almost every page of the journals. Audubon rises in the morning, snatches his gun, shoots everything that shows itself, and then sits down to draw his victims. Some naturalists look upon all this blood-shed and torture as inevitable, or even enjoyable. That is the way to get together a museum of dried skins or a portfolio of drawings ; it is not the way to solve scientific questions, nor to gain real insight into the works of nature.

L. C. M.

SEWER GAS AND HEALTH.

Sewer Gas, and its Influence upon Health. Treatise by H. A. Roechling, C.E. Pp. 224. (London: Biggs and Co., 1898.)

THERE is hardly a Corporation in the United Kingdom, we venture to say, to whose members sewer gas is not a hideous nightmare. It is the legacy of a bygone generation of hygienic enthusiasts, and is likely to prove the *bête noir* of many a succeeding generation of despairing sanitarians. Despite the brilliant achievements in the domain of hygiene of which the present century can justly be proud, the sewerage problem remains still a gordian knot the disentanglement of which seems as far off as ever.

Public opinion has swayed backwards and forwards, immense sums of money have been expended in what may be designated as vast hygienic experiments, sewers have been laid and relaid, ventilators introduced and abolished, and innumerable devices invented and applied in the hope of effectually getting rid of this mysterious and subtle influence in our midst.

Mr. Roechling in the above volume has added one more to the many indictments which have been published against sewer gas. These indictments are necessarily of a somewhat vague description, founded, as they must be, more on personal conviction than on strictly scientific facts; for our precise knowledge of the character and properties of this gas is at present so extremely limited, that we are frequently reduced to the manipulation of mortality statistics for a basis of attack. We must not, therefore, approach this book in the hope of finding a pyramid of new facts, for we may have to be satisfied with hardly a molehill, but we may recommend it as containing a useful summary of the circumstantial evidence which can be adduced against sewer gas.

The arrangement of the material, however, leaves much to be desired, and the writer is needlessly verbose. Considerably more than half the book is taken up with appendices, to which the preceding portion of the book has constant reference, and these appendices would be very much the better for judicious pruning. Page after page, for example, are devoted to detailed reports of cases of supposed poisoning through sewer gas ; over twenty pages are occupied with reporting in full the legal proceedings connected with a case of blood-poisoning, &c. All this, no doubt, serves to swell the size, but it certainly does not increase the value of the volume.

As an example of the justifiably perplexed condition of some of our public authorities on the question of sewe gas, we may cite the case of Leicester as mentioned by the author. Up to the year 1881 the sewers of this city were in a very foul condition, and were not ventilated in any way, and the typhoid death-rate was as high as 32·2 per 100,000. In 1881, however, the Town Council decided to open up the sewers, thoroughly cleanse them

and ventilate them by open covers at street level. Subsequent to this, and up to the year 1886 the typhoid death-rate showed a most remarkable decrease, falling during this period at its lowest to 16·3 per 100,000. Yielding, however, to the pressure of numerous public complaints about the obnoxious smells rising from the sewers in the various thoroughfares of the town, the Sanitary Committee decided in 1886 to close the open street ventilators, and to erect in their place cast-iron pipes up the sides of houses wherever the necessary permission of the house-owners could be obtained.

Since 1886, also, improvements have been made in the sewerage system of the town, for the old and small main sewers have been replaced by larger and better constructed ones at a cost of nearly 200,000*l.*; but in spite of this and other sanitary improvements, the typhoid death-rate has actually risen in Leicester during this latter period. *Felix qui potuit rerum cognoscere causas!*

It must indeed be frankly admitted that our knowledge of the conditions—and there may be many factors, which determine outbreaks of epidemic disease—is at present in some respects hopelessly inadequate. No more conclusive example of this is to be found than is presented by the diphtheria epidemic which has taken such a firm hold of London, and which has also manifested itself in various other parts of the country, and, despite all the boasted hygienic enlightenment of the closing years of the century, pursues its triumphant course practically unchecked.

Sewer gas may be charged with a great deal, but we also know that other factors—as, for example, infected water and milk—are also heavily weighted with responsibility in the dissemination of disease, and that to shift the whole burden of a particular epidemic upon any one single factor becomes the more unreasonable the wider our scientific horizon is extended.

G. C. FRANKLAND.

OUR BOOK SHELF.

Chambers's Algebra for Schools. By William Thomson M.A., B.Sc., F.R.S.E. (London: W. and R. Chambers 1898.)

THIS is a plainly written and well-arranged book of secondary grade, quite worthy of the crucial test which only practical teachers can apply. Among its praiseworthy features may be mentioned the attention paid to degree, homogeneity, and symmetry; the early introduction of the method of detached coefficients; and the elementary discussion of graphs. The chapter on indices is more satisfactory than is usually the case in works of this kind; on the other hand the chapter on surds is disappointingly conventional, and that on logarithms might certainly be revised with advantage. All logarithmic calculations ought to be printed in the form in which a computer would write them down on paper; explanations, of course, may be added when necessary.

The chapter on the binomial theorem for any exponent is not satisfactory: it would be much better simply to state the conditions under which the theorem is true, and to give some numerical examples to illustrate the use of it for purposes of approximate calculation.

The examples are numerous, and there is, on the whole, a refreshing absence of those fantastic absurdities which are never found except in text-books and examination papers. In the examples on variation, illustrations derived from physics might very well have been inserted: the same thing may be said about the examples on equations.

It is probably useless to protest against the method of solving quadratics by completing the square; like the Imperial system of weights and measures, it has become a national fetish, and its cult is proof against all the arguments of common sense. G. B. M.

Die Kraft und Materie im Raume. Grundlage einer neuen Schöpfungstheorie. By A. Turner. Fifth edition. Pp. xxiv + 407, and 20 plates. (Leipzig: Theod. Thomas, 1897.)

IN his preface to the present edition of this work the author remarks:—

"We have given positive proofs of the untenability and the imaginary foundation upon which rest the hypotheses which have for their subject-matter the theory of vibration of a cosmic ether, whether these relate to light, heat, or to the artificial terms under the ægis of 'the conversion of work into heat, energy into electricity, &c.,' in short the greater part of the hypotheses which form the foundation and chief support of the privileged sciences of to-day.

"They represent no scientific truths, but, together with the catch-words indicated, serve merely as a cloak for ignorance, their supporters having no suspicion of the nature or true inwardness of the phenomena in question or of their causal connection."

Turning to the body of the work we find, expressed in somewhat similar style, a theory of the universe postulating matter and space as ultimate realities. Matter consists of centres of force attracting or repelling each other when they approach each other within certain limits. Light is the impression made on the optic nerve by radiant matter. The phenomena of heat are due to the repulsion of one substance by another, and so on. At the end of the book 150 theses are printed for the convenience of those who feel impelled to combat the author's views.

The Observer's Atlas of the Heavens. By William Peck, F.R.A.S., F.R.S.E. Charts 30; pp. 32. (London and Edinburgh: Gall and Inglis.)

THIS volume contains catalogues giving information relating to double stars, variable stars, nebulæ, and other celestial bodies, together with thirty star charts in which the positions of nine thousand objects are shown.

The charts include the whole celestial sphere, and are drawn to a large scale, five degrees of a great circle being equal to one inch. They are arranged so that, as far as possible, each constellation is shown complete in itself. The scale of magnitudes is well chosen, the stars appearing with the same relative importance on the charts as in the heavens. The practical value of the atlas would be greatly enhanced, however, if a scale of magnitudes were attached to each chart.

The brighter stars, down to the third magnitude, are shown to a half, and fainter stars to a whole magnitude. To facilitate identification in the various catalogues, either a letter or Flamsteed number is attached to every important star. A commendable feature is the insertion of the various data, from which the charts were compiled, in the form of catalogues of the different celestial bodies. These catalogues will be found very useful, and include such information as the magnitudes of the brighter stars to the nearest tenth, and the positions of stars down to the fourth magnitude, with their Flamsteed and British Association numbers.

Other useful information is included, such as diagrams showing the appearances of over one thousand double stars when near the meridian, and a chart of the moon with an index.

Undoubtedly, this atlas will be found very useful by astronomical observers, especially amateurs, for whose requirements it seems to be particularly designed.

LETTERS TO THE EDITOR

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

Protective Mimicry and Common Warning Colours.

I HAVE just read with interest Sir George Hampson's criticism of certain supposed examples of protective mimicry. Such outspoken attacks are satisfactory in bringing out the truth one way or the other ; and they contrast very favourably with vague expressions of opposition unaccompanied by reasons, and not stated in a manner or on an occasion which would permit reply.

I find from his letter that insufficiently supported conclusions are not confined to those who accept the theories in question. Sir George Hampson described a new geometer (*Abraxas etridoides*) from a single specimen in a private collection, and pointed out its resemblance to a *Teracolus* (*T. etrida*) from the same part of the world. Colonel Swinhoe directed the attention of the President of the Entomological Society to the resemblance, considering that it supported his (the Colonel's) contention that *Teracolus* is a protected genus. From these facts Sir George Hampson draws the remarkable conclusion that Colonel Swinhoe had in all probability never seen the species of *Abraxas* referred to. I give the inference in his own words—"this was quite enough for such an ardent student of mimicry as Colonel Swinhoe to base the statement on, without knowing any more of the species, and probably without ever having seen it, the type being in a private collection." The last reason would be more convincing if it was not followed by the statement—"I have, however, lately received more specimens." If Sir George Hampson, why not Colonel Swinhoe? As a matter of fact, Colonel Swinhoe received several specimens of *Abraxas etridoides* many months before he wrote to the President about them. There is a specimen in the Hope Collection here, presented by him in the early summer of last year.

All this does not affect the theory of mimicry. But the letter goes on to argue that the resemblance cannot be mimetic because the *Abraxas* rests in damp woods, while the *Teracolus* is flying on the plains 6000 feet below ; and, furthermore, that the former is protected by distastefulness, while the latter is not. Similar objections are then raised against the supposed mimetic resemblance of Chalcosid moths to Danaine and Papilionine butterflies.

Now I quite agree that these criticisms, and especially that of the special protection of the moths, are destructive of any interpretation of the resemblance based on Bates' theory of protective mimicry. But they do not similarly affect that theory of mimicry (or more accurately common warning [synaposematic] colours) which we owe to Fritz Müller. Being aware of the distasteful qualities of *Abraxas*, I had at once placed the example under the latter category and not under the former.

The Müllerian theory supposes that a common type of appearance among distasteful insects in the same locality acts as a common advertisement to enemies, so that the loss of life which must ensue during the time in which each generation of enemies is being educated to avoid the owners of a particular type of pattern and colouring, is shared between these species instead of being borne by each of them independently.

Prof. Lloyd Morgan's recent experiments on young birds of many species prove that there is no inherited knowledge of suitability or unsuitability for food, but that everything of an appropriate size and at the right distance is pecked at and tested. On the other hand the young birds are extremely quick in learning, and have very retentive memories. Furthermore one unpleasant experience makes them suspicious of other things, and they remember well the appearance of the insect which gave them a disagreeable surprise. Many more such experiments are needed, but taken alone they go far to show that the education of young birds is actually of the kind which is presupposed by Fritz Müller's theory.

And what is true of birds is probably true of other animals as well. My experience with lizards points in the same direction.

Sir George Hampson has previously pointed out that birds sometimes devour *Teracoli ;* but I have induced a lizard, by hunger, to eat an *Abraxas*. It is probable that *Teracoli* are, *on the whole*, avoided by birds ; and if this is also true of the *Abraxas*, the resemblance may well be advantageous in spite of the difference in habits and the difference of station, even granting that the "good round sum" of 6000 feet is an absolute barrier to the *Teracoli* below and the *Abraxas* above. But future investigation may show that they approach much nearer than this.

The facts brought forward in Sir George Hampson's letter, while, I submit, by no means fatal to the Müllerian theory of mimicry, seem to be entirely destructive of the other suggestions by which the attempt has been made to explain these resemblances—suggestions which depend upon similarity in climatic or other physical or chemical conditions connected with locality.

The last paragraph of the letter demands a word of protest. If insufficient field observations have been made, it is because the observers have thought of other things, and chiefly the amassing of specimens ; but it is, in part, due to the extreme difficulty of the observations themselves. And under any circumstances the museum work was necessary for the theory. Mr. Godman, in his presidential address to the Entomological Society, told us that the theory was suggested to Bates as a result of the comparison of specimens at home, although of course his memory of observations in the field was also necessary. The work in the study enabled him to bring under observation at a single time the captures which were separated by great intervals of time and space ; and no doubt it was the opportunity thus afforded of taking a broad view of the resemblances as a whole, which enabled him to originate the theory.

It seems strange that a writer whose energetic and successful work has involved so much "matching of specimens in a drawer," should speak of mimicry as "degraded" by such study. It is a necessary and important study for the naming of species as well as the recognition of examples of mimicry, and as such it deserves respectful attention, although it may at times have led to the creation of "museum-made" species on an even larger scale than the manufacture of "museum-made mimicry."

The matching of ribbons of uniform colour can hardly be compared with any degree of fairness to the matching of the complex patterns on the wings of Lepidoptera ; but in the matching of highly developed specimens of decorative art by the anthropologist, and in the attempt to determine whether the resemblance is due to a common origin, or to accident, or to the mind of man working independently along the same lines, we have problems which present much in common with those confronting the student of mimicry.

In conclusion it may be well to remind those who oppose the theories of mimicry on the ground that the evidence is not demonstrative, that we believe in evolution although we do not see one species growing into another. We believe the theories of mimicry and of common warning colours, not because we have before us demonstrative proof in a complete knowledge of the details of the struggle for existence—it will be very long before we attain to this—but for the same reason that we believe in evolution—because the theory offers an intelligible explanation of a vast number of facts which are unexplained by any other theory as yet brought forward, and especially because it enables us to predict the existence of facts which we can afterwards verify.

EDWARD B. POULTON.

Oxford, February 18.

Oat Smut as an Artist's Pigment.

WITH reference to Mr. David Paterson's interesting letter in NATURE for February 17 (p. 364), it may be noted that a copy of an etching from a painting by Berghem, in the Kew Museum, No. 2 (Case 115, No. 200), is drawn with smut of wheat (*Ustilago tritici*), and that, according to Dietel (*Die Naturlichen pflanzenfamilien*, Th. I. 1 Abth. p. 6), ladies in Japan are accustomed to use the dark olive-brown spores of *Ustilago esculenta* as a pigment for painting the eyebrows.

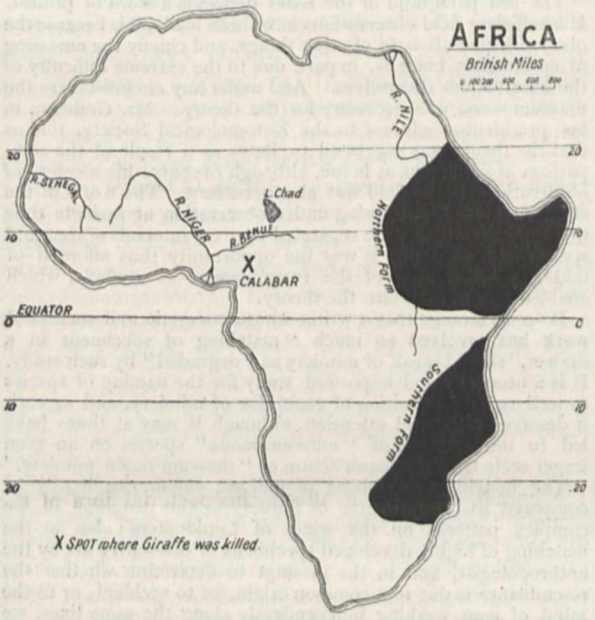
H. MARSHALL WARD.

Botanical Laboratory, Cambridge, February 18.

Giraffe from the Niger Territories.

MY brother, the late Lieut. R. H. McCorquodale, of the 3rd Dragoon Guards, while doing special service duty in West Africa, was fortunate enough to kill a very fine giraffe (female). This is a most interesting record, as it is the only specimen

that has ever been obtained in these regions. The skull, which was sent home to me, along with a considerable number of heads of antelope, lion, leopard, &c., is now in the British Museum, and Mr. Oldfield Thomas, of that institution, has compared it with the skulls of both the Northern and Southern forms; such marked differences have been noticed, that opinion is in favour of the possibility of its being a new species—for the time being, until it has been more fully worked out, he has made it a special sub-species, and named it *Giraffa camelopardalis peralta*. The giraffe was killed south of the Benue River, north of Calabar. The accompanying map will roughly show the geographical distribution of the two known forms, the haunts of these animals being filled in. Although one or two specimens



have been recorded on the eastern shores of Lake Chad, and also on the Senegal River, from 10° N. to 20° S. of the equator no fact is on record of a giraffe having been seen or killed within the degrees mentioned in all that part designated West Africa. The map will show at a glance the immense tracts of country between the habitats of these animals and the spot where this single animal was killed. In a letter I had from Sir George Taubman Goldie, the Governor of the Niger Company, he says: "This is the only giraffe ever known in these regions; I have no doubt there are others, but they have never been seen."

The above facts were mentioned by me at a meeting of the Linnean Society, on the 20th of last month; and Mr. Thomas exhibited the skull at the Zoological Society on the 1st inst., and among some of his remarks stated the skull to be the largest he had ever seen.

W. HUME MCCORQUODALE.

Abridged Long Division.

HAVING been working on similar lines for some years, I was very much interested in the late Mr. Dodgson's letter on abridged division in NATURE of January 20, and I should like to offer a few observations and to give a variation of the method which appears much simpler. It will be admitted that Mr. Dodgson's plan is of limited application, and rather complicated for general use. There is nothing to hinder the method given below from being universally used, though it may not in all cases be the shortest. It also has the merit, I think, of directness and uniformity.

It is, of course, based on the theorem in geometrical progression.

$$\frac{N}{ar^n \mp m} = \frac{N}{ar^n} \pm \frac{mN}{(ar^n)^2} + \frac{m^2N}{(ar^n)^3} \pm \ldots \frac{m^{n-1}N}{(ar^n)^n},$$

e.g. (1) Divide 246813579 by 989. Here $a = 1$, $r = 10$, $n = 3$, $m = 11$.

1000|246813579
246813|579 × 11 = 2714943
2714|943 × 11 = 29865
29|865 × 11 = 330
|330
249558·717 quotient.

It will be observed that in multiplying by $m = 11$, we need only use the figures to the left of the line, and if the first figure to the right of the line be > 5, call it one more; thus,

$2715 \times 11 = 29865$, and $29{\cdot}8 = 30 \times 11 = 330$.

If extreme accuracy be required, the computer has only to carry the process further.

In this example we need not do so, as the divisor is 1000 throughout.

(2) Divide 975318642 by 3997.

4000|975318642
243829|6605 × 3 ÷ 4
182|8722 × 3 ÷ 4
|1372
244012·6699 quotient.

Remainder in integers

$$= 8642 - (2 \times 4000 - 4012 \times 3) = 2678.$$

The 8642 and 4012 are the $n + 1$ figures of dividend and quotient respectively.

(3) Divide 12345678975312468 by 69993.

70000|12345678975312468
176366842504|46 × 7 ÷ 7 = × 1
17636684|25
1763|66
|17
Quotient 176384480952|5

Actual remainder

$$= 312468 - (2 \times 70000 - 80952 \times 7) = 39132$$

retaining only the last $n + 1$ figures.

(4) Divide 975312468 by 7003.

7000|975312468
139330|353 × 3 ÷ 7
59|713
Quotient 139270|6

Actual remainder $2468 - (0 \times 7000 + 9270 \times 3) = 4658$, retaining only last $n + 1$ figures.

It will be noticed here that we subtract to get the quotient. The reason is evident. We actually divide by 7000 instead of 7003, and therefore the quotient is too great.

If the remainder be known, as *e.g.* in recurring decimals, the following process, published by me some years ago, is shorter than the ordinary method, besides possessing the advantage of *finding its own quotient*.

Divide 85296419765·1 by 9731

973
41879·2
1946
3993·3
2919
6107·4
3892
9221·5
4865
52435·6
5838
84659·7
6811
7784·8
7784
....

The quotient [87654321. It is obtained the reverse of the ordinary way.

This method bears the same reverse relation to ordinary

division as the left method does to the right in an ordinary multiplication, *e.g.*

(1)	(1)	(2)	(2)
321	321)241713(753	321	24171·3
753		753	
2247	2247	963	96
	1701		407·5
1605	1605	1605	160
963	963	2247	224·7
241713	963	241713	224
	....		

Anfield Road, Liverpool. ROBT. W. D. CHRISTIE.

Earthquake in North Britain.

IT may be of interest to you to note that on Wednesday, February 16, at about 1.35 p.m., a sharp shock of earthquake was felt here. Houses were shaken, dishes rattled and tumbled, and much alarm was created, though no damage was done. At the time mentioned there was a loud report, as if of a heavy shot fired underground: earth movements—such as would result from violent concussion—immediately followed, lasting for about two seconds; the character of the movements then seemed to alter from vertical to horizontal, the latter being sustained for nearly four seconds. About two minutes after the first report a second was heard, louder and sharper than the first, but no tremors were felt. Judging from the sounds, it would appear that the wave travelled from west to east.

I may state that within recent years several shocks of earthquake have been felt in the district.

Kilsyth, N.B., February 18. JAMES M'CUBBIN.

ON THE USE OF GLYCERINATED CALF LYMPH FOR PROTECTIVE VACCINATION AGAINST SMALL-POX.

THE terms of the Report of the Royal Commission on Vaccination, published towards the end of the year 1896, made it evident that there was a general feeling on the part of the Commissioners that the use of calf lymph should be encouraged as far as possible; and it was patent to those who grasped the full significance of the Report, that in order to fall in with popular sentiment, even apart from other considerations, some effort would be made by those in authority to examine carefully into the claims advanced on behalf of calf lymph vaccination as carried out at home and in European countries. For some time past it has been recognised by those who have been cognisant of Dr. Monckton Copeman's work on the "glycerination" of vaccine lymph, and especially of that derived from the calf, that the advantages connected with the use of this lymph are of such a nature that many of the objections that have been urged against the use of calf lymph are practically eliminated. Although this work has been going on in our midst, it appears that, in order to obtain any knowledge of the practical outcome of Dr. Copeman's investigations, we are compelled to turn our attention to the large vaccine establishments of France, Germany, Belgium and Switzerland, where, under State control, the use of glycerinated calf lymph has now come to be recognised as the method, of all others, which is attended with the greatest success.

The addition of a certain bulk of glycerine to vaccine material does not at first sight appear to be a very important matter, but, as Dr. Copeman has demonstrated, this glycerine does exert an extraordinary influence.

Taking the method employed in the Institute in Berlin as an example, we find that the vesical pulp collected from a single calf weighs from 10 to 15 grammes; to this is added a mixture of glycerine and water of equal parts, fourteen times the bulk of the vesicular pulp; it then, if used carefully, forms a sufficient volume to vaccinate 15,000 individuals.

All this we learn from the Report drawn up by the Medical Officer of the Local Government Board, in conjunction with Dr. Monckton Copeman, published in "The Supplement containing the Report of the Medical Officer for 1896–97 to the Twenty-sixth Annual Report to the Local Government Board."

The advantages early claimed by Dr. Copeman for this method are:

(1) That the addition of glycerine in this diluted form has the effect of ensuring the destruction of micro-organisms that are sometimes found even in the calf lymph collected under the very best conditions. It has been maintained that certain of the cases of erysipelas that have followed vaccination with calf lymph have been due to the accidental presence of certain of these organisms. Again, the possibility of infection with tubercle has sometimes been raised, though there is very little evidence of such infection being conveyed by vaccination; still the point has been raised, and it is right that it should be considered as a possibility. Glycerination of the lymph entirely does away with any danger from either of these or other allied sources. The addition of the glycerine kills off not only non-pathogenitic microbes, but such pathogenitic organisms as are ever likely to be found in vaccine lymph. This in itself, then, is a forward step of vital importance to those who, whilst fully convinced of the advantages of vaccination, and of the enormous preponderance of these over the possible disadvantages, are desirous that such disadvantages as there are shall be removed, and that every cause of objection should be done away with for those who have conscientious, even though unfounded scruples, against the use of lymph taken from the child, or from the calf under ordinary conditions.

(2) The dilution with glycerine appears to have absolutely no effect in diminishing the specific activity of the lymph, although it affects the bacterial flora of the lymph in such a marked degree. It is even maintained that such specific activity is actually increased, though it is difficult to see how this can be the case. It is possible, however, that various changes set up by bacteria are inhibited, and that in consequence the active elements in the lymph remain in a stable and unaltered condition for a longer period.

It is interesting to note in this connection that, although the lymph is diluted some fourteen or fifteen times, it remains sufficiently active at the end of three or four weeks to produce a good crop of vesicles when the same amount of the dilute fluid is used as is ordinarily employed of the undiluted vaccine. It is evident, therefore, that the amount of active principle present in ordinary vaccine is far in excess of what is necessary. That being the case the amount of available fluid is multiplied by fifteen, and to that extent the production of a good supply of trustworthy calf lymph is facilitated, and it becomes a comparatively easy matter to supply a pure lymph at a small cost. Hitherto at the animal vaccine establishment in Lamb's Conduit Street the amount that could be obtained from a single calf was, at the outside, only sufficient for the vaccination of some 200 to 400 patients, and this had to be done under somewhat unfavourable conditions—namely, directly from the calf to the arm of the patient—in order that there might be as few organisms in the lymph as possible, as naturally any organisms would multiply comparatively rapidly in stored lymph to which antiseptics could not be added. With the lymph from a single calf, used according to the new method, 4000, 6000, or even 15,000 vaccinations may be carried out, of course not at once from calf to arm, as the lymph may be kept under observation for some time, during which test-plate cultivations may be made, and the presence or absence of micro-organisms demonstrated. The glycerine does not kill certain organisms instantaneously. Consequently test-plates, made immediately after the emulsion has been prepared, may

contain a number of organisms. In such a case the vaccine would be left to mature—*i.e.* to get rid of these organisms—which it will do in a few days at the outside. As soon as such organisms can no longer be demonstrated in plate cultures, or as soon as the exact period at which they disappear has been absolutely determined, the glycerinated vaccine may be used by the operator, who may have full confidence that no secondary or untoward conditions, which can in any way be attributed to impurity of the vaccine lymph, will arise.

In view of these facts, and of the splendid results that have been obtained in Paris, Brussels, Berlin, Cologne, Dresden and Geneva—the vaccine Institutes in which cities were specially visited and reported upon by Sir Richard Thorne Thorne and Dr. Monckton Copeman—and in view, also, of the recommendation of the Royal Commission on Vaccination, all who take an interest in this question (and the number of these is far greater than many people imagine) will hail with delight any measure brought forward by the Government to facilitate the preparation and encourage the use of glycerinated calf lymph, especially wherever it is found necessary to apply the compulsory clauses of the Vaccination Act, and also for vaccination generally.

Perhaps one of the main advantages adduced in favour of vaccination with calf lymph is that the animals may in the first instance be carefully selected, so that only such as are of sound constitution and good family history need be employed; but even then, under the old system, owing to the outlay involved if the calves were killed at once and not used for food, a post-mortem examination could not be obtained, or thorough inspection of the organs made. It was, therefore, not possible for the vaccinating officer to state that there was no disease in the animal. Now that such a large amount of lymph can be obtained from a single calf, it would scarcely be justifiable to neglect this post-mortem inspection; consequently, as the lymph should not be used for a few days after it has been taken and made into an emulsion, the medical officer is able to assure both himself and his clients, that the animal from which the special lymph he is using has been taken is absolutely free from flaw or blemish, whilst the after-treatment of the lymph with glycerine enables him to certify that the effects of accidental contamination from outside are completely neutralised.

It is somewhat humiliating to us as a practical nation to find that a method worked out theoretically by an Englishman should have received attention, and been applied practically in almost every important European country before it has been thought necessary to draw attention to it at home. Still, we are glad that at last Government has been brought to see its duty in this matter, and to make preparations for acting up to the light it has received.

For the information of our readers we may quote Sir Richard Thorne Thorne's conclusions, drawn up after visiting the establishments to which reference has already been made:—

"(1) It is desirable that vaccination, both primary and secondary, carried out under the auspices of the Government, should be performed exclusively with vaccine lymph direct from the calf.

"(2) There will probably be advantage in retaining, for a time at least, the system of calf-to-arm vaccination at the Board's Animal Vaccine Station for such parents and others as may specially desire it, and for the purposes of comparing its results with those following the use of calf lymph preserved in one or another way.

"(3) The distribution of calf vaccine from the National Vaccine Establishment should be limited to glycerinated or similar preparations of lymph and pulp material, in air-tight tubes, or other glass receptacles.

"(4) To give effect to the above it will be requisite that the Board's Animal Vaccine Station should be reorganised, both as regards construction and administration. Notably will it be requisite that it should include a properly equipped laboratory, under the direct supervision of a bacteriological expert."

It is to be hoped that in any legislative measure which may be formulated and passed, due effect will be given to each of these four conclusions, although from many points of view it would appear desirable that the second recommendation should be made to cover a comparatively short period, as most people who have studied the question are now fully of the opinion that calf-to-arm vaccination has no advantages over vaccination with glycerinated lymph, and few parents who are likely to express any opinion at all, may be expected to ask for calf-to-arm vaccination of their children.

We look upon this document as one of the most important that has been published from the Department for some time, and we heartily recommend a perusal of its contents to those who are in any way interested in the study of the vaccination question.

NOTES ON SOME VOLCANIC PHENOMENA IN ARMENIA.

AS we descended from the central mountains of Armenia towards the south along the road from Akstafa to Erivan, we suddenly came upon a beautiful sheet of water lying glassy and restful in the lap of the mountains. Those on the left, sloped down to its shore with every diversity of valley, creek and headland, and with gently moulded outlines which told of subaerial waste, and gave the impression of a mountain land the base of which the waters had but recently begun to bathe. From the heights on which we stood the lake seemed to follow a somewhat narrow sinuous course, which suggested the idea that we were looking on a dammed-up valley. But it could not be the submerged end of a long valley invaded by the sea, for we were still between 6000 and 7000 feet above sea-level. On the right, beyond the lake, conical hills, often nicked at the summit, with long ridges radiating from them, rose in strong contrast to the more ancient rocks of the northern slopes, and suggested plainly by their geographical outline a volcanic region which had been so recently active that there had not yet been time for its distinctive features to have been obliterated.

Soon we wound our way round the north-western end of the lake, and found that we had to cross its principal outlet, and then immediately descend rapidly into the valley of the Araxes. Here, then, we might hope to see some reason for this strange holding up of such a vast body of water on the edge of the mountain land.

As we turned round to the right beyond the little village of Elenofka we found the passage barred by long moraine-like ridges. We had just seen snow-covered summits and glaciers in the Caucasus, a little further north, and moraines, telling of the former much greater extension of those glaciers. We asked ourselves whether similar conditions might not have produced glaciers and moraines here also on the slopes of the Armenian mountains? But when we reached the first of the ridges we found that it was not a moraine at all, but a lava-flow with scoriaceous surface and more solid rock within. The stream with its equalised flow had cut but a very small gap in these barriers, one after another of which had been thrown forward, and had built up a mass which, from the physical geography of the country, we inferred must be thousands of feet in thickness. What the depth of Lake Gokcha was we were not able to ascertain, but it runs for forty-three miles along the base of the mountains and widens out in places to a breadth of twenty miles. To save room our diagram (Fig. 1) is taken across the narrow western end, so that it does not indicate the proportion this enormous body of water bears to the size of the valley

below. Should that lake by any great shock be suddenly let out—not an improbable catastrophe—what a terrible deluge would sweep the plain of the Araxes ; and, if the lake were wholly or partly drained, what a history of the gradual heaping up of waters on the flanks of an active volcanic region might be studied in its depths.

Here we saw not a mountain valley dammed, but the whole foot of a mountain region enclosed by volcanic

FIG. 1.—Diagram to explain the mode of occurrence and origin of Lake Gokcha.

ejectamenta having their origin along a belt of country lying a little off and in front of the high ground. From this the inference is obvious that the outlet was not always where we crossed it, and we were therefore prepared to find here and there curious conditions of the rock pointing to a different line of exit for the percolating and overflowing water.

What struck us most in examining the outflowing stream at Elenofka was its very small volume considering the extent of the lake that feeds it, and we could see no evidence of any considerable difference of level between the late summer's flow and the winter's flood waters. The stream filled its channel up to its reedy green bank, and no bare beds of sand and gravel or heaps of torrent débris suggested that it ever rose any higher. Perhaps when the waters do rise, they find their way through broken or scoriaceous rock to other outlets.

Driving on through ridge and tumbled crag of brown and black cindery rock—the great barrier of lava that holds back the lake—we suddenly came to the southern flank. We looked out through an opening in the lava over the rich valley of the Araxes, and first caught sight of Ararat rising grandly alone into the soft southern sky. Distance did not dwarf its 17,000 feet ; but whether it was active at the same time that the Elinofka volcanoes were locking up Lake Gokcha, I cannot say. Perpetual snow now covers this hill of ancient fires. There it has stood for ages, looking down on the region where tradition carries us back to the earliest homes of civilised man.

As we descended from the great masses of lava around Lake Gokcha, we suddenly came upon a most interesting and suggestive section, where the road winds under a cliff, partly natural and partly cut back for the road itself, so as to exhibit now a face of newly-bared rock. In this we saw alternations of dark green or brown-black obsidian, and a white product of decomposition of volcanic rock standing in vertical planes (see Fig. 2). The white rock is, especially in the upper part of the cliff, apt to be broken up into a kind of breccia made up of pieces of all sizes and shapes. The first impression produced by the section would be that it consisted of a number of bands of obsidian alternating with a coarse agglomerate of fragments of one and the same kind of decomposed igneous rock, and all turned on end by subsequent movement. But an examination of the ground soon showed that view to be untenable, because the section was cut through the terminal margin of a lava-flow which had come down from the great volcanic group forming the southern rim of Lake Gokcha (see Fig. 3, in which the arrow indicates the direction of flow). The obsidian bands are therefore at right angles to the bedding.

Another view was therefore suggested, namely, that the obsidian was injected or found its way along vertical fissures in the crushed and brecciated rock of an earlier flow. But had this been so, there seemed no reason to limit the injection to the vertical planes. The molten liquid mass would have penetrated in all directions through the fractured rock. Besides, an examination of the rock in detail showed that the obsidian was not injected, for it occurred in isolated masses in the midst of the white porcelanous or powdery rock. The plates assumed a fan-shaped arrangement in places, as if their position had been determined by joints converging down-

FIG. .

wards. The mode of occurrence of the rock suggested the true explanation of the phenomenon. The white rock was decomposed obsidian. The whole mass was a quickly cooled lava traversed by shrinkage joints at right angles to the cooling surfaces, and roughly parallel to the line of flow. Water followed the cracks, acted on the silicates, and changed the glassy lava to the white chalk-like mass in which bands of obsidian, preserved between the joints, still remained samples of what the whole rock once was.

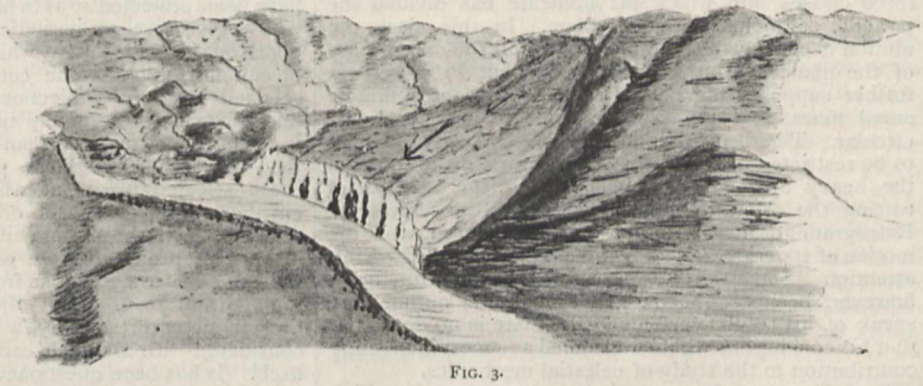


FIG. 3.

A similar change may be observed at Obsidian Cliff in the Yellowstone Park in America, where the same alternation of bands of decomposed and sound obsidian may be seen as in the Armenian section, though not on such an extensive scale. The same process picks out by decomposition the spheroidal shells, which are

invisible in the sound part. An analogous process may also be seen in the grand cañon of the Yellowstone River, where the rhyolites have been weathered into a white or yellowish, mealy-textured rock along the great fissure, which allowed a freer passage to, and still emits, in diminished quantities at the bottom of the gorge, heated water and steam from the dying-out volcanic furnace below.

So along the Armenian lava-flow water easily got in from the surface, or followed the longitudinal cracks in the rapidly cooled rock, and, being itself heated by the process, acted upon the silicates, and carried off the more soluble portions. A diminution in volume accompanied the process, and the reduced rock broke up.

May be the old valley down which this lava flowed was an ancient outfall of Lake Gokcha before its rim had been built up as high as it now stands. Perhaps at one time some of the water of the lake found its way through fissured masses to lower levels, and carried on the work of destruction within the rock itself.

We want many more facts respecting this most interesting district—we would like to know the depth of the lake, the direction of any observed lines of fissure, and if there is any evidence of the waters of the lake having ever been suddenly drained off into the valley of the Araxes. We hope, therefore, that Mr. Loewinson Lessing, whose knowledge and skilful arrangements enabled us to see so much of the district, and whose courtesy and thoughtfulness made our excursion so pleasant, may be able to carry on the work for which he is so well qualified, and will communicate to the world the result of his further investigations.

T. MCKENNY HUGHES.

PERIODIC ORBITS.

FOR some years past, Prof. G. H. Darwin has been engaged on the numerical solution of a particular case of the problem of three bodies, and at different times he has given some account of the progress he has made. He has now collected his very extensive material, relating to both the mathematical methods employed and the discussion of the numerical results, into one compact summary under the title of "Periodic Orbits," which appears in *Acta Mathematica*, vol. xxi. The special case treated by Prof. Darwin refers to one of three classes into which M. Poincaré has divided the periodic solutions of this problem. In this class, the motion is entirely in two dimensions, and the excentricity of the planet's orbit is very small; but Prof. Darwin further supposes the perturbed body to have infinitely small mass, and the planet's orbit to be absolutely circular. The discussion of even this one class has had to be restricted in the course of the work, on account of the heavy arithmetical labour which the method of tracing the orbits by mechanical quadratures involved. Retrograde orbits have not been considered, and the motion of superior planets is still engaging Prof. Darwin's attention. Some thirty examples of periodic orbits have, however, been examined; and though the author may speak of his results very modestly, there is no doubt but that his conclusions will be welcomed as a most interesting contribution to the study of celestial mechanics.

Prof. Darwin defines a periodic orbit as one in which a third body can continually revolve so as always to present the same character relative to the two other bodies of the system. These orbits are not necessarily confined to a single revolution round the primaries, or round any other point in space, but the difficulty of the determination of the path increases with the number of circuits described, and on that ground the present treatise is confined to the examination of "simple periodic orbits," or those which are re-entrant after a single circuit, though loops may, and do, occur in the orbit. In the system considered, the distance between the sun and the principal planet, here called Jove, is taken as unity, and the ratio of the mass of the sun to that of the planet as 10 : 1. This hypothesis differs considerably from the actual circumstances prevailing in our system, but it offers the advantage of exaggerating all the phenomena of perturbation, and permits the clear exhibition of the deductions in diagrams that are easily appreciated. Some of the stellar systems may offer conditions more nearly parallel to those here assumed. A looped orbit has been suggested in the case of one of the components of ζ Cancri, though possibly with insufficient data, and in some other cases, the presence of a disturbing body seems likely to produce an orbit of very irregular form.

We have accustomed ourselves to consider the relations of superior and inferior planets and of satellites to be fixed and definite, but Prof. Darwin traces the conditions under which these forms cease to be permanent, and when consequently the third body of a system can assume the characteristic motion of either an inferior planet or a satellite. With a particular value for the constant of relative energy, it is possible for both kinds of planetary and satellite motion to become confused, and for a body which originally started in one way to exhibit the peculiar motion of either of the other two. Prof. Darwin began his numerical work by an assumed case in which it was possible for an inferior planet and satellite to interchange their parts. The satellite was made to start at right angles to a line joining the sun and Jove, at a distance of 1·08 from the sun, Jove's distance being unity. The resulting orbit is fully drawn and shows how the body hangs in the balance, between the two centres, before the elliptic form of the orbit asserts itself, as the body approaches the sun. Starting the satellite from a conjunction remote from the sun, but at slightly different distances from Jove, it is found that the resulting orbits show a great diversity of character, which cannot always be foreseen. Perhaps the most remarkable curve in this family arises when the satellite starts at a point 1·095 from the sun. After making a loop, the satellite recrosses the line of conjunction and moves directly towards the planet, so that it is impossible to determine its subsequent path without very accurate computation. "I do not think," says Prof. Darwin, "any one could have conjectured how the body should have been projected so as to fall into Jove." The positions which give rise to periodic orbits are shown by the distances from the sun at which the curve meets the line of conjunction after one complete circuit. If for two selected points of projection, the curve returns to this line at places alternately nearer to and more remote from the sun than those from which it originally started, then there must be some point intermediate between these selected points at which the curve will be re-entrant. Other forms of orbits giving rise to distinct families, have been computed, and drawn, when the satellite is projected from points intermediate between the sun and Jove, and also from conjunction on the side remote from Jove. Most of these orbits do not possess the character of stability, a point which the author has considered with as much care as the form of the orbit itself. It has been questioned whether all orbits are not essentially unstable, if the number of revolutions be sufficiently great. The result of the present investigation is to show that orbits may be stable if the perturbation of Jove by the planet can be neglected. This is the only approximation that Prof. Darwin has permitted himself, and he remarks "that for a very small planet the instability must accordingly be a very slow process, and I cannot but believe that the whole history of a planetary system may be comprised in the interval required for the instability to render itself manifest."

WOLDEMAR VON SCHRÖDER.

HEIDELBERG has had to mourn the loss in rapid succession of three of its most distinguished professors—Victor Meyer, Erwin Rohde and, on January 28 of this year, Woldemar von Schröder.

Schröder was born at Dorpat in 1850, where his father was director of the Gymnasium. On his mother's side he inherited a taste for literature and poetry, but on entering the University at Dorpat, in 1868, he devoted himself to the natural sciences, possibly influenced thereto by his uncle, von Schrenk (of St. Petersburg), who was celebrated for his journeys and researches in Siberia. At first he studied chiefly chemistry and physics under Karl Schmidt and Arthur von Oettingen, and trained himself under Lemberg to that high pitch of analytical skill which he manifested in all his later work. After a break in his studies, due to persistent pains in the head and trouble with his eyes, he again returned to work; now, however, turning his attention rather into a biological direction. In 1878 he left Dorpat with the degree of Master of Chemistry, and went to Leipzig, where he was at once attracted by the striking originality and personality of Karl Ludwig, and in his laboratory saw for the first time the perfection of physiological experimenting. But Schröder was one of the few who were not content to learn by merely assisting Ludwig in personally carrying out all the experiments, and he struck out into paths of his own. Skilled as a chemist, he soon became an expert operator, and succeeded for the first time in successfully extirpating the kidney in birds, and thus settling a most important question as to the seat of formation of uric acid. In 1879 he became assistant to Schmiedeberg in Strassburg, and here it was that he carried out the great research with which his name will for all time be connected in the annals of physiology. Very little was at that time known as to the mode and seat of formation of urea, and Schröder threw a flood of light into the darkness. Having by extirpation of the kidneys, and artificial circulation through the excised organs, proved that urea is not formed by them, he next carried on an artificial circulation of blood containing ammonium carbonate through the muscles, and found that in them also no synthetic formation of urea takes place. He now turned to the liver and, again making use of artificial circulation, proved without any possibility of doubt the power of this organ to actively synthetise urea from ammonium carbonate and from certain substances present in the blood from an animal in full digestion. This was a great work, for not only did it reveal clearly a striking instance of synthetic activity in the animal organism, and thus place our belief in the fundamental similarity of plants and animal protoplasm on a firm basis, but it fixed definitely one seat of formation of urea in the animal body. In recognition of this work he received the degree of Doctor from the Natural Science Faculty of Tübingen in 1882, and similarly, and in the same year, he was made a Doctor at Strassburg, where he became Privat-docent in 1883. For this he wrote his inaugural dissertation on the alkaloids of opium, and thus diverged into that branch of science, pharmacology, which was henceforth to be the business of his life. During the next few years his chief works were on the physiological action of caffeine and of theobromine as related to caffeine, while at the same time he converted theobromine into a more soluble and assimilable compound, making it thus available for medicinal purposes. In 1890 Schröder was called to Heidelberg as Professor of Pharmacology, and he it was who really founded the existing Pharmacological Institute, turning the older accommodation to the best account, utilising or enlarging every corner of it, and completely remodelling and organising the teaching. Here he worked until his death, stimulating his pupils by his personal example and collaboration, brightening their labours by his sympathetic and genial ways, and impressing on all the right spirit of scientific life.

THE KEKULÉ MEMORIAL.

THE death of August Kekulé on February 13, 1897, terminated a career rich in scientific achievement. In him we have lost an investigator who has exerted a profound influence on the development of chemistry.

The theory of valency and of the linking of atoms, and our present views as to the structure of carbon compounds, have acquired their definite form and clearness by the labours of Kekulé. His theory of benzene derivatives, in particular, has given the most powerful impulse to investigation in the domain of pure chemistry; while no scientific theory has done more to promote the development of chemistry as a branch of industry. While Kekulé is eminent by his scientific achievements, he is not less so by reason of the effects produced by his teaching. The publication of his "Lehrbuch der Organischen Chemie" marked an epoch in the history of chemistry. This treatise has done more to familiarise chemists with modern views than any other work of the kind.

The greater number of German professors of chemistry, and many of those in other countries, have either studied under Kekulé or under those who were his pupils: and gratitude calls for the erection of some permanent memorial of his striking personality.

Such a memorial would be a statue in bronze of the founder of structural chemistry, which would be fitly placed in front of the Chemical Institute at Bonn—in the place where for thirty years he lived and taught and worked.

All friends, admirers and pupils of Kekulé are accordingly invited to contribute to this object. Subscriptions, which will be forwarded to the Central Committee at Bonn, will be received by Dr. Hugo Müller, 13 Park Square East, Regent's Park, N.W.

JAMES DEWAR.	HUGO MÜLLER.
G. CAREY FOSTER.	FRANCIS R. JAPP.
T. E. THORPE.	RAPHAEL MELDOLA.

NOTES.

ACTING under the rule which empowers the annual election by the Committee of nine persons "of distinguished eminence in science, literature, the arts, or for public services," the Committee have just elected Viscount Dillon (president of the Society of Antiquaries), Mr. R. T. Glazebrook, F.R.S., and Sir George Scott Robertson into the Club.

THE meeting for the discussion of the scientific advantages of an Antarctic expedition takes place at the Royal Society this afternoon. We purpose giving a full account of the meeting in next week's NATURE, accompanied by a map showing all known land south of latitude 45° S., with drift and pack ice limits, so far as known, and the positions and dates of the highest latitudes reached.

THE Berlin correspondent of the *Standard* reports that the German Antarctic Expedition Committee, which met at Leipzig on Saturday last, unanimously resolved, after a long discussion, to advocate the despatch of a ship towards the South Pole on or near the meridian of the island of Kerguelen. Oceanic, geodetic, and biological researches are to be made during the voyage, and, if possible, the expedition will winter in the Antarctic zone. In that case geological observations are to be made at a fixed station, and exploring journeys on the inland

ice and to the unknown west coast of Victoria Land, discovered by Sir James Clark Ross, will be undertaken in the spring. The return of the expedition, which will last two years in all, and will make observations on the home voyage as well as on the way out, will take place in the southern autumn. Dr. Erich von Drygalski, well known as an explorer of Greenland, was appointed the scientific head of the expedition.

LORD LISTER is suffering from a severe cold, and was prevented by it from occupying the chair at Dr. Nansen's lecture on Monday.

WE are glad to see the announcement that Sir Richard Quain's strength has so far improved that no further official bulletins will be issued.

THE Pasteur Institute at Paris has received a donation of 1600*l.* from Mme. E. Durand, for the purpose of carrying on investigations on tuberculosis.

THE personal estate of the late Mr. J. W. Zambra, formerly of the firm of Negretti and Zambra, the well-known philosophical instrument makers, has been valued at 176,075*l.*

THE fifth International Congress of Hydrology, Climatology, and Geology will be held at Liége this year, from September 25 to October 1, under the patronage of His Royal Highness Prince Albert of Belgium.

THE Physical Society of Frankfort-on-Main propose to erect a monument to Philipp Reis, the inventor of the telephone, and have appointed a committee to obtain subscriptions for this purpose. The estimated cost of the memorial is 1500*l.*

THE fourteenth International Horticultural Exhibition is to be held at Ghent from April 16 to April 24 next. This exhibition, which takes place every five years, is organised and managed by the Royal Society of Agriculture and Botany at Ghent. It is under the patronage of the King and Queen of Belgium, and is subsidised by the national, provincial, and municipal Governments.

H.R.H. THE PRINCE OF WALES has consented to open the International Photographic Exhibition at the Crystal Palace on Monday, April 25, and not Wednesday, April 27, as originally announced. The latest date for the reception of exhibits in each section will therefore be two days earlier than that first stated on the prospectus.

AT the meeting of the Physical Society of London, to be held at Eton College on Saturday, February 26, the Rev. T. C. Porter will exhibit and describe several interesting experiments. The subjects with which he will deal are: (1) a new theory of geysers; (2) a new method of viewing Newton's rings; (3) experiments bearing on the sensation of light; (4) a method of viewing lantern projections in stereoscopic relief; (5) winter observations on the shadow of El Teide, with a new method for measuring approximately the diameter of the earth; (6) temperature of the water of Niagara.

THE death of M. Gauthier-Villars was referred to, with expressions of regret, at the meeting of the Paris Academy of Sciences on February 7. Since 1835 the *Comptes rendus* of the Academy have been printed by the firm of Gauthier-Villars, and, in spite of the large quantity of matter on a variety of subjects, and the idosyncrasies of authors, the hour of publication has never been delayed. The firm has published for many years the publications of the Bureau des Longitudes, those of the Paris Observatory, and of the Bureau Central météorologique. M. Gauthier-Villars also assisted the French Government and the Academy in the publication of the complete works of Lagrange, Fermat, Fourier and Cauchy, and his name is associated with many other scientific enterprises.

THE anniversary meeting of the Geological Society was held on Friday last. Mr. W. Whitaker, F.R.S., was elected president in succession to Dr. H. Hicks, F.R.S., whose presidential address appears in another part of the present issue. The new vice-presidents elected are Prof. J. W. Judd, C.B., F.R.S., and the Rev. H. H. Winwood. Prof. W. W. Watts has succeeded Mr. J. E. Marr, F.R.S., as secretary, the other secretary being Mr. R. S. Herries. To the list of members of Council were added the names of Dr. G. J. Hinde, F.R.S., Mr. W. H. Hudleston, F.R.S., Prof. H. G. Seeley, F.R.S., Prof. W. J. Sollas, F.R.S., and Mr. A. S. Woodward. The medals and prize-funds were awarded to the geologists whose names have already been announced (p. 252).

SURGEON-MAJOR BLACK, Edinburgh, has received a letter from Mr. C. L. Wragge, dated Sydney, January 7, referring to a new high-level meteorological station. In the course of the letter Mr. Wragge says:—"You will be pleased to know that I have quite successfully established a mountain experimental observatory on the summit of Mount Kosciusko 7328 feet above sea-level, and the highest point in all Australia; also a sea-level station on the south-east coast adjacent at Merimbula, where simultaneous observations are taken. The hours are midnight, 4 a.m. and 8 a.m.; noon, 4 p.m. and 8 p.m.; also half-hourly from 8.30 a.m. to 11.30 a.m. inclusive. Simultaneous readings are also taken at a new station in Sydney, at Sale in Victoria, and at Hobart, and on Mount Wellington, Tasmania."

THE meeting, held in the rooms of the Manchester Literary and Philosophical Society on February 16, to consider what should be done to assist in making the forthcoming Congress of Zoology a success, was well attended by representatives of various natural history and scientific societies in the centre and north of England. Mr. J. Cosmo Melvill presided. Prof. S. J. Hickson explained to the meeting the objects of the International Congress of Zoology and the probable programme of the week in August at Cambridge. The following resolution was then proposed by Mr. Masefield, president of the Conchological Society, and carried unanimously:—"That this meeting of persons resident in the centre and north of England, and interested in zoological progress, offers its most cordial support to the Committee now organising the fourth meeting of the International Congress of Zoology, to be held in Cambridge in the last week of August, and expresses a sincere hope that all societies instituted for the study of zoology and kindred subjects will contribute in accordance with their means to the funds of the Congress, and appoint one or more representatives from their members to attend the Congress." The delegates at the meeting were enthusiastic about the Congress, and their cordial co-operation will encourage as well as assist directly the work of the Executive Committee.

AT its annual meeting on February 2, the Russian Geographical Society awarded a special Constantine medal to Dr. Nansen; a Constantine medal to V. I. Roborovsky, for his journeys in Central Asia; the Count Lütke's medal to I. I. Strelbitzky, for his journeys in Persia and Manchuria in 1891–96; the new Semenoff's medal to Dr. Sven Hedin, for his three years' journeys in Central Asia. A large gold medal of the Society was awarded to I. K. Zhdanoff, for his ethnographical works, and especially for his work on "Russian Epical Poetry"; and small gold medals to Th. Witram, for pendulum measurements in the Far East; to F. Sperck, for his large work on the climate of the Astrakhan region; to S. Rybakoff, for the collection of specimens of musical texts of songs amongst the Ural natives; and to S. Gulishambaroff, for his work "The World's Trade in the Nineteenth Century and Russia's Part in it." Silver medals were awarded to MM. Pastukhoff, for his ascension of the Elbrus; Abels, for hypsometrical measurements in the Urals;

B. A. Fedchenko, for a communication on the Talas Alatau; Timonoff, for a paper on the water-communications on the tributaries of the Amur; Sapozhnikoff, for work on the glaciers of the Altai; Kovanko and Semkovskiy, for the organisation of international balloon ascensions in which the Society took a part; and to Prince Obolensky, Tomilovskiy and Utyesheff, for their daily observations upon the motion of the clouds.

MR. LEONHARD STEJNEGER, of the U.S. National Museum, paid another visit to the Russian Fur-seal Islands (Commander Islands) in the Northern Pacific, last year, by order of the U.S. Government, and has just issued his report (Treasury Department, Document No. 1997). The examination of the "Rookeries" was made mostly in company with one of the British Commissioners, Mr. Barrett-Hamilton, and appears to have been a work of some difficulty and danger, owing to the wild weather generally prevalent, and the utter absence of means of communication. Mr. Stejneger's general conclusions demonstrate "a very great decrease in the breeding females" of the Fur-seals since 1895, when he made his last official report (U.S. Fish-Commission, *Bulletin* for 1896, Article 1). He also alleges "great mortality in the pups, due to starvation." He comes finally to the conclusion that a *zapuska*, or total prohibition of killing seals on land for a period of years (which he formerly advocated), would be rather an injury than a help to the seal-herds, as it would "increase the number of superfluous bulls."

SINCE he succeeded Sir Harry Johnston as Commissioner and Consul-General of Nyasaland, Mr. Alfred Sharpe has not ceased in the good work carried on so long by his former chief, of collecting and sending home examples of the fauna and flora of that Protectorate. Mr. Sharpe is now on his way home on leave, much impaired in health, we regret to say, from his long stay in the tropics, but brings more collections with him. A memoir, by Mr. Thomas, on the mammals procured by Mr. Sharpe, will appear in the next part of the Zoological Society's *Proceedings*, and Captain Shelley is at work on the birds obtained by this energetic administrator.

THE colonial report on "Cocos-keeling and Christmas Islands," 1897 (c.-8650-14) contains a few useful natural history and other notes. A small brilliant red crab is frequently seen up the hills, running in and out of holes or from under stones. Once a year, in the month of December or January, the male and female travel down to the sea margin, where the female deposits her eggs, and the parents again return. They take fifteen days going and fifteen days returning, and travel in bodies like ants. After the eggs are hatched, the young, when big enough, move up the hill. Darwin doubted whether the crab climbed trees; but it is now a well-ascertained fact, though the purpose is still unknown. Both Mr. Forbes and the reports of H.M.S. *Challenger* describe the white tern or noddy as a beautiful bird with black eyes; but no mention is made of the beautiful purple-blue of the beak up to the nostril, the feet and the tarsus. This is probably due to the fact that two or three hours after the birds are shot the colour of the beak and feet die away. A short description of three native dances is also given.

PROF. J. C. EWART, F.R.S., contributes to the *Zoologist* an illustrated article upon zebra-horse hybrids. His experiments prove that it is a comparatively simple matter to cross various breeds of mares with a Burchell Zebra, and, if experts are to be trusted, the hybrids promise to be as useful and hardy as they are shapely and attractive. The preliminary difficulties having been overcome, Prof. Ewart points out that it remains for those in authority to take such steps as may be necessary to ascertain of what special use, if any, zebra hybrids may be in the various parts of the Empire, but more especially in Africa and India.

A SNOWSTORM of considerable severity occurred over the south-western districts of England during Monday night, the snow gathering to a considerable depth in places, and causing much inconvenience and delay to ordinary traffic. In parts of Devon, Somerset and Dorset, the drifts were several feet deep. At Hurst Castle, Hants, a reporting station of the Meteorological Office, the melted snow and sleet measured 1·6 inches of water. Thunder and lightning were also experienced during the storm. This disturbed weather was occasioned by the arrival of a shallow cyclonic area over the south-western portion of our islands, which lingered in those parts during Monday and Tuesday.

THE U.S. *Monthly Weather Review* for November last contains an account of the celebration of the fiftieth anniversary of the establishment of the Royal Meteorological Institute in Berlin, on October 16, 1897. The jubilee festivities were divided into three parts: an address in the Memorial Hall of the Royal Geodetic Institute, an inspection of the magnetic and meteorological observatories of the Institute, and a banquet. The high recognition given in Germany to meteorological science was evidenced by the presence of the Emperor and Empress, who were accompanied by a brilliant retinue, and listened to the address of Dr. v. Bezold, the Director, who sketched the activity of the institution during the whole period of its existence. At the present time the organisation consists of 188 stations for regular observations, 1336 thunderstorm stations, and 1844 rainfall stations. Various experimental investigations are conducted at the Potsdam Observatory, and, owing to the generosity of the Emperor, scientific balloon ascents on a large scale are occasionally made for the study of the physics of the upper air. At the close of the address, the Minister of Education announced certain decorations to be given in connection with the celebration. The great gold medal in science was presented to Dr. v. Bezold, and Orders of the Crown or of the Red Eagle were presented to Dr. Hellmann, Dr. Sprung, Dr. Vogel, and to Herr Treitschke, proprietor of the observatory on the Inselsberg, near Erfurt, and to various other scientific men. Numerous addresses and telegrams of congratulation were received from all parts, including one from the Grand Duke Constantine, on the part of the Imperial Russian Academy of Sciences.

IN his "Twelfth and Concluding Memoir on the Theory of Screws," published in the *Transactions of the Royal Irish Academy*, Sir Robert Ball completes the solution of a problem which has for the past five-and-twenty years been associated with his name. A feature of his paper is the series of summaries of this and the eleven preceding memoirs, and we feel that we can do no better than quote in his own words Sir Robert Ball's summary of his latest investigation: "At last I succeeded in accomplishing what I had attempted from the first. I could not develop the complete theory, which I felt certain must exist, until I had obtained a geometrical method for finding the instantaneous screw from the impulsive screw. When this was accomplished in the midsummer of 1897, the geometrical theory in Dynamics, which I had striven for a quarter of a century to obtain, was at last manifest. How my difficulties were overcome has been set forth in this Memoir. There are, no doubt, many other questions that would repay investigation at almost every stage of the subject. But the problem which I had proposed to myself so many years ago, and which I have steadily kept in view ever since, having been at last resolved, I have felt that this series of papers should cease."

MR. E. CHARLES HORRELL, writing in the *Journal of Botany* for February, invites the co-operation of bryologists in working out the comital distribution of British mosses in the way that the distribution of flowering plants was done by Watson. With the object of eing how far the lists of mosses already published

would enable him to compile a census of the 112 Watsonian vice-counties, the writer has looked through most of the magazines, county floras, proceedings of local natural history societies, the Botanical Record Club's Reports, &c., in the library of the British Museum, and he finds that fairly good lists have been published for about fifty vice-counties; there are, therefore, about sixty-two vice-counties in Great Britain for which he can find no lists of the commoner mosses. Mr. Horrell has already received lists or offers of assistance from correspondents in about thirty-four vice-counties, but would much like to find a moss student in each vice-county who would undertake to prepare a list of his district during the next two or three years. Mr. H. N. Dixon and Mr. E. M. Holmes have offered their aid in examining doubtful or critical species. Mr. Horrell's address is 44 Brompton Square, London, S.W.

IN a contribution to the *Transactions* of the Nova Scotia Institute of Science, ix., Mr. E. H. Archibald describes a series of determinations, made at Dalhousie College, of the conductivity of aqueous solutions containing potassium and sodium sulphates. The object was to ascertain if the conductivity was calculable in the case of mixtures of these solutions from the formulæ given by the dissociation theory of Arrhenius and others. It would appear that for mixtures of solutions of these salts, not more concentrated than 0·8 equivalent gramme-molecules per litre, it is possible by the aid of the dissociation theory to compute the conductivity within, or but little beyond, the limits of the error of observation. For more concentrated solutions the differences between the calculated and observed conductivities ranged up to 1·47 per cent.; but this discrepancy seems attributable, in part at least, to certain asssumptions regarding the ionisation-coefficients, which could not be regarded as rigorously correct, except at infinite dilution.

MESSRS. MACMILLAN AND CO. will publish in a few days the first volume of a comprehensive treatise on "Magnetism and Electricity," by Prof. Andrew Gray, F.R.S. In this work an attempt has been made to present the subject from the beginning from the point of view of action in a medium, and to bring the experimental and theoretical results described as far as possible down to date. The present volume, though it takes for granted a knowledge of some of the most elementary phenomena and apparatus, aims at giving an account of experimental work as well as of the related magnetic or electric theory. It includes the ordinary phenomena of magnetism and their theory, a discussion of electrostatics and of steady flow of electricity, of electromagnetism and of the electromagnetic theory of light. The treatment is as far as possible dynamical, and to facilitate reference to dynamical theorems, a chapter on general dynamics has been included in this first volume. In Volume ii. will be given, among other matters, an account of experimental work on magnetism, of recent work on Hertzian, Röntgen, and other radiations, and of general dynamical theories of electromagnetic action, a continuation of the discussion of the voltaic cell begun in Volume i., and a chapter on electrolysis.

THE Mexican Scientific Society, which is called "Antonio Alzate," is doing excellent work, to judge from the recent numbers of its *Memorias* which have reached us. Among other papers we find seismic observations at Orizaba, by M. C. Mottl; physico-chemical studies on the fat of the Yoyote shrub (*Thevetia yecotli*), by Prof. Villaseñor; on the decimalisation of the circle and of time, by M. J. de Mendizábal-Tamborrel; on the concentration of auriferous and argentiferous minerals, by T. L. Laguerenne; on the augmentation of weight of tuberculous and anæmic patients in rarefied air, by Dr. D. Vergara Lope; studies on the transpiration of Mexican plants, by Prof. L. G. Seurat; on the syrup of iodide of iron, by Prof. F. Solórzano; on orogenic movements, by M. P. C. Sánchez; on the temperature of plants, by MM. Moreno and Anda; measurement of the tension of the blood of the dog, by Dr. D. Vergara Lope; and formulæ for the velocities and pressures in guns, by M. F. Angeles; as well as reviews of books, &c. The Society, besides publishing these *Memorias* in a convenient size for binding up with the majority of octavo scientific papers, has adopted the excellent plan of beginning each paper on a right-hand page; any specialist can thus bind up separate papers on selected subjects without impairing the rest.

A RECENT number of the *Cape of Good Hope Agricultural Journal* contains an article on "The serum method of treating cattle as a preventive of rinderpest in South Africa," in which the joint report of the French experts and the Government Veterinarian is given *in extenso*. It contains rules for the application of the method of treating cattle by the injection of protecting blood, and attention is called to the importance of procuring the blood from animals which have suffered from rinderpest in its most severe form, and which have been "salted" or rendered immune to the disease one to five months previously, and have received at least one injection of rinderpest blood. It is urged that general measures should be taken throughout the whole of South Africa to prevent the spread of rinderpest, the protective measures already adopted by the Governments of the South African Republic, Orange Free State, and the Cape Colony have had some good effect, but it is feared that unless further and more vigorous steps are taken, the epidemic will conquer the whole of South Africa. If we consider that it was in the beginning of the year 1896 that rinderpest first made its appearance in Matabeleland and Mashonaland, and in less than eighteen months had destroyed all the cattle of these two countries, and had also overwhelmed the territory of the South African Republic and the Orange Free State, the necessity for united and strong action appears sufficiently imperative. It is at present, the report tells us, spreading from north to south, and from east to west, and seriously threatens the herds of the Cape Colony, Basutoland, Natal, and Zululand. As regards the subsequent use of the carcases of rinderpest animals, the consensus of opinion appears to deprecate as unsafe the practice of simply salting and drying rinderpest oxen hides, whilst it is also stated that the farmer cannot be trusted to convert fat into soap without risk of accidentally spreading the disease.

THE Kekulé Memorial Lecture, delivered before the Chemical Society on December 15 (see p. 180), by Prof. F. R. Japp, F.R.S., is published, with a portrait of Kekulé, in the February issue of the Society's *Journal*.

UNDER the title of "A Visit to Giessen; or, Thoughts on Liebig and Chemistry in Germany," Prof. Senier, of Queen's College, Galway, recently delivered a lecture. The lecture has now been published by Mr. Edward Ponsonby, Dublin, and it makes a very interesting pamphlet on Liebig and his work.

THE second part (for February 1898) of the monthly *Journal of Applied Microscopy*, published by the Bausch and Lomb Optical Company, Rochester, N.Y., contains a full account, with illustrations, of the very extensive and complete laboratories connected with Cornell University, viz. those for botany, microscopy, histology, embryology, bacteriology, and pathology.

THREE well-arranged catalogues of works on various branches of the mathematical and physical sciences have just been issued by Messrs. William Wesley and Son. The catalogues include works from the libraries of the Rev. A. Freeman, Dr. Albert Marth, and Dr. Hind. Rare and valuable memoirs and books are enumerated in the lists, and the scientific bibliophile who consults the catalogues will be repaid for his trouble.

THE results of meteorological observations made at Bangalore, Mysore, Hassan, and Chitaldrug, under the direction of Mr. J.

Cook, during 1896, has just been issued from the Mysore Government Central Press. In addition to meteorological statistics, the volume contains several plates, upon which the observations are represented graphically. The Report of the Meteorological Service of Canada for the year 1890 was also received a few days ago, together with a report on the observations made during 1895. Both of these reports are almost completely taken up with rows of figures referring to the meteorology of the Dominion.

THE Manchester Museum, Owens College, has just published, as a museum handbook, Parts ii. and iii. of a Catalogue of the Hadfield Collection of Shells from the Loyalty Islands. Since the first part of the catalogue was published, further consignments of shells have been received at the museum, the number of species recorded being thus increased from 630 to 860. The complete catalogue should be of considerable value to conchologists, as the collection of shells described in it is the largest and most important that has been received in this country from the Loyalty Islands.

THE first number of the thirty-second volume of the *American Naturalist* marks the issue of the magazine in a new and more attractive form. It is the purpose of the editors to make the periodical a means of encouraging the movement towards a closer union of the natural sciences. Superficial observations and poorly-grounded speculations are not to be published in its pages, but only articles and other contributions which have significance from various points of view. This ideal is a commendable one, and it remains for American naturalists to help the journal to attain it.

THE current number of the *Journal of the Royal Microscopical Society* (published bi-monthly on the third Wednesday in February, April, June, August, October and December) contains the tenth and concluding part of Mr. F. Chapman's very important account of the Foraminifera of the Gault of Folkstone. The greater part of the number is, as usual, occupied by the summary of recent researches in zoology, botany, and microscopy (structural and applied). The object aimed at is to give a brief abstract of every important paper (not purely systematic) in these departments of science, each section being under the care of a specialist sub-editor. The paragraphs on bacteriology are especially full and complete.

UNDER the title of the "Universal Lamp Time Chart," Mr. D. E. Benson, of Southport, is publishing an accurate and ingenious chart, constructed by Mr. G. Napier Clarke and himself, to show graphically the time at which cyclists must light up on any day of the month in any part of the British Isles. Separate charts are required for each month, and also for England and Wales, Scotland and Ireland; but though this will probably prevent the charts from being widely used, the idea of representing by a graphic construction the times for lighting and extinguishing lamps in different latitudes and longitudes in the British Isles is so good, that the authors deserve encouragement. Another publication in which those of our readers who ride cycles will be interested is "The Cyclist's Pocket Book" (Archibald Constable and Co.). The book contains a large amount of useful information and memoranda on the practice of cycling, and a few hints on the initial treatment of the commoner casualities to which cyclists are liable.

THE additions to the Zoological Society's Gardens during the past week include two Australian Sheldrakes (*Tadorna tadornoides*) from Australia, two Chinese Quails (*Coturnix chinensis*) from China, six Pintail (*Dafila acuta*), European, purchased; a Great Kangaroo (*Macropus giganteus*), an Australian Cassowary (*Casuarius australis*) from Australia, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MARCH 1898:—

March 1. 8h. 49m. Jupiter's Sat. IV. in conjunction S. of planet.
2. 10h. 10m. to 12h. 33m. Jupiter's Sat. III. in transit.
2. 10h. 51m. to 12h. 33m. Jupiter with only one visible satellite.
2. 13h. 40m. to 14h. 36m. B.A.C. 2238 (mag. 6·5) occulted by the moon.
4. 7h. 10m. to 8h. 29m. d^1 Cancri (mag. 5·9) occulted by the moon.
4. 8h. 44m. Minimum of β Persei (Algol).
9. 11h. 12m. to 11h. 51m. q Virginis (mag. 5·7) occulted by the moon.
9. 13h. 29m. to 15h. 14m. Jupiter with only one visible satellite.
9. 13h. 29m. to 15h. 53m. Jupiter's Sat. III. in transit.
9. 14h. 12m. Jupiter's Sat. IV. in conjunction N. of planet.
13. 14h. 38m. to 15h. 49m. α Scorpii (Antares, mag. 1·1) occulted by the moon.
15. Illuminated portion of disc of Venus = 0·993.
,, ,, ,, Mars = 0·968.
16. 16h. 46m. Jupiter's Sat. III. begins transit.
16. 16h. 46m. to 16h. 58m. Jupiter with only one visible satellite.
20. Pons-Winnecke's comet due at perihelion.
21. Minor axis of Saturn's outer ring 17″·63.
24. 10h. 27m. Minimum of β Persei (Algol).
25. 12h. Jupiter in opposition to the sun.
Equatorial diameter = 44″·95.
Polar ,, = 42″13.
26. 2h. Mercury in conjunction with Venus. Mercury 1° 14′ N.
26. 9h. 24m. Near approach of 23 Tauri (mag. 4·2) to the moon.
27. 7h. 16m. Minimum of β Persei (Algol).
30. 11h. 13m. to 12h. 14m. δ Geminorum (mag. 3·7) occulted by the moon.

ANOTHER LUNAR HOAX?—From very early times the moon has frequently been selected as a suitable object upon which to exercise the imagination or base an elaborate hoax. We may remember that Hubert gravely declared to King John "that five moons were seen to-night: four fixed: and the fifth did whirl about the other four, in wondrous motion." Such rough descriptions were good enough for the times in which they were uttered; but in days of more exact knowledge, the lunar fable must be prepared with greater elaboration and decked in a more scientific garb. When this century was young, a tale obtained some credence, because it was artistically disguised, concerning what astronomers could see on the moon's surface. It was reported that Sir David Brewster and Sir John Herschel had seen a lunar forest with trees resembling "the yews grown in English churchyards," and a "lunar ocean breaking in large white billows upon the strand, while the action of very high tides was quite manifest upon the face of the cliffs for more than a hundred miles." Now, at the end of the century, comes the latest lunar myth, and it necessarily must be surrounded with still greater nicety of detail, and clothed with an accurate terminology.

The author of the alleged discovery in this instance is Dr. Georg Waltemath, an astronomer of Hamburg, and his assertion is, that there is evidence of the existence of a second moon, circling about the earth, but with such low reflective power that it has usually escaped observation even when in opposition. The author has perceived the desirability of making this hypothetical moon do a useful work in celestial mechanics, by explaining that the difference between the observed and computed secular acceleration of the moon's mean motion arises from the action of the newly discovered body. Perhaps it might also, with a little art, be made to explain the motion of the perihelion of Mercury. A new comer who is able to remove some existing difficulties, is naturally more welcome than one who might introduce fresh disturbances. Therefore the mass must not be very great, and Dr. Waltemath assigns to the new body that he has discovered or deduced, a mass of 1/80 of that of the moon, and a diameter of 700 kilometres. The distance is pu

at rather more than one million kilometres, 2·67 times the distance of the moon, and this gives the sidereal period 119·207434 days. The mean daily motion is given to the ninth decimal of a degree. We cannot say here what is sometimes said of a long row of decimals: the more figures one gives, the greater the chance for some of them being correct. The anomalistic period, too, is given with sufficient accuracy; so is the excentricity and the longitude of the node; everything, in fact, to enable an astronomer to compute the position of our new satellite. It is, of course, quite possible that Dr. Waltemath fully believes in the existence of this object. In that case we should say, he is the only person who does; for when we ask on what kind of observation does this very accurate orbit rest, we find that the author has employed that large collection either in which persons have believed that they have seen objects of doubted value transiting the sun, whether bright or dark. He seems to have trusted to those wild and reckless assertions that are made from time to time about "ruddy fireballs" or "night suns," or other vague descriptions, and on such loose and inaccurate data he has unfolded his strange and wondrous tale. This hypothetical satellite ought to have been seen transiting the sun on February 3, and, if we have correctly apprehended the author, may even yet be seen on July 30.

OCCULTATION OF CERES.—The extremely rare phenomenon of the occultation of Ceres, on November 13 last, has been observed by M. Schorr, of Hamburg, and M. Harzer, of Kiel. A note in the *Bulletin de la Société Astronomique* for February states that only the reappearance was possible to be observed, and it was noted that the increase of light during one or two seconds was gradual, and not sudden as in the case of a star.

A REMARKABLE OBJECT.—In Circular No. 46 from the Wolsingham Observatory, dated February 16, the Rev. T. E. Espin states that "a remarkable object hitherto unrecorded was discovered on January 16, and seen on three other nights. It is elliptical, one degree long, major axis 336°, and rather resembles some obscuring medium than a nebula, and is, I believe, unique." This object is situated on the northern border of Perseus adjoining the constellation of Auriga, its position being:

R.A. 4h. 26m. 0s., Decl. + 50° 44′ (1855).

VARIABLES IN STAR CLUSTERS.—Prof. Pickering, in Circular No. 24 from the Harvard College Observatory, states that "since the announcement made in Circular Nos. 2 and 18, of variables discovered in clusters, a further examination of the clusters ω Centauri, Messier 3, Messier 5, and N.G.C. 7078 has been made by Prof. Bailey. As a result, the numbers of known variables in these clusters have been increased by 62, 19, 22 and 24, respectively, making the total numbers 122, 132, 85 and 51, or 390 in all four clusters. Adding to these the 47 already announced in other clusters, makes the total number 437."

In the *Bulletin de la Société Astronomique*, M. A. Chévremont announces the discovery of a variable star upon the eastern margin of the globular cluster in Aquarius (M. 2). Whilst the stars of the cluster are of about the 15th magnitude, this new variable rises to mag. 12, at maximum, and is probably distinct from the cluster itself. It has a period of about thirty days, gradually decreasing from maximum to its minimum of mag. 14, in about fifteen days; the actual form of the light-curve is, however, only vaguely known, other observations being required to replace the hiatus of its ascent.

A LARGE REFLECTING TELESCOPE.—We learn from *Popular Science News* that another great telescope is approaching completion. In 1895 the Rev. John Peate commenced at Greenvill, Pennsylvania, the construction of a mammoth glass speculum for a reflecting telescope designed for the American University, Washington. After two years of arduous toil, Dr. Peate has given the great mirror its final touches—that is, in grinding and polishing—and it is now ready for silvering and for the further and important stage of mounting. This large disc of glass is more than 61 inches in diameter.

PARALLAXES OF STARS.—From observations made at the Cape Observatory, Dr. Gill concludes that the parallax of α Centauri certainly lies between the limits 0″·74 and 0″·75. This is equivalent to a distance of 275,000 times the radius of the earth's orbit. In the same journal (*Bulletin de la Société Astronomique*), we are informed that Dr. Gill comes to the conclusion that the parallax of Rigel is not greater than 0″·01, hence the distance of this star is certainly more than 20 million times the distance of the sun; it has, therefore, a "light journey" of 320 years.

The same author, in the *Monthly Notices* for January, gives, from his most recent researches, the parallax of α Gruis as 0″·015 ± 0″·007.

From measures of the mean parallaxes of the stars β, γ, δ, ε and ζ in Ursa Major, M. Hoffler has obtained the small value of 0″·0165 ± 0″·011. This number indicates that the system formed by these stars is separated from the earth by such a distance that it would take 200 years for the light to reach us. The distance of β and ζ is at least 4 million times greater than that which separates the earth from the sun. From the calculations made by this astronomer, ε Ursæ Majoris would be a star forty times brighter than Sirius, which, at the present distances of the stars, is considered the most brilliant in the sky.

FURTHER EXPLORATIONS IN AMERICAN MOUNDS.[1]

THE greater part of this volume is occupied by Mr. Moore's account of his systematic exploration of the mounds on the Georgia coast, the Marquis de Nadaillac's short paper being added to draw attention to the parallelism between burial customs on both sides of the Atlantic. Mr. Moore's contribution is a worthy continuation of his previous work, and the classified results of his numerous excavations, accompanied by excellent diagrams and illustrative plates, form a welcome addition to the material already existing for purposes of comparative study. Americans have every reason to be satisfied with the manner in which the archæological investigation of their country is being carried out: such researches as these of Mr. Moore in Georgia, and those of Mr. Cushing among the Keys of Florida, reflect the greatest credit upon all who have contributed to bring them to a successful issue.

The general results of these explorations tend to confirm in a striking degree the conclusion that men in similar states of primitive culture hold similar views upon all the fundamental questions of life and death. Such resemblances are not merely confined to generalities; they may be observed in the most minute matters of detail. Thus not only does the puzzling co-existence of inhumation and incineration recur as frequently in American as in European barrows, but many peculiarities of interment, noticed by Canon Greenwell and others, are repeated in a very remarkable manner in these Georgian mounds. Amongst these peculiarities may be instanced the preference shown for the southern and eastern sides of mounds; the laying of unburned skeletons upon one side and in a contracted position; the presence of charcoal, and pigments like powdered hæmatite; the deposit of potsherds belonging to *different* broken vessels, and the protection of bodies by coverings of wood. But in spite of these numerous coincidences we are as far off as ever from discovering the psychological laws which regulated the disposal of the dead by primitive man. Mr. Moore found bodies in all kinds of positions. They were "flexed" upon one side, or extended at full length, sometimes in anatomical order, sometimes showing signs of having been transferred to the place of burial after the flesh had been removed by exposure to the air; bones of one or more skeletons were "bunched" in heaps; confused masses of bones belonging to many different persons occurred together, some being calcined, others not; there were "pockets" of cinerated remains; urn burials, both cremated and uncremated; and unburned bodies placed upon the sites of fires. In a word, the apparent confusion reaches an extreme degree, and almost the only regularities of association which Mr. Moore ventures to point out are the more frequent presence of implements and ornaments in the neighbourhood of confused masses of bones, their comparative scarcity with flexed burials, and their complete absence in the neighbourhood of extended skeletons, though these last were generally at the base of the mound, and were often placed in large artificial excavations. As to the general question of the simultaneous occurrence of inhumation and cremation, we must still, perhaps, fall back on the former hypothesis

[1] *Journal of the Academy of Natural Sciences of Philadelphia*, 2nd series, vol. xi. Part 1, Philadelphia, 1897. (1) "Certain Aboriginal Mounds of the Georgia Coast," by Clarence B. Moore. (2) "Inhumation and Incineration in Europe," by the Marquis de Nadaillac.

that mere juxtaposition with fire as a ceremonial purification may have been in some cases considered equally efficacious with the actual incineration of the bones. The Marquis de Nadaillac has brought together, with admirable clearness and brevity, a mass of negative evidence proving that no distinctive significance can be proved to attach to either of the two great methods of burial; indeed, in places like Hallstadt the confusion seems absolute.

The people who built these mounds must have been a race with very little stone, and almost without copper. Of this metal only a chisel and a few ornaments were found, among the latter being a ring still in its place upon a finger-joint. Their pottery was well represented, though lacking in diversity of type. It was ornamented by cord-marking, by incised and painted designs, and by complicated stamped patterns, some of which give the impression of having been derived from the grain of wooden ware, while others appear to owe their origin to life forms. All the types discovered are copiously illustrated in the plates at the end of the book, and in the woodcuts inserted in the text. The tobacco-pipes discovered differed from those found in Florida, and a mortuary earthenware with a ready-made perforation at the base was non-existent.

Of the other objects found associated with bodies, those made of shell were the most numerous. They included various implements, some possibly agricultural, drinking cups, ornamented gorgets, and large numbers of beads, the latter hardly ever showing traces of contact with fire. Objects of stone and chert were less numerous, but among them may be mentioned celts, hammers, lance and arrow heads, and discoidal stones smaller than those used in the game of *Chungke*, but probably employed in a game of a similar kind. The small pebbles, frequently found in little heaps near human remains, are supposed by Mr. Moore to be the contents of rattles, the turtle-shell covering of which has decayed away. Bone pins were of frequent occurrence; and animals' jaws ground away on the lower part, leaving a flat surface, were discovered in a few instances. Almost everything made of wood had entirely disappeared. What the art in wood of the mound-builders may have been we must conjecture from the discoveries made in the Florida Key dwellings, where the peat has been instrumental in arresting decomposition.

The south-eastern corner of the United States is an area of peculiar ethnographical interest, owing to its proximity to the greater Antilles and to South America: it is fortunate that its exploration has been entrusted to such competent hands, and that the results are published in so admirable a manner.

A JUBILEE VOLUME OF "WIEDEMANN'S ANNALEN."

ON December 11, 1847, Gustav Wiedemann was made Doctor of Philosophy of Berlin University with a thesis "De Novo quodam Corpore ex Urea producto." To celebrate the fiftieth anniversary of that event, the publishers of *Wiedemann's Annalen der Physik und Chemie* conceived the happy idea of printing a jubilee volume composed of special papers by the more regular contributors. The result is a collection of fifty-seven papers by a number of eminent men, including Kohlrausch, Nernst, Ostwald, Quincke, Drude, Warburg, E. Wiedemann, and others of equal distinction.

Four years ago, the golden jubilee of the *Annalen* was celebrated with a retrospect by Hermann von Helmholtz. These annals, with their lineal ancestors, *Poggendorff's and Gilbert's Annalen*, cover over a century of German physical science, and are a noble monument to German intellectual activity. No better jubilee gift could have been made to the veteran editor than this collection of choice fruits of his colleagues' labour. We subjoin some extracts which will indicate the nature and value of the work offered, regretting that space does not permit of more.

Reversal of the valve action in discharge tubes, by E. Hagenbach. When the gas in a discharge tube is only slightly exhausted, a conduction current is established at a certain pressure. At higher exhaustions a radiation of electricity sets in, chiefly from the kathode. This radiation takes place more easily from a point kathode than from a surface at the lower pressures, while at higher pressures the reverse is the case.—Torsion and magnetism, by P. Drude. The explanation of the connection between torsion and magnetism must be based upon the different amounts of internal friction encountered in longitudinal and transverse deformations respectively, giving rise to a peculiar orientation of the magnetic molecules.—The law of Wiedemann and Franz, by F. A. Schulze. This law maintains that the ratio between the thermal and electric conductivities is approximately the same for all metals. The author tested this for iron and steel rods, and found them to exceed the ratio, but not by so much as has been alleged by previous investigators.—Theory of galvanic polarisation, by A. Oberbeck. The determination of the galvanic polarisation in the original circuit is not an impossibility, as has been alleged. It may be closely approached along several lines. The capacity of a cell is a function of the polarisation. It becomes infinite when a certain superior limiting value of the polarising force is reached which produces the maximum polarisation. After that the polarised cell behaves like a constant cell opposed to the main current.—Magnetic after-effect, by I. Klemenčič. Instead of disappearing in strong fields, the magnetic after-effect, or the "viscous magnetic hysteresis," goes on increasing, but its percentage in the total magnetisation becomes less.—An acoustic thermometer for high and low temperatures, by G. Quincke. This thermometer is based upon the interference of a direct and reflected sound-wave of known length, produced by a standard tuning-fork. The wave travels along a tube surrounded by the temperature to be measured. A hearing tube is moved to and fro within the interference tube until a node is reached, indicated by the silence of the hearing tube. The displacement of the latter is read on a divided scale, and immediately indicates the temperature required.—Excitation of stationary waves by electric spark discharges, by F. Melde. An embroiderer's "gold thread" is made to vibrate between the knobs of a battery of jars, somewhat on the principle of the electrostatic cells.—Magnetic susceptibility and atomic magnetism, by G. Jäger and S. Meyer. The authors have found an interesting new relation between the paramagnetic metals. They investigated the magnetic susceptibilities of the chlorides, sulphates, and nitrates of iron, nickel, cobalt, and manganese in aqueous solution at various temperatures. The metal was found to be the decisive element, the acid being without influence. The magnetic susceptibilities per gramme-atom of nickel, cobalt, iron, and manganese were as 2 : 4 : 5 : 6. The gap between 2 and 4 is probably filled up by chromium.—Stratified discharge in the open air, by Max Toepler. The author has succeeded in obtaining a distinctly stratified discharge at atmospheric pressures, which recalls the stratified anode light, by interposing in the path of the spark a semi-conducting plate of dry slate, granite, syenite, or basalt, and ballasting the discharge with a heavy water resistance. Between the bright surface on the kathode and the first stratum a sharp black space is seen, usually very narrow, which is analogous to the black kathode space, and tends to show that there is no fundamental difference between ordinary and vacuum discharges.—Magnetic images, by H. Jaeger. The method of magnetic images may be extended to the case of a constant current traversing a conductor in the neighbourhood of an iron plate. The field created by the current and by the iron plate is the same as if another conductor were placed at the geometrical image of the first conductor in the iron plate, and the latter were removed.—Heating effect of Röntgen rays, by E. Dorn. The author measured the heating effect produced on sheets of platinum or palladium contained in a glass vessel with an aluminium window. The vessel communicated with a Toepler pressure gauge, and the heat was measured by the expansion of the gas. The expansion obtained is much larger than would be accounted for by a dissociation of the gas.—Electroscopic detection of electric waves, by A. Toepler. Describes a modified electroscopic arrangement of great sensitiveness. Two upright metallic cylinders stand in a box with walls of glass and ebonite. One of the rods is connected with a rectilinear resonator, the other is put to earth. Any wave incident upon the resonator which produces sparks, sets in violent motion a fine aluminium wire suspended between the two cylinders, which conveys the discharge from one to the other. The aluminium wire is attached to a steel needle, which is just held suspended by its point by a permanent magnet.—Counter electromotive force of aluminium, by V. von Lang. It is well known that in an aluminium-carbon electrolytic cell a current with a voltage under 22 will only pass in the direction carbon-aluminium, and this has been utilised for the electro-chemical rectification of an alternate current. Similarly, in an arc with two aluminium electrodes, a counter E.M.F. of some 19 volts is

developed. An arc with one electrode of aluminium and one of carbon allows the current to pass with greater ease from aluminium to carbon, which is just the reverse of what happens in the cell.—Influence of magnetism on the strength of electric vacuum discharges, by A. Paalzow and F. Neesen. The discharge was produced by a constant high-potential battery. When the lines of force acted across the path of the current, the latter was always enfeebled, and sometimes broken. When they acted along the path, the magnetic field acted like an increase of pressure of the gas, delaying both the setting-in of the discharge and its extinction in the course of exhaustion.—Relation between the positive light and the dark kathode space, by E. Wiedemann. When a positive wire anode is brought into the dark kathode space, the resistance of the intervening gas is not lessened but increased. The positive light bends back until it merges in the negative glow. The same thing happens when the anode is surrounded by a narrow tube. In every case, the discharge traverses the positive strata and the negative glow in succession before it enters the dark space.—Simple demonstration of the Zeemann effect, by W. König. An emission flame which can be placed in a strong magnetic field is viewed through an absorption flame and a dichroiscope or a doubly-refracting prism, which gives two images of the emission flame side by side. On making the field one of the images brightens up, owing to the length of its light waves being changed, and therefore no longer absorbed by the absorption flame.—Magnetic and electric wind, by O. Lehmann. Describes some curious cases of the modification of the path of an electric discharge by a magnetic field. An arc between a ring of carbon and a concentric rod of carbon may be made to spin round rapidly, and a comet-like appendage may be made to revolve round the kathode in an "electric egg."

MAN IN RELATION TO THE GLACIAL PERIOD.[1]

AS there appears even now to be a doubt in the minds of some as to whether man reached Britain before, during, or after the time known to geologists as the "Glacial period," it might be well on the present occasion to re-examine some of the evidence which has been brought forward to prove the presence of pre-Glacial man, especially from those areas in Britain which are now admitted to contain Glacial deposits, or to have been overspread by ice and snow in the Glacial period.

The most important evidence yet obtained, is that which has been furnished by the ossiferous caverns in the glaciated areas; but the occurrence in the same areas of the remains of extinct mammalia, which are now admitted to have been contemporary with the Cave Man, buried under great thicknesses of Glacial deposits, must also have an important bearing on the question.

All the evidence tends to show that the so-called Tertiary and Quaternary periods merged gradually into each other, and were not separated by any great break in Britain. The higher mountains, before the close of the Tertiary period, must have been covered in part by ice and snow, and the so-called Glacial period can only have a chronological importance as indicating the increased intensity and climax of that cold condition gradually ushered in at the earlier time. For the same reason there is no marked and definite line separating the fauna of the Pliocene from that of the Pleistocene, for we find remains of the animals of the warmer period closely associated with those of the colder in the same deposits and under conditions which show clearly that they lived in those areas at the same time.

North Wales and the North-west of England.

It is generally admitted that during the latter part of the Pliocene period the mountains of North Wales stood at a considerably higher elevation than they do at present; therefore it is but natural to suppose that during that time the streams which flowed from them gradually deepened, widened, and also possibly carved out some of the pre-Glacial valleys. The Carboniferous limestone along the flanks of the mountains, which had at an earlier time been much broken and crushed by earth-movements, now suffered from the additional effects of subaerial action, and wide fissures and caverns were gradually formed in it. In time some of these, as the streams found outlets at lower levels, would be left comparatively dry, and would then be suitable for habitation by man and beast.

In nearly all those caverns where remains of the extinct animals and the implements of contemporary man have been found, there is some amount of sediment underlying the remains. This must have been left there by the streams or floods which also deposited the materal which filled up the narrow descending fissures, thereby making a fairly level floor to the caverns before occupation. This material in every case, unless where there is evidence of its having been subsequently disturbed, consists entirely of such local materials as would be brought down by the streams from the immediately adjoining higher ground. When the higher caverns were first occupied by hyænas it is probable that there was comparatively little ice or snow on the mountains, and many of the animals which lived in the valleys and on the plains extending from them were southern types. Gradually, however, as the cold increased, northern forms appeared on the scene, and a commingling of the two groups took place.

The geographical features in the west and north-west in later Pliocene times may be briefly summarised as presenting high mountainous areas in Wales, Cumberland, the South of Scotland, and in parts of Ireland bordering the Irish Sea and St. George's Channel, with extensive plains traversed by great rivers in the areas now submerged, between the west coast of England and Wales, and Ireland. The conditions here were then in every way suitable to form feeding-grounds for herds of the great mammalia, and indeed such as could never have been repeated afterwards in these areas either in late Glacial or in post-Glacial times.

Animals from the south-east could reach these north-western plains across Cheshire and the lowlands in the centre of England, and others from the south by the plains on the west coast of Wales. In this way northern and southern animals would in a sense freely commingle and be afterwards driven to more southern areas together as the cold increased, and the conditions became more and more unsuitable to them. At first, in the mountains bordering these plains, when only their higher parts were covered with ice and snow, glaciers would occur only in the higher valleys; but as the cold increased they would become confluent with those from adjoining areas, and in time reach the plains and there coalesce to form, perhaps, as has been suggested, one vast sheet reaching across from England to Ireland. Most of the animals, ere the last stage had been reached, would, of course, have disappeared from those parts towards more suitable southern areas.

That the foregoing is, in brief, the history of the incoming of the Glacial period in the north-west is evident from the deposits which have been found in and about the caverns, and in sections at various points on the hills, in the valleys, and around the coast of North Wales.

Wherever the earlier materials have been preserved, especially at high levels, they are seen to consist entirely of local materials, *i.e.* such as would be derived from the immediate neighbourhood, or carried down by streams or ice from the adjoining higher ground.

Over this, and partly mixed up with it in the areas not reached by the northern ice, there is an admixture of materials from other Welsh districts and in the valleys opening out to the north, and along the coast there is the further admixture of erratics from northern areas. It is an interesting fact that the boundary-line in the Vale of Clwyd reached by the northern erratics is very little more inland than the area in which the caverns we have explored occur.

Of the history of the subsequent changes I need say but little; but it seems to me that there is fairly good evidence to show that a considerable subsidence did take place towards the close of the Glacial period, and that this was afterwards followed by a certain amount of upheaval in the same areas.

The presence of such thick deposits of drift, below the level of the sea, at the entrance to the Vale of Clwyd, with bones of the early Pleistocene mammalia at the very base, is a fairly sure test of a stage of subsidence, and it is also difficult to account for the finding of numerous foraminifera in clays at a height of about 200 feet above present sea-level around the coast unless alternating movements of subsidence and upheaval took place. The marine sand with broken shells at high levels, formerly looked upon as sure evidence of subsidence to that depth must not be relied upon too confidently, as in no case has it been clearly shown

[1] "Evidences of the Antiquity of Man furnished by Ossiferous Caverns in Glaciated Districts in Britain." Abstract of Presidential Address to the Geological Society, delivered at the annual meeting, February 18, by Dr. H. Hicks, F.R.S.

that the organisms lived in the positions where the shells are now found. In some cases there are also fairly clear indications that the deposits have been transported to fairly high levels by ice which had passed over and scraped up materials from the sea-bottom.

It seems safer, at present, from the evidence which has been brought forward of late years by so many competent observers, to assume that towards the close of the Glacial period the earth-movements produced changes only of a few hundred feet rather than the greater depression and upheaval suggested by the earlier geologists.

Early Pleistocene Conditions on the East Side of England.

On the east side of England, as on the west, there were at this time great plains, extending out from the valleys, and much of the area now covered by the North Sea must have been dry land where northern and southern animals commingled. That this was the case is shown by the finding of their remains in close association in the hyæna-den at Kirkdale and in other caverns in Yorkshire. Prof. Phillips many years ago came to the conclusion that the Kirkdale Cave was occupied in the "pre-Glacial condition of the land which is now Yorkshire," and he also maintained that the lowest Hessle Gravels which rest upon the chalk, and which contain mammoth and other remains, and are covered by Boulder-clay, are pre-Glacial in age.

Mr. G. W. Lamplugh's careful researches seem to show clearly that the Sewerby Gravels, which have yielded so many Pleistocene remains, are at the base of the glacial series in that area. He says of the fauna at the base of the drift at Sewerby:—"It is essentially the fauna of the Kirkdale Cave."[1] In his conclusions, given in the same paper, when referring to the physical conditions prevailing in the area during the formation of the drift-deposits, he says:—"At a period not long anterior to that of the glaciation of the coast, Flamborough Head was in existence as a bold promontory jutting out into a sea whose level was slightly above that of to-day. Most of the mammals characteristic of the Glacial period were already living, and tenanted the interior in large numbers. The climate was moist and not very severe, the prevalent winds, as shown by the sand-dunes of Sewerby, being from the west or south-west. After the land had remained for a long time stationary, a slow elevatory movement set in, and the climate became much colder; so that the Chalk-surface was disintegrated by frost and eroded by sudden floods, which spread thick beds of muddy detritus over much of the low or slightly sloping ground in the vicinity. Meanwhile the bed of the North Sea was being rapidly filled with ice through the great extension of the Scandinavian glaciers, till at length the Scotch and Scandinavian ice coalesced, and what remained of the North Sea was well-nigh ice-locked."

Although some southern forms whose remains have been discovered in the forest-bed on the Norfolk coast do not appear to have reached much further north than that area, this does not, in my opinion, make it in any way certain that even these were not, in part at least, contemporaneous with the so-called mixed early Pleistocene fauna of the more northern districts. It is also an important fact that many of the most characteristic animals whose remains have been discovered in the caverns in North Wales and Yorkshire are now always included in the fauna of the forest-bed. The position of the forest-bed of Norfolk under high cliffs of Boulder-clay is also very similar to that of the lower deposits near the entrance to the Vale of Clwyd, containing Pleistocene remains and trunks of trees in like manner covered over by a great thickness of Glacial drift. It may also be compared with the forest-bed in Holyhead Harbour, buried under "stiff blue clay," in which two perfect heads of the mammoth were found when the excavations for the railway were made in 1849. The tusks and molars were buried two feet deep, in a bed of peat three feet thick, with stumps and roots of trees.[2]

It may be well to mention that the following mammals, whose remains have been found in caverns in North Wales, Derbyshire, and Yorkshire are now generally given as forming a part of the fauna of the Norfolk forest-bed, and that several of them, such as the glutton, musk sheep, and mammoth must be considered typically northern animals. The list is taken from those published by Prof. Boyd Dawkins or Mr. E. T. Newton, and there are animals which may be classed as characteristic of arctic, temperate, and hot climates. Animals whose remains have been found in caverns in association with human implements, and which are stated also to occur in the Norfolk forest-bed, viz. *Elephas antiquus*, *E. primigenius*, *Hippopotamus amphibius*, *Equus caballus*, *Sus scrofa*, *Bison*, *Ovibus moschatus*, *Cervus elaphus*, *Cervus capreolus*, *Megaceros*, *Machairodus*, *Canis lupus*, *C. vulpes*, *Hyæna crocuta*, *Ursus spelæus*, *Gulo luscus*, *Lutra vulgaris*, *Arvicola amphibius*.

When the cold increased, the animals on the East coast, as on the West side, were driven further and further south, and those least able to bear the increased severity of the climate were the first to migrate from the various areas. The southern forms may consequently be looked upon, for the areas in which they have been found, as the oldest fauna; but it is reasonable to suppose that they were contemporary with the more northern forms, which at that time lived in other districts where the conditions were more suitable to them. When the northern forms reached the South of England, the conditions in and around the mountainous districts were such that few animals could remain there, as most of the valleys and plains had become buried under ice and snow, and they would have to seek feeding-grounds outside these areas. It is to this period that we must assign the remains of the mammoth and rhinoceros which are so abundantly found on the old land-surfaces on the north of the Thames, usually hidden under great thicknesses of drift, as in Endsleigh Street, and in other places in Middlesex. Here, and in some areas further south, they could have lived during most of the Glacial period until at last driven away, when the valleys and plains became covered with vast sheets of water, due in part probably to subsidence, but largely owing to the gradual melting of the ice and snow further north. Whether the mammoth and rhinoceros continued to live much longer in some parts of the South and South-west of England there is very little evidence at present to show. The supposition, however, held by some that they returned to the glaciated areas after the Glacial period had passed away does not seem to me in any way probable, for hitherto their remains have only been found either under or in the drift, and not above it, excepting when they have been washed out from the earlier deposits.

Summary.

The evidence which has been obtained from ossiferous caverns at high elevations in the glaciated areas shows conclusively that the remains of the extinct mammalia found in them must have been introduced before any of the Glacial deposits now in or upon them could have been laid down, therefore either before or so early in the Glacial period that there could not have been at the time any considerable amount of snow on the neighbouring mountains, or glaciers even in the higher valleys.

From caverns in glaciated areas in North and South Wales, where palæolithic implements have been found in association with remains of the extinct mammalia, facts have been obtained which make it certain that the implements were those of man living at the same period as the extinct animals in those areas, and therefore of pre-Glacial age. It has also been shown that as the cold increased the higher valleys became filled with glaciers, and the caverns became uninhabitable. That afterwards, as the snow-line and glaciers descended lower and lower, some of the caverns were subject to inundations, which not only disturbed and rearranged the deposits previously in them, but wholly or partially filled them up with local materials. That in the Vale of Clwyd, North Wales, the local glaciers gradually coalesced with those from the western and northern areas, and a mixed material was distributed over the district to a height of over 600 feet, burying the ossiferous caverns beneath it. During this time also water re-entered some of the caverns, redisturbing in part the earlier contents and depositing some of the mixed drift over that previously in the caverns.

While these caverns were occupied as dens by the hyænas, northern and southern animals commingled in the valleys and on the great plains reaching out from them to the area now covered by the Irish Sea.

From numerous examinations made of undisturbed Glacial deposits in Wales, the North of England, and Scotland, it has also been proved very clearly that the extinct mammalia, whose remains are found in association with the implements of Palæolithic Man in caverns, must have lived there before those deposits had been laid down, as their remains always occur at the base or in the lower parts of the drift, and never above it. Further, there is not a particle of evidence to show that the extinct mammalia ever revisited those areas after the close of the Glacial period.

[1] *Quart Journ. Geol. Soc.*, vol. xlvii. (1891).
[2] "Principles of Geology," Lyell, vol. i. (1867) p. 545.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. W. D. Niven, F.R.S., has been appointed an Elector to the Plumian Professorship of Astronomy, and Sir W. H. Broadbent an Elector to the Downing Professorship of Medicine.

Mr. J. Graham Kerr, of Christ's College, well known for his adventurous journeys as a naturalist in South America, has been elected a Fellow of Christ's College.

PROF. G. B. HOWES, F.R.S., is to receive the honorary degree of LL.D. from the University of St. Andrews.

WHEN a shorthand writer, only familiar with the phonographic signs of the vocabulary of every-day life, endeavours to take notes of a science lecture, he soon finds his deficiencies. To exercise pupils in the art of making shorthand notes during lectures, Mr. Percy E. Kingsford, of Dover College, has inaugurated a course of special science lectures (with experiments and other illustrations) as nearly as possible of the character of those which his students will receive when they pass to the science or technical college, or medical school. The practice thus afforded the students will be very valuable. Science lecturers who have suffered at the hands of newspaper reporters, and have had ideas fathered upon them which they would be the first to repudiate, will join with us in wishing that all phonographers would undergo a similar course of training in reporting scientific lectures. It is very difficult to obtain an accurate verbatim report of the speeches made at any meeting where scientific subjects are discussed.

AN open competitive examination for the entry of engineer students in Her Majesty's Navy, and for the entry of students in Naval Construction, will shortly be held. The opportunities offered by this branch of the naval service are not so widely known as they ought to be. Candidates for the studentships must not be less than fourteen, nor more than seventeen years of age. A competitive examination is held every year in April, the subjects being arithmetic, writing from dictation, composition, grammar, French (or German or Italian), Latin, elementary physics and chemistry, geography (including physical geography), algebra (including quadratic equations), Euclid's Elements (Books I.–IV., VI., and definitions of V.), and freehand drawing. Successful candidates go to the admirable Engineering College—the Royal Naval Engineering College—at Keyham, Devonport, and there receive, under Prof. A. M. Worthington, F.R.S., a thorough course of instruction in the various branches of engineering science, while at the same time they receive practical training in the Dockyard. The best of means is thus afforded the students of acquiring the groundwork of the theoretical and practical knowledge required of a modern naval engineer. During the five years which the students have to serve at Keyham, the parents or guardians are required to pay the sum of 40*l.* per annum; but for this the students receive an excellent education, as well as board and lodging and medical attendance. At present, a large number of the students come from naval ports, such as Portsmouth and Devonport; but if the studentships were more widely known, doubtless many places which are now but rarely represented would send in candidates for them.

THE jubilee of Queen's College, London, will be celebrated during the first week in May. The College was founded in 1848, and incorporated by Royal Charter in 1853. It was the pioneer of the movement for the development of educational facilities for women, and in the list of past and present professors and lecturers the names of a number of distinguished men of science occur. Among the names of Fellows of the Royal Society who have served the College, but have now passed away, we notice D. T. Ansted, Edward Forbes, W. B. Carpenter, and W. A. Miller; while among the present Fellows whose names figure in the list are Prof. H. G. Seeley and Prof. J. M. Thomson. The College curriculum is divided into three parts for students of different ages, and in each of the departments the development of mental powers without undue strain is the object of the instruction, preparation for public examinations being given but secondary consideration. A college which in these days does not shape its curriculum according to the syllabuses of examining bodies deserves encouragement; and Queen's College should, therefore, not lack responses to the appeal which the Council has issued for means to enlarge and generally improve the premises, so as to meet the increased requirements of modern education. Among the additions will be a large lecture-room for science lectures. The estimated cost of the whole work will exceed 7000*l.*, of which sum more than 3000*l.* have still to be raised. The College has no endowment for such purposes, and it appeals for help to all who recognise the important share it has taken in the development of women's education. The object is a worthy one, and it is to be hoped that the greater portion of the sum required will be raised before the jubilee celebration in May. The Lady Resident would be glad to receive the names and addresses of old students, in order to send invitations for the forthcoming event.

A COPY of the general report on public instruction in the North-western Provinces of Oudh, for the year 1896-97, has been received. The institution of a Faculty of Science in the University of Allahabad is referred to, and mention is made of various other efforts to encourage the study of science. What appears to be more needed than anything else is a more liberal supply of apparatus for experimental purposes. It is discreditable that Prof. Murray, who has charge of the physical science classes in one of the Government colleges, should have to report: "We have about nine metre scales in the laboratory; no two are exactly alike, and which (if any) is correct it is impossible to say. Similarly the variations in our various measures of resistance one with another are in some cases as much as 30 per cent. of the whole." But notwithstanding this unsatisfactory state of things, the report shows that means are being taken to strengthen the colleges on the science sides, both by providing additional apparatus and by increasing the accommodation. The subjoined extract from the report shows that the development is taking place on the right lines:—"Steps have been and are being taken to make school education less bookish, and more practical. An English writer, after thirty years of teaching, has recently urged that geography should be taught mainly by means of map drawing; that text-books should be used chiefly as books of reference; that lessons in arithmetic and geometry should include practical work in measurement; that in teaching modern languages the written or spoken language should be made the basis, and instruction in grammar founded upon it; that mastery of English does not come by grammar and analysis, but by observation and practice; and that true science consists in a scientific habit of mind, and not in a knowledge of scientific facts. These views appear to me to be fully applicable to India, and as a matter of fact similar aims have been kept in mind latterly in these provinces, particularly as regards geography, arithmetic, geometry and science. The idea of using text-books in most subjects as books of reference is, however, so contrary to the notions of masters and boys that it will be long before the new revelation is generally received."

SCIENTIFIC SERIALS.

American Journal of Science, February.—The 27-day auroral period and the moon, by H. H. Clayton. Auroras were observed in 1895 on January 19, February 15, March 14, and April 10, with no intermediate cases. The probability of an accidental distribution in this manner is only 1 in 19,683. This period is probably due to the varying position of the moon north and south of the equator. When the moon's period is counted from its greatest northern position, there is a maximum on the 14th day, which coincides with the moon's greatest southern declination. There are minima on the 6th and 20th days, and a secondary maximum on the first day. The moon is an electrified body, charged negatively like the earth, and the potential gradient at the earth's surface depends upon the moon's position in the heavens.—Some products found in the hearth of an old furnace upon the dismantling of the Trethellan tinworks, Truro, Cornwall, by W. P. Headden. The ores smelted in this furnace for about 100 years were the usual Cornish tin-ores carrying some arsenopyrite, which is cobaltiferous, and accounts for the cobalt in the samples. The chief products described are stannous sulphide, SnS, with some iron, a new iron arsenide, FeAs, an arsenide of tin, Sn_6As, and stannic oxide, or an artificial "wood tin." The latter was an irregular mass weighing about one and a half pounds. There was a central portion of metallic tin running lengthwise through the mass. It was probably formed by slow oxidation of a block of tin, but whether that was due to simple air and moisture or to other hot gases cannot now be determined.—Kant as a natural philosopher, by G. F. Becker.

Kant's fame as a metaphysician has completely overshadowed his reputation as a physicist; but all his earlier papers were on physical subjects, such as the theory of winds, the earth's rotation period, the rings of Saturn, and, best-known, the nebular hypothesis of the universe. His great object in life was to discourage visionary speculation and to reduce all subjects to the confines of reason. Where Newton had in some cases to postulate the direct intervention of the Creator, Kant based his explanation upon known physical laws. If he had known the laws of thermodynamics, his nebular hypothesis, which only fell short in that respect, would have completely anticipated Laplace.—The islands and coral reefs of the Fiji group, by A. Agassiz. This is an extract from a letter dated Suva, Fiji Islands, December 15, 1897, describing a cruise in the Australasian twin-screw steamer *Yaralla*. The writer says: The great variety of causes which have been active in shaping the present physiognomy of the reefs and atolls of Fiji shows the impossibility of assigning any one factor, like subsidence for instance, as is done by Dana and Darwin, as the single cause for the formation of the many different kinds of atolls and barrier reefs to be found in the Fiji group. The formation of the great barrier reef of the southern shores of Viti Levu is due to causes very similar to those which have given to the northern coast of Cuba between Nuevitas and Matanzas its present physiognomy.

Symons's Monthly Meteorological Magazine, February.—Meteorological observations at Camden Square, London, N.W. There are few records day and night for forty years without a break, and no station with suitable exposure in London which has been at work so long. We are glad to see that Mr. Symons intends to give a series of tables showing the results of his observations for each month, and the present number, being the first of a new volume, contains those for January 1858-97.—Warmth, dryness, and high barometer in January 1898. A number of notes are quoted upon the above subjects; the table above referred to shows that, for London, the features of 1898 are: barometer almost unprecedently high; mean dry bulb temperature, 0·05° above 1884, and therefore the highest on record; minimum in air and on grass, 0·6° and 0·5°, respectively, above the highest previous records, which were in 1875 and 1884; rain, only about a third of the average, but more than twice that of 1880.—In the Conway Valley geraniums were found in blossom out of doors.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 3.—"Comparison of Oxygen with the extra Lines in the Spectra of the Helium Stars, β Crucis, &c.; also Summary of the Spectra of Southern Stars to the $3\frac{1}{2}$ Magnitude and their Distribution." By Frank McClean, F.R.S.

In a previous paper read before the Society on April 8, 1897, it was suggested that the special lines present in spectra of the first division of helium stars (Type I., Division I*a*) might possibly be due to oxygen.

The indications in the spectra of the northern stars that these extra lines are due to oxygen are slight, as the lines at best are indistinct. Among the southern stars, however, there are several in the spectra of which these lines are better defined, and there is one, viz. β Crucis, in which they are very fairly defined.

Upon the plate which accompanies the paper a series of photographs of stellar spectra are reproduced. The lines are drawn out by themselves below the spectrum of β Crucis. They are then compared directly by juxtaposition with a drawing of the spectrum of oxygen. The close similarity of the whole grouping of the two spectra as they appear on the plate admits of little doubt that the extra lines actually constitute the spectrum of oxygen.

The spectrum of γ Argus is given on the plate in order to identify it as a helium star. It contains two crucial lines of helium. The Wolf-Rayet stars, of which it is the principal example, are thus classified as helium stars.

A summary of the spectra of 116 stars to the $3\frac{1}{2}$ magnitude in the Southern Hemisphere is given. They were photographed between May and October last with an object-glass prism, mounted in front of the Cape astrographic telescope. The photographic spectra are classified on the same system as in the previous paper. The table of distribution for the whole sphere by areas and classes is given.

There are in all 89 helium stars (Division I.), distributed 71 in the galactic zones and 18 in the galactic polar areas, the areas being equal.

The 81 stars in Division II., the Sirian stars, and Division III., the Procyon stars (which along with Division I. constitute Secchi's Type I.) are rather irregularly distributed throughout the sphere. To the extent of the observations there is no condensation of stars of Divisions II. and III. in the galactic zones as there is in the case of stars of Division I.

The 106 stars in Divisions IV. and V. (II. and III. of Secchi's types) are fairly evenly distributed throughout the sphere.

The general distribution of the types of spectra throughout the sphere to the extent of the observations bears out generally the conclusion that stars with spectra of the more advanced types, in order of development, are evenly distributed in space. Also that stars with spectra more recent in order of development are mostly congregated in the galactic zones. The helium stars of Division I. are predominant in the Southern Hemisphere, being congregated in the lower or southerly halves of the galactic zones. They include 48 stars out of a total of 94 stars in those areas. They are also more closely congregated in the vicinity of the galaxy than is the case in the northerly halves of the galactic zones. In the contiguous constellations of Musca, Crux, Centaurus, Lupus, and Scorpio there are 27 helium stars out of a total of 36 stars included in the tables.

February 17.—"Upon the Structure and Development of the Enamel of Elasmobranch Fishes." By Charles S. Tomes, M.A., F.R.S.

The nature of the hard polished outer layer of the teeth of this group of fishes has been from time to time a subject of discussion, some authors holding that it is enamel, whilst others deny its claim to be so styled.

The general conclusion arrived at by the author is that, just as the whole teeth of the Elasmobranchs present the simplest known form of tooth development, so do they also present the first introduction of enamel as a separate tissue.

In its first introduction it was a joint product, made under circumstances which almost precluded any slow and gradual formation of an outer layer upon the teeth; but in the further specialisation of teeth in reptiles and mammals the tooth germs sink more deeply into the submucous tissue, and are protected for a much longer time.

The enamel organs become more specialised, and finally take upon themselves the entire work of enamel building, manufacturing both the organic matrix and furnishing it with lime salts, as unquestionably happens in mammals.

And if these conclusions be correct, it would be quite justifiable to call it enamel, even though the dentine papilla has had a share in its production.

Geological Society, February 2.—Dr. Henry Hicks, F.R.S., President, in the chair.—The President announced that Dr. Charles Barrois, Secretary of the Organising Committee of the VIIIth International Geological Congress, which will be held in Paris in 1900, would shortly come to London to invite the Geological Society to the Congress, and to consult the Fellows with regard to the proposed excursions and the subjects of discussion.—"Contributions to the Glacial Geology of Spitsbergen," by E. J. Garwood and Dr. J. W. Gregory. The extent of glaciation of Spitsbergen has been exaggerated, for there is no immense ice-plateau, but normal glaciers with some inland sheets and Piedmont glaciers. These differ from Alpine glaciers, as they are not always formed from snow-fields at the head, and though some of the glaciers (as the Baldhead Glacier) have tapering snouts in front, most have vertical cliffs. Chamberlin's explanation that the latter are due to the low angle of the sun is insufficient, and they seem to be caused by the advance of the ice by a rapid forward movement of its upper layers. The ice of these upper layers falls off and forms talus in front, over which the glacier advances, carrying detritus uphill with it, and producing a series of thrusts. The Booming Glacier illustrates cases of erratics carried in different directions by the same mass of ice. The deposits of the Spitsbergen glaciers are of four types: (1) moraines of Swiss type; (2) those formed mainly of intraglacial material; (3) those formed of re-deposited beach-material; (4) deposits of glacial rivers, and re-assorted drifts. The materials of the second are subangular and rounded; scratched and polished pebbles and

boulders are abundant, and the fine-grained matrix, which is frequently argillaceous, is often well-laminated and false-bedded. Some of these drifts are stratified, others unstratified, and contorted drifts occur. This type of moraine is remarkably like some British boulder clay. The third class is sometimes formed by land-ice, at other times beneath the sea; the latter shows stratification. The superglacial and intraglacial streams, so far as seen, were usually clear of drift. Under the fourth head an esker in a tributary of the Sassendal is described. The direct geological action of the marine ice is of four kinds: transport of material, contortion of shore-deposits, formation of small ridges of boulder-terraces above sea-level, and striation, rounding, and furrowing of rocks along the sea-shore. Traces of former glaciation are described in the case of the Hecla Hook beds, and of certain beds of late Mesozoic or early Cainozoic age in Bunting Bluff. Under the head of general conclusions the authors state that they have discovered no certain test to distinguish between the action of land-ice and marine ice; that there is no evidence to prove that land-ice can advance far across the sea; and that there is evidence, which they regard as conclusive, of the uplift of materials by land-ice. They note that the mechanical processes connected with the advance of the glaciers are of three kinds. All the material seen transported by the glaciers was superglacial or intraglacial, and not subglacial. Some striation of intraglacial material is caused by differential movement of different layers of ice. The advance and retreat of the Spitsbergen glaciers is very irregular, and apparently due to local changes. The observations of the authors support the views of those who ascribe a limited erosive power to glaciers. Lastly, the theory that glacial periods occurred as a consequence of epeirogenic uplifts receives no support from Spitsbergen.—An interesting discussion followed, in which Sir Martin Conway, Prof. Bonney, the Rev. Edwin Hill, and Mr. Marr took part. Mr. P. F. Kendall said that the paper would mark a distinct epoch in British glacial geology. Hitherto, one body of geologists had attributed the drift-deposits of Britain to the agency of land-ice, while another had invoked the agency of the sea. The latter had argued that glaciers cannot move uphill, that they cannot transport materials from lower to higher levels, that glaciers cannot gather up materials over which they are moving, and that, even if they could pick up shells they would grind them to powder—"On a Quartz-rock in the Carboniferous Limestone of Derbyshire," by H. H. Arnold-Bemrose. The paper describes the occurrence in the field and the microscopic structure of a rock consisting essentially of quartz, which is found in the mountain limestone in several localities. It occurs in irregularly-shaped bosses and veins, and shows no signs of stratification. The author considers that the quartz-rock is not a gritty limestone, altered by the growth of crystalline quartz around the detrital grains, but that it is a limestone replaced by quartz.

Mathematical Society, February 10.—Prof. Elliott, F.R.S., President, in the chair.—Lieut.-Colonel Allan Cunningham, R.E., read a paper entitled "On Aurifeuillians." These are defined as the *algebraic prime factors* of two functions, viz.: of $(X^{2n} + Y^{2n})$ when $2nXY = \square$, and of $(X^n + i^{n+1}. Y^n)$ when $nXY = \square$, where n is *odd*, and $i = \sqrt{-1}$. Their salient property (discovered by Mr. Aurifeuille, of Toulouse) is that they are *algebraically* resolvible into two factors (say L, M). Also L, M are expressible in the same 2^{ic} forms as their product-function. The quotient of one Aurifeuillian by another of the same order has the same properties. The properties of the two Aurifeuillians of orders 2 and 3, viz.:

$$(x^4 + 2^2y^4) \text{ and } (x^6 + 3^3y^6) \div (x^2 + {}^3y^2),$$

were stated at some length. The application to Fermat's numbers $(2^{4\nu+2} + 1)$ and $(3^{6\nu+3} + 1)$ was given, and a table of the factorisation thereof into *prime* factors was given, extending (with gaps) to $(2^{210} + 1)$, $3^{105} + 1)$. In opening the discussion on the paper, Mr. Bickmore pointed out that Aurifeuille's formulæ, which were enunciated without complete proof by Lucas, might be completely proved by the theory of complex integers. Thus the formulæ express the algebraical prime-factor of $a^n - (-1)^{\frac{n-1}{2}} b$, of n as the difference of two squares, when n is an uneven integer, and $\frac{ab}{n}$ is a perfect square. But the algebraical prime-factor is the norm of the binomial n^{ic} integer

$$a - (-1)^{\frac{n-1}{2}} b\rho^2,$$

which, when

$$a = x^2 \text{ and } b = ny^2,$$

is equal to

$$\left\{x - (-1)^{\frac{n-1}{4}} y\rho\sqrt{n}\right\} \times \left\{x + (-1)^{\frac{n-1}{4}} y\rho\sqrt{n}\right\}.$$

Gauss's results give

$$(-1)^{\frac{n-1}{4}}\sqrt{n} = f(\rho),$$

a rational integral function of ρ; hence, finally,

$$N_n\left\{x^2 - (-1)^{\frac{n-1}{2}} ny^2\rho^2\right\} = N_n\{x - y\rho f(\rho)\} \times N_n\{x + y\rho f(\rho)\}.$$

The formulæ also express as the difference of two squares the algebraical prime-factor of $a^{2n} + b^{2n}$, when n is an uneven integer, and $\frac{ab}{2n}$ is a perfect square; in this case the final result is

$$N_n(x^4 + 4n^2y^4\rho^4) = N_n\left\{x^2 - 2ny\rho f(\rho) + 2(-1)^{\frac{n-1}{2}} ny^2\rho^2\right\} \times N_n\left\{x^2 + 2ny\rho f(\rho) + 2(-1)^{\frac{n-1}{2}} ny^2\rho^2\right\}.$$

Kummer's tests show that if n be > 3, the absolute term in each of the complex integers is correctly fixed; hence, y being a factor of every term except the absolute term, if either Aurifeuillian factor be a prime, it has any prime factor of y as a residue of order n, when $n > 3$. The process also expresses complex n^{ic} integers with *more* terms than two, which are expressible in the form

$$x^2 - (-1)^{\frac{n-1}{2}} ny^2,$$

(x and y being themselves complex integers of order n) as the product of two complex n^{ic} integers.—The President (Lieut.-Colonel Cunningham, *pro tem.* in the chair) communicated a paper by Mr. J. E. Campbell on the transformations which leave the lengths of arcs on any surface unaltered. The object of the paper was to obtain the infinitesimal transformations which have the property of leaving unaltered the lengths of arcs on any given surface in space of $n + 1$ dimensions—that is, the transformations which leave $dx_1^2 + \ldots + dx_n^2 + dz^2$ invariant where $z = f(x_1 \ldots x_n)$. It is remarkable that this problem can be solved completely when $n > 2$, though not when $n = 2$. At the conclusion of the paper it is proved that if H is the Hessian of $f(x_1 \ldots x_n)$, then

$$H \div \left\{1 + \left(\frac{dy}{dx_1}\right)^2 + \ldots + \left(\frac{dy}{dx_n}\right)\right\}^{\frac{n+2}{2}}$$

is an invariant for such substitutions; this is a generalisation of the well-known theorem that the measure of curvature (on a surface in ordinary space) is unaltered by transformations which leave the lengths of arcs invariant.—Mr. Hargreaves made a short impromptu communication.

Zoological Society, February 15.—Dr. Albert Günther, F.R.S., Vice-President, in the chair.—A letter was read from Mr. Dudley Le Souëf, of Melbourne, containing a summary of some observations on the transfer by the mother of an embryo kangaroo (*Macropus giganteus*) by her mouth into her pouch.—A report was read, drawn up by Mr. A. Thomson, the Society's head-keeper, on the insects exhibited in the insect-house during the year 1897, and a series of the specimens was exhibited.—The Secretary exhibited a series of specimens of butterflies, which had formed part of a collection lately on view at the Dunthorne Gallery, in illustration of the mode of mounting employed in "Denton's Patent Butterfly Tablets."—Mr. W. P. Pycraft read the first of a series of contributions to the osteology of birds. The present part (of which the following is an abstract) related to the Steganopodes. The fact that in the tropic-birds, cormorants, gannets, and frigate-birds, all the toes are united by a common web, has led to the belief that these forms are closely related; they form the sub-order *Steganopodes* or *Totipalmatæ* of authors. A comparison of the osteology of the group confirms this opinion.—Dr. W. G. Ridewood read a paper on the skeleton of regenerated limbs of the midwife-toad (*Alytes obstetricans*). He demonstrated the possibility of the development, in the regenerated hind limb of the larva, of tarsal, metatarsal, and phalangeal cartilages identical in every respect with those of the normal limb.—Mr. G. A. Boulenger,

F.R.S., described a new species of sea-snake from Borneo, which he proposed to name *Hydrophis flowerí*, after Mr. Stanley Flower, its discoverer. Mr. Boulenger also gave an account of the reptiles and batrachians lately collected by Mr. W. F. H. Rosenberg in Western Ecuador. Seventy-seven species were enumerated, of which twenty-three, viz. eleven reptiles and twelve batrachians, were described as new.

CAMBRIDGE.

Philosophical Society, January 24.—Mr. F. Darwin, President, in the chair.—A new method in combinatory analysis with applications to Latin squares and associated questions, Major P. A. Macmahon, R.A., F.R.S. The author applies the theory of symmetric functions to obtain solutions, hitherto unachieved, of problems in combinatory analysis associated with the question of Latin squares.—On Abelian functions in connection with two-dimensional fluid motion, H. F. Baker.—On the production of a cloud by the action of ultra-violet light on moist air, C. T. R. Wilson. If the light from an arc lamp be brought to a focus, by means of a quartz lens, within a vessel containing moist dust-free air, a bluish fog becomes visible in the course of a few minutes along the path of the light. The cloud particles remain in suspension for hours after the light has been cut off. The phenomenon is shown even in unsaturated air, but the faint blue haze which then develops takes much longer to form. When the radiation is not sufficiently intense to show these effects, a dense fog can still be obtained by bringing about slight supersaturation by expansion. These clouds, unlike those obtained by Tyndall (*Phil. Trans.*, 160, p. 333, 1870) and by Aitken (*Edin. Trans.*, 39, I. p. 15, 1897) by the action of light on various vapours, are due to the ultra-violet rays alone; for if a thin sheet of glass or mica (substances which are opaque to these rays) be interposed, not a trace of fog or rain is formed even when a high degree of supersaturation is brought about by expansion. It is possible that the small particles to which the blue of the sky is due are the result of this action of the ultra-violet rays, of which sunlight, when it first enters our atmosphere, doubtless contains a plentiful supply.—On the use of logarithmic co-ordinates in physics, J. H. Vincent. The paper divides all curves into "translatants" and "non-translatants." As examples of the former, Mr. Boys' chart of wave and ripple velocities is referred to, and an impedance chart is constructed. Non-translatants are not in general suited to this method of plotting. By suitable devices the logarithmic homologue of the equation for the propagation of waves on a frozen sea is drawn, although this is a non-translatant. The paper concludes with suggested uses of tri-dimensional logarithmic coordinates and semi-logarithmic coordinates.—On the diffuse reflection of Röntgen rays, Prof. J. J. Thomson. The paper contains the theory of the electromagnetic effects produced by suddenly setting an electrified body in motion. It is shown that a thin pulse of intense electromagnetic disturbance is generated which travels outwards with the velocity of light. The magnitude of the magnetic force at a point P due to the pulse is when the velocity w of the particle is small compared with the velocity of light equal to $we \sin\theta/2ar$, where $2a$ is the diameter of the particle O, e the change on the particle, r the distance PO, and θ the angle between OP and the direction of motion of the particle. Using the theory of the Röntgen rays given by the author in the *Phil. Mag.*, February 1898, the result just quoted is applied to find the intensity of the radiation scattered when Röntgen rays are incident on a collection of positively and negatively electrified bodies. The intensity of the scattered rays in a direction making an angle θ with the incident ray varies as $(1 + \cos^2\theta)$. So that the intensity of the scattered light when $\theta = 0$ would be twice that when $\theta = \pi/2$. Photographs taken by the scattered rays in these two positions showed that there was little, if any, difference of intensity in these directions. This result indicates that the scattered Röntgen radiation is probably more nearly allied to fluorescence than to the scattering of light by small particles. Experiments were made on the absorption of the light diffusely "returned" (to use Sir George Stokes' phrase) from lead and platinum by thin sheets of platinum and red lead; these showed that there was no strong selective absorption by thin platinum of rays scattered from platinum, or by lead of rays scattered from lead. A mathematical investigation is given to show that in the case of rapidly damped radiations selective absorption would not be exhibited.

PARIS.

Academy of Sciences, February 14.—M. Wolf in the chair.—On certain singular examples of successive approximations, by M. Émile Picard.—On the masses of the planets, by M. E. Roger.—Remarks on a note by M. Anceaux. Of the three laws given in this note, the first only is rigorously exact, the second is an approximation, and the third a consequence of the two others.—*Résumé* of the solar observations made at the Royal Observatory of the Roman College during the second half of 1897, by M. P. Tacchini. Observations are given for the distribution of sunspots, protuberances, and faculæ.—On the extension of the decimal system to the division of the day and the circle; advantages and practical methods, by M. J. de Rey Pailhade.—On the singular Abelian functions, by M. G. Humbert.—On some general algorithms, and on iteration, by M. Léméray.—On the surfaces which admit an infinite, discontinuous group of birational transformations, by M. P. Painlévé.—Deformation of metals, by M. Mesnager.—Direct measurement of the period of the Hertzian oscillations, by M. L. Décombe. Photographs of the explosive spark from a revolving mirror showed that it is possible to fix on a gelatino-bromide plate oscillations of which the period is less than a five-millionth of a second. The necessary conditions were a very high velocity of rotation of the mirror, the employment of a collimating lens, in the focal plane of which the spark is placed, of very small focal length. The results obtained confirmed the theory of Poincaré and Bjerknes, according to which the radiations emitted are of one wave length only.—Emission of secondary rays in air under the influence of the X-rays, by M. G. Sagnac. It is shown experimentally that air through which the X-rays are passing gives off secondary radiations capable of affecting an electroscope. This phenomenon is comparable to the emission of light by a liquid containing a small quantity of a fluorescent substance in solution during the passage of a luminous bundle.—On a new contact-breaker for induction coils, by M. V. Crémieu. The ordinary form of contact-breaker used in induction coils is attended with the inconvenience that the oppositely induced electromotive forces are not symmetrical. This difficulty is overcome by the apparatus described, but at the expense of a larger amount of energy, since to obtain a spark of a given length the electromotive force of the primary circuit must be double that required by the ordinary form.—On a crystallised hydride of dicamphene, by MM. A. tard and G. Meker The dry hydrochloride of terebenthene is fused and sodium added; a hydrocarbon $C_{20}H_{34}$ can be obtained from the product of the reaction. It is noteworthy as being one of the few terpenes obtainable in the crystallised state.—Action of cyanamide upon bromanil in presence of potash, by M. H. Imbert. The substance obtained appears to be the potassium salt of dicyanimino-dibromo-dioxyquinone.—Researches on organic phosphorus, by M. J. Jolly. The experiments given tend to show that phosphorus does not exist in the organic molecule in an unoxidised state.—The production of carbon monoxide in the blood after inhalations of chloroform, by M. L. de Saint-Martin. In attempting to confirm the statement of MM. Degrez and Nicloux that prolonged inhalation of chloroform produces carbon monoxide in the blood, the author finds that normal blood, treated in a vacuum at 40°, with an organic acid, also gives off small quantities of carbon monoxide.—On the oxydase of *Botrytis cinerea*, by M. J. Laborde. A study of the effect of this oxydase upon the fermentation of grapes, with especial reference to the decolorisation of the wine.—Tuberculosis and pseudo-tuberculosis, by MM. Bataillon and Terre. The authors have previously described a form of the tubercle bacillus capable of existing in cold-blooded animals, such as the frog. A third form of this bacillus, originally human, has now been obtained after a passage of three days in the frog. On solid media this form grows rapidly at temperatures between 12° and 48°, and is distinguished from the form previously described by three points: appearance of cultures, power of easily developing at high temperatures, and rendering beef-broth turbid. The colonies on the potato are brownish, and the bacilli are not stained by the methods of Gram or Ehrlich. Experiments on animals led to the conclusion that many cases of pseudo-tuberculosis are in reality true tuberculosis, having as a cause one of the numerous forms of Koch's bacillus.—The parasites of cancer and sarcoma, by M. F. J. Bosc. As a result of the examination of numerous tumours it was found that the abnormal formations foreign to the tissues could be grouped under five morphological types: microbial forms, granulations, cellular forms of very variable origin, encysted

forms and sarcodic forms. All these forms exist in epithelioma, carcinoma and sarcoma, but the last-named contains especially the microbial forms and the granulations.—Remarks on the Bloch-appendices in the siluroids of genus *Aspredo*, by M. Léon Vaillant.—On the place of the sponges in classification, by M. Yves Delage.—Influence of the X-rays on germination, by MM. Maldiney and Thouvenin. From experiments upon *Convolvulus arvensis*, *Lepidium sativum*, and *Panicum miliaceum*, it would appear that the X-rays hasten germination.—The melanosis of the mandarin orange, by M. Trabut.—Detection and rapid estimation of manganese in plants and vegetable earths by a colorimetric method, by M. P. Pichard. The method is based upon the ignition of the ash with an alkaline carbonate, and subsequent formation of permanganate by the use of lead peroxide and nitric acid.—On the conglomerate of the Amône in the Swiss Ferret valley, by MM. L. Duparc and F. Pearce.—On the formation of anhydrite by the calcination of gypsum at high temperatures, by M. A. Lacroix.—On the origin of the overlapping layers in the region of Ubaye, by MM. W. Kilian and E. Haug.—On some phenomena of fluvial erosion and corrosion, by M. Jean Brunhes.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 24.

ROYAL SOCIETY, at 4.30.—Meeting for Discussion.—Subject: The Scientific Advantages of an Antarctic Expedition. The Discussion will be opened by Dr. John Murray, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—On the Manufacture of Lamps and other Apparatus for 200 volts Circuits: G. Binswanger, Byng.

FRIDAY, FEBRUARY 25.

ROYAL INSTITUTION, at 9.—The Theory of Colour Vision applied to Modern Colour Photography: Captain W. de W. Abney, C.B., F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Problem of Train Resistance: C. E. Wolff.

SATURDAY, FEBRUARY 26.

ROYAL INSTITUTION, at 3.—The Structure of Instrumental Music: W. H. Hadow.

PHYSICAL SOCIETY (Eton College), at 4.—The Rev. T. C. Porter will describe (1) a New Theory of Geysers; (2) a New Method of Viewing Newton's Rings; (3) Experiments bearing on the Sensation of Light; (4) a Method of Viewing Lantern Projections in Stereoscopic Relief; (5) Winter Observations on the Shadow of El Teide, with a New Method for Measuring approximately the Diameter of the Earth; (6) Temperature of the Water of Niagara.

MONDAY, FEBRUARY 28.

SOCIETY OF ARTS, at 8.—The Principles of Design in Form: Hugh Stannus.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Annual Range of Temperature in the Surface Waters of the Ocean, and its Bearing on Oceanographical Problems: Dr. John Murray, F.R.S.

INSTITUTE OF ACTUARIES, at 5.30.—The Relation of the Actuarial Profession to the State: J. Nicoll.

TUESDAY, MARCH 1.

ROYAL INSTITUTION, at 3.—The Simplest Living Things: Prof. E. Ray Lankester, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—On the Perforate Corals collected by the Author in the South Pacific: J. Stanley Gardiner.—The Myology of the Terrestrial Carnivora, Part 2: Prof. B. C. A. Windle and F. G. Parsons. On the Brain and some other Points in the Anatomy of *Bassaris*: F. E. Beddard, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Papers to be further discussed: The Theory, Design, and Practical Working of Alternate-Current Motors: Llewelyn B. Atkinson.—Dublin Electric Tramway: H. F. Parshall.

RÖNTGEN SOCIETY, at 8.—Photographic Activity and Penetration of Röntgen Rays at Different Vacua: J. H. Gardiner.—Other Papers by Wilson Noble and Hall Edwards.—Mr. Isenthal will show some New Apparatus.

WEDNESDAY, MARCH 2.

SOCIETY OF ARTS, at 8.—Kites: their Theory and Practice: Captain B. F. S. Baden-Powell.

THURSDAY, MARCH 3.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Relationship of Variations of the Ground Water Level to the Incidence of Malarial Fevers in Chotta Nagpur, Bengal: Dr. L. Rogers.—On the Depletion of the Endosperm of *Hordeum vulgare* during Germination: H. T. Brown F.R.S., and F. Escombe.—Experimental Observations on the Early Degenerative Changes in the Sensory End Organs of Muscles: Dr. F. E. Batten.

ROYAL INSTITUTION, at 3.—Recent Researches in Magnetism and Diamagnetism: Prof. J. A. Fleming, F.R.S.

LINNEAN SOCIETY, at 8.—On the Sense Organs of the Lateral Line in certain Fishes: F. J. Cole.—On the Occurrence of *Carex helvola* in Britain: G. C. Druce.—On Arctic Spiders from Franz Josef Land: Rev. O. Pickard-Cambridge.

CHEMICAL SOCIETY, at 8.

FRIDAY, MARCH 4.

ROYAL INSTITUTION, at 9.—Some Recent Results of Physico-Chemical Inquiry: Prof. T. E. Thorpe, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Andrée and his Balloon: H. Lachambre and A. Machuron (Constable).—Year-Book of the Royal Society, No. 2, 1897-98 (Harrison).—Meteorology in Mysore, 1896: J. Cook (Bangalore).—Magnets and Electric Currents: Prof. J. A. Fleming (Spon).—Twenty-fourth Annual Report of the Local Government Board, 1894-95. Supplement: Inland Sanitary Survey, 1893-95 (Eyre).—Report of the Meteorological Service of the Dominion of Canada, 1890 and 1895: R. T. Stupart (Ottawa).—Storm and Sunshine in the Dales: P. H. Lockwood (E. Stock).—Pike and Perch: A. Jardine (Lawrence).—The Kingdom of the Yellow Robe: E. Young (Constable).—Lessons with Plants: L. H. Bailey (Macmillan).—Through China with a Camera: J. Thomson (Constable).—Proceedings of the London Mathematical Society, Vol. xxviii. (Hodgson).—Leçons sur l'Intégration des Équations: E. Goursat, 2 Vols. (Paris, Hermann).—Œuvres Scientifiques de L. Lorenz, Tome 1, Deux Fasc. (Copenhague, Lehmann).—A Treatise on Universal Algebra, with Applications: A. N. Whitehead, Vol. 1 (Cambridge University Press).—Peneroplis: F. Dreyer (Leipzig, Engelmann).

PAMPHLETS.—The Twelfth and Concluding Memoir on the Theory of Screws: Sir R. Ball (Dublin).—Die Geometrisch-Optischen Tänschungen: W. Wundt, No. 2 (Leipzig, Teubner).—A Suggested Improvement of the Current Theories of the Tides: J. H. S. Moxly (Rivingtons).—Vaccination a Delusion: Dr. A. R. Wallace (Sonnenschein).

SERIALS.—National Geographic Magazine, January (Washington).—Monthly Weather Review, November (Washington).—Zoologist, February (West).—Proceedings of the Bristol Naturalists' Society, new series, Vol. viii Part 2 (Bristol).—Studies from the Yale Psychological Laboratory, Vol. 4, 1896 (New Haven).—Journal of the Franklin Institute, February (Philadelphia).—Astrophysical Journal, January (Chicago).—Journal of the Chemical Society, February (Gurney).—American Anthropologist, November and December (Washington).—Proceedings of the Indiana Academy of Science 1896 (Indianapolis).

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