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THE EVOLUTION OF COUNTING.

The Number Concept: its Origin and Development. By Levi Leonard Conant, Ph.D. 8vo. Pp. 218. (New York and London: Macmillan and Co., 1896.)

PROF. CONANT has produced a book which supplies a gap in scientific literature, and on it he has expended great diligence in collecting the materials, and circumspection in dealing with them. The problems of the origin and development of the number concept are important alike to the anthropologist and the psychologist, and all attempts to connect these two branches of science are most welcome; for the scope of the book, therefore, and for its execution, Dr. Conant is to be congratulated.

In a few instances, languages have been found to be absolutely destitute of pure numeral words; the Chiquitos of Bolivia, for example, expressed their idea for one by *etama*—"alone"—they had no real numerals. A few other South American languages are almost equally destitute of numeral words, but some indirect expression shows a conception of the difference between 1 and 2, or, at least, between 1 and many.

There is a surprising paucity of numeral words among the native races of South America, Australia, New Guinea, and among the Pigmy peoples. Many of these have only two numerals. It is probably true that no Australian language contains a pure, simple numeral for 4; a few tribes have a numeral for 3. The same obtains for the Papuan as opposed to the Melanesian tribes of British New Guinea, whereas the numerals of the latter (S. H. Ray, *Trans. Internat. Congr. Orientalists*, London, 1892–93, p. 770) have decided affinities with those of the Melanesian archipelagoes. It is also characteristic of the Australians and the Papuans (as here restricted) to count by pairs; but this is not a Melanesian custom, though it is employed in Polynesia. The Mincopies (Andaman Islands) and the Veddas have numerals for only 1, 2, beyond which they say "and one more, and one more," &c.; for the Bushmen, 3 means simply many. The Pigmies of Central Africa, according to Stanley, have separate numerals up to 6, but the words for 1 (*ujju*) and 6 (*ijju*) are so closely akin, that it suggests that 6 was to them a new 1. These Pigmy people are considerably in advance of the others just referred to, so far as their system of numeration is concerned.

The author carefully points out that it is not a general law that those races which are lowest in the scale of civilisation have the feeblest number sense or the least possible power of grasping the abstract idea of number. If the life of any tribe is such as to induce trade and barter, a considerable quickness in reckoning will be developed among them. In giving 1, 2, 3, 5, 10, or any other small number as a system limit, it must not be overlooked that this limit mentioned is in all cases the limit of the spoken numerals at the savage's command. The actual ability to count is almost always, if not always, somewhat greater than their vocabularies would indicate. By means of their fingers, toes, or other parts of their body, or by the aid of sticks and other objects, the savages with even the lowest number concept can indicate higher numbers than their spoken numbers. Most proceed with more or less readiness as far as their fingers will carry them, and this limit is frequently extended to 20.

The primitive savage counts on his fingers until he has reached the end of one, or more probably of both, hands. Then if he wishes to proceed further some mark is made, a pebble is laid aside, a knot tied, &c., to signify that all the counters at his disposal have been used. Then the count begins anew, the terms already used are again resorted to, and the name by which the first halting-place was designated is repeated with each new numeral; hence *thirteen*, *fourteen*, &c. In Teutonic languages the smaller number is prefixed to the base, *e.g.*, *fünf und zwanzig*; but the direct method (*twenty-five*) is far more common, though both are found in all parts of the world.

The formation of numeral words by subtraction, though it seems decidedly odd to us, is of common occurrence. In Latin, 19 is *undeviginti* (1 from 20); the Bellacoola, of British Columbia, say for 19 "one man less 1," as in their numeral scale 20 is "one man," for them 15 is "one foot," and 16 "one man less 4." Many tribes seem to regard 9 as "almost 10," and to give it a name which conveys this thought.

The following Zuñi scale is interesting:—

1, "taken to start with."
2, "put down together with."
3, "the equally dividing finger."
4, "all the fingers but one done with."
5, "the notched off."
6, "another brought to add to the done with."
7, "two brought to and held up with the rest."
8, "three brought to and held up with the rest.
9, "all but all are held up with the rest."
10, "all the fingers."
11, "all the fingers and another over above held."
20, "two times all the fingers."
100, "the fingers all the fingers.
1000, "the fingers all the fingers times all the fingers."

While the savage almost always counts on his fingers, it does not seem at all certain that these words would necessarily be of finger formation. The numerals for 1 and 2 would be formed long before the need would be felt for terms to describe any higher number. Universal as finger counting has been, finger origin for numeral words has by no means been universal. In nearly all languages the origin of the words for 1, 2, 3, and 4 are so entirely unknown that speculation respecting them is almost useless.

The first real difficulty which the savage experiences in counting, the difficulty which comes when he attempts to pass beyond 2, and to count 3, 4, and 5, is of course slight. Beyond 5, primitive man often proceeds with the greatest difficulty. Whenever the fingers and hands are used at all, it would seem natural to expect for 5 some general expression signifying *hand*, for 10 *both hands*, and for 20 *man*. Such is the ordinary method of progression, but some people express 10 by *man*, perhaps because they do not use the toes in counting; thus the Api word for 200 is "10 times the whole man taken 2 times."

Without the establishment of some base, any system of numbers is impossible. A binary system is characteristic of Australia, but it occurs elsewhere; instances of quaternary numeration are less rare than are those of ternary, and there is reason to believe that this method of counting has been practised more extensively than any other, except the binary and the three natural methods—the quinary, the decimal, and the vigesimal. There is probably no recorded instance of a number system formed on 6, 7, 8, or 9 as a base.

In its ordinary development the quinary system is almost sure to merge into either the decimal or the vigesimal system, and to form with one or the other, or both of these, a mixed system of counting. Whether or not the principal number base of any tribe is to be 20, seems to depend entirely upon a single consideration—are the fingers alone used as an aid to counting, or are both fingers and toes used? If the former, the resulting scale must become decimal. The quinary is never the principal base in any extended system. The Celtic races showed a preference for counting by twenties, which is almost as decided as that manifested by the Teutonic races for counting by tens.

With such a vast field from which to collect materials for his study, it is inevitable that Prof. Conant should have overlooked some authors who might have furnished him with additional examples, and that he should have made a few slips. Among the omissions may be noted Dr. Von den Steinen's discussion on the numeration of the Bakaïri in his "Unter den Naturvölkern Zentral-Brasiliens," Mr. Ray's studies in the languages of New Guinea, Mr. H. Clifford's account of the Negritos of the Malay Peninsula (*J. Roy. As. Soc. Straits Br.*, 1892), Dr. S. Günther's study on numerical systems (*Beitr. Anth. Urgesch. Bayerns*, 1890, ix.). On p. 96 the Torres Islands in the New Hebrides are confused with Torres Straits, and the languages of Darnley Island (p. 24) and Warrior Island (p. 107) are Papuan (Torres Straits), and not Australian dialects. Anthropologists would have been thankful if the ethnological aspect of the question had been dwelt upon a little more fully; for example, the ethnologist is not at a loss to account for the superior development of the number sense in the Nicobarese as compared with that of the neighbouring Andamanese. The book is admirably printed, and is packed with valuable information clearly and logically arranged.

A. C. HADDON.

GEOMORPHOGENY.

Leçons de Géographie physique. Par Albert de Lapparent. Pp. xvi. + 590. Illustrations. (Paris: Masson et Cie., 1896.)

IF Prof. de Lapparent had been writing in America, he would have introduced the word *Geomorphogeny* in the title of his latest book; but in Europe, he observes in the preface, there is some risk of frightening those whom he would wish to instruct if they are confronted by an unfamiliar term at the outset. The title "Lessons in Physical Geography," although quite without terror, is not fairly descriptive, for this fine volume is no ordinary treatise of physical geography in the usual vague sense. "Lessons on the Genesis of Geographical Forms" would, in the author's view, and in ours, be more descriptive; but the full scope of the work would, perhaps, hardly be suggested even by such a title.

Whatever he may call it, a book by Prof. de Lapparent is sure of a cordial reception by students and men of science in all parts of the world, for he combines the traditional grace and charm of French scientific writers with a temperateness of judgment and width of view which, rightly or wrongly, foreigners do not always associate with the writings of his countrymen. The avowed object of the work is to furnish a body of doctrines, logically linked together, which shall help to place geography on a truly rational basis. This basis is, in Prof. de Lapparent's opinion, a geological one, for he argues that the knowledge of no geographical form can be complete unless its antecedent conditions are known, and in geology alone can the clue to these be found. We might perhaps demand an even deeper foundation than geology, by taking into account the relations of form and position and the means of determining these mathematical conditions by astronomical observations; but geology may be freely accepted as the layer in the pyramid of geographical science which comes immediately below physical geography, and is most indissolubly connected with it.

The volume takes the form of twenty-five "lessons" or chapters; but it may be divided into two parts, approximately equal in bulk—the enunciation of the general principles of geomorphogeny, and the application of these to the configuration and structure of each of the continents. The great lines of terrestrial relief are first outlined, and the conditions of land-modelling are then discussed in fuller detail and with a more comprehensive grasp than in any other book of the kind with which we are acquainted. The various agencies at work on the land-surface are treated in turn, and their action illustrated by a great wealth of instances. The normal course of erosion in a region is first explained, and the various complications introduced by structural conditions, classed as genetic and tectonic, are then introduced. Genetic conditions are those produced by the original formation of the portion of land under consideration, *e.g.* whether sedimentary, igneous, or glacial; tectonic are those subsequently produced by movements of the crust. Considering the predominant part played in the modelling of the land by running water, it is natural that several lessons should be devoted to this agency, in the discussion of which a prominent place is given to the view of the cycle of erosion so vigorously set forth of recent years by Prof. W. M. Davis, of Harvard. One can hardly say of any part of this theory that it is new. Geologists have worked so long at the phenomena of erosion, that it is now difficult to fit each stage of the process with the name of the first observer or theoriser. But there is no doubt that, however universally the knowledge of the processes of the origin of scenery by denudation were known, the credit for expressing the nett result of them in terse and appropriate language is due to Prof. Davis, and his mode of statement is accepted by Prof. de Lapparent with full acknowledgment. The conception of the origin of surface features through a process of evolution, a continuous succession

of adaptations to environment, is clearly stated ; and the view of a land-surface modelled by the action of its rivers, and passing through the consecutive stages of adolescence, maturity, old age, and decrepitude, with a possible rejuvenescence by partial upheaval during the later stages, is set forth in an attractive manner. This is perhaps the nearest approach to a theory of physical geography which has yet been advanced, and the results of applying it serve to invest with fresh interest the monotonous topography of regions which, having run their course of natural life, await in the condition of a "peneplain" the revivifying tectonic power which will start their old sluggish rivers into fresh activity, throwing them out of harmony with their surroundings, and setting them to work to dig, carry, and build until they have created a new land, and, as is the way of the world, again destroyed it.

Looking on a river as an individual, or rather as a living system, any change in one part is shown to affect the whole. For example, the slow cutting down of the outlet of a lake, the surface of which serving as a base-level has dictated the configuration of the country above, lowers the level, accentuates the upper slopes, quickens the tributaries one by one, causing them to erode their valleys more vigorously, and in time perhaps to work back and tap the affluents of some other system, reversing their flow and extending the sphere of the power of the main river. The continual adaptation of river to land may in large measure be taken as the key to the origin of scenery in regions of normal drainage.

Prof. de Lapparent does not view aqueous erosion as all-powerful ; he gives great weight to tectonic changes in preparing the way and laying down the lines along which erosion is to act, as, for example, in outlining the depressions of fjord and lake valleys. To glaciers he assigns a comparatively humble place : they cannot dig, but they are excellent polishers, and inexhaustible carriers ; while if they cannot make valleys, they may at least preserve them unfilled for future occupation by lakes. The treatment of regions of internal drainage with their arid climates and characteristic æolian land-forms is particularly good.

We cannot, of course, attempt to summarise here a volume of six hundred pages, in which there is a steady unfolding of a definite plan supported by innumerable examples. It is only possible to allude to the chief contents. After the geomorphogenic introduction, two lessons are given to geological principles and their application in palæogeography, or the reconstruction of the map of the world in past ages. This introduces the systematic description of Europe, and of the other continents in less detail, from the point of view of the origin of their land-forms. Although necessarily in general terms, the description is sufficiently full to give a fair idea of the origin of all the more striking features of mountain and plain, and the general hydrographic system. There are points which might be criticised in detail ; for example, one of the most important features in the existing geography of Scotland—the 25-foot raised beach which forms the sites of almost all the coast towns, both on the east and west—is not mentioned, but the larger features are very clearly described.

The work of M. de Lapparent builds largely upon the foundations of Suess, Penck, Richthofen, and numerous British and American geologists whose contributions to knowledge are carefully acknowledged. It is emphatically a book for teachers and for students of geography ; a model of strong and clear reasoning in the elaboration of a theory where no theory was generally recognised before, and a rich storehouse of facts and references full of suggestiveness, and affording evidence of the widest reading and the most careful thought.

HUGH ROBERT MILL.

THE RESEARCHES OF NEWELL MARTIN UPON THE HEART AND RESPIRATION.

Physiological Papers. By H. Newell Martin. Reprinted as Memoirs from the Biological Laboratory of the Johns Hopkins University. III. 4to. Pp. 264. (Baltimore : Johns Hopkins Press, 1895.)

THE Johns Hopkins University at Baltimore was founded in the year 1876, and Newell Martin left Cambridge, to the personal regret of all his English friends, to become the first occupant of the chair of Biology. This he held during seventeen years, in the course of which the department over which he presided grew from small beginnings to large and extensive laboratories fully furnished with apparatus, animals and privatdocents in the most up-to-date Teutonic style. In the summer of 1893, Prof. Martin was compelled by ill-health to resign his professorship, and in recognition of the value of his work, and as a token of their affection and esteem for him, his American friends and pupils have republished the scientific papers and some of the public addresses which were written and delivered by him during his tenure of the chair.

Most of the work done by Prof. Martin during this period is upon the action of the mammalian heart, and the papers upon this subject occupy nearly one half of the volume. As all physiologists know, Martin was the first to carry out with success experiments upon the action of the isolated heart of the mammal, most of our knowledge regarding the isolated heart having been derived from experiments upon cold-blooded animals. It was not to be expected that there would be any serious divergences in the mode of action of the heart in the two cases, and in fact the results which Martin and his pupils obtained regarding the effects of pressure of temperature and of drugs were such as might probably have been anticipated. Nevertheless it marked a distinct advance in what the Royal Society officially terms "natural knowledge" to have succeeded in determining these points in the mammal, and that Society set the stamp of its recognition upon the work by selecting one of the most important of these papers as the Croonian lecture for 1883.

The other researches relate exclusively to the mechanism of respiration in the frog and in the mammal. The peculiar character of the respiration in the former animal has always excited the interest of physiologists, and in more recent years it had been studied graphically by Paul Bert and Burdon-Sanderson. Martin subjected the normal respiratory movements in the frog to a careful examination, and arrived at con-

clusions of much interest. He was also able to show, both in the frog and mammal, the influence of the mid-brain upon those movements.

One of the most important pieces of work here recorded is that in which Martin experimentally determined that the internal intercostal muscles are expiratory in their function throughout their whole extent, thus finally settling a question which had divided physiologists ever since physiology was recognised as a science. This he was enabled to do not by experiments upon models, nor upon the cadaver, but by direct observation in the living animal; a method which will always remain the only satisfactory one for solving such problems.

The physiologists of this country owe a debt of gratitude to their American colleagues for having provided them in so handsome a form with this important collection of monographs. E. A. SCHÄFER.

OUR BOOK SHELF.

Atlas d'Ostéologie. Articulations et Insertions Musculaires. By Prof. Ch. Debierre. Pp. viii + 92. (Paris: Alcan, 1896.)

THIS atlas contains 88 plates with 251 figures illustrating the human skeleton. Figures are also given to illustrate the ligaments of the various joints, and, further, for each bone the muscular attachments are indicated by red printing. The mode of development and microscopic of bone are illustrated by five figures, and in a few cases a certain amount of comparative osteology is introduced. The figures are by no means better than those given in the standard text-books, and it is a pity that no mention is made in each case of the amount of reduction or magnification made in the drawing. Some of the figures are very confused, and the individual parts difficult to recognise. This is especially the case with such figures as the base of the skull with the soft parts left attached (Fig. 82). In many cases it seems a mistake that the figures have not been drawn on a larger scale, as much room is often wasted on the plates.

Mechanics for Beginners. By W. Gallatly, M.A. Pp. 253. (London: Macmillan and Co., Ltd., 1896.)

THE special characteristics of this book are stated to be (1) the large number of examples—eight hundred—of which one hundred and sixty are worked in full; (2) the great attention given to work, power and energy; (3) the classification, in small sections, of problems of the same type, the method of dealing with each section being explained by a worked example. Teachers of elementary theoretical mechanics will know how to appreciate these important qualities of the book. The descriptions are very clear, and the diagrams are helpful. The student who uses the treatise as a text-book, familiarising himself with the illustrative examples, and working through only a part of the well-selected and comprehensive exercises, will be equipped for almost any examination in elementary theoretical mechanics. And he will, at the same time, lay up in his mind a fund of useful knowledge.

Engineer Draughtsmen's Work. By a Practical Draughtsman. Pp. 96. (London: Whittaker and Co., 1896.)

STUDENTS in technical schools will find in this book a number of valuable hints on the use of mathematical instruments and the work of drawing-offices. The information is very elementary, but its character is such that it will train young draughtsmen to be accurate and methodical in their work.

Forty-eight pages of advertisement are bound up with the ninety-six pages of text.

LETTERS TO THE EDITOR.

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Flying Engines.

IN the summer of 1893, I made some experiments on the effect of steam-jacketing small steam-engine cylinders by placing the whole of the cylinder and valve chest inside the boiler; the increase of economy was so marked, that I was led to try whether a small toy engine could be made to sustain its own weight in the air by the lifting power of an air screw on the crank-shaft.

Fig. 1 shows this little engine. The boiler is of seamless steel $2\frac{1}{2}$″ diameter, 14″ long, and ·01″ to ·015″ in thickness; the steam cylinder, single acting, $1\frac{1}{4}$″ diameter by 2″ stroke, and about ·03 thickness of tool steel; the piston is of thin cup form, also of tool steel; the admission valve is cylindrical, $\frac{5}{16}$″ diameter, cutting off at $\frac{3}{4}$ stroke. The whole of the valve and cylinder are within the boiler. Some parts of the engine were soft soldered, and some hard soldered; the screw is of cane covered with silk. The working pressure was limited to about 50 lb. per square inch. The total weight of the apparatus, with water, as in Fig. 1, is $1\frac{1}{4}$ lb.

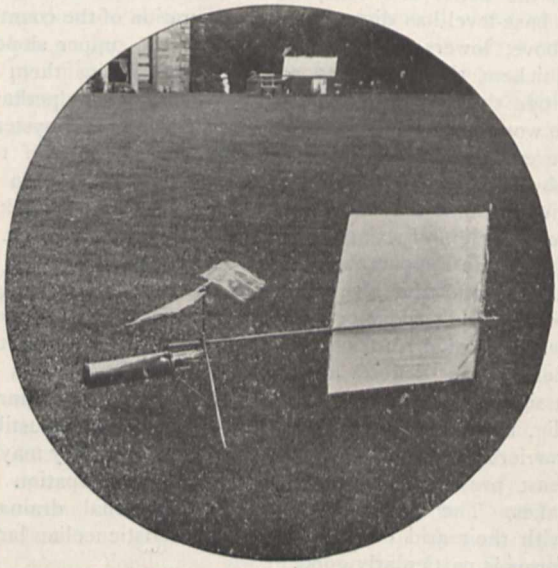

FIG. 1.—Steam engine and boiler working lifting screw; large plane to prevent rotation of boiler; total weight $1\frac{1}{4}$ lb. I.H.P. developed, $\frac{1}{4}$. Raised itself about 12 feet in the air, with steam contained in boiler. No firing after start. Initial pressure 50 lb. Maximum revolution about 1200 per minute.

Steam was raised by placing the boiler over a spirit-lamp, and when 50 lb. was registered on the gauge, and the engine started, it raised itself in the air vertically to a height of several yards. The revolutions of the engine were about 1200 per minute, and the i.h.p. $\frac{1}{4}$ horse-power.

The same engine was then mounted on a framework of cane, covered with silk, forming two wings of 11 feet span, and a tail, the total area being about 22 square feet. The total weight was now $3\frac{1}{2}$ lb., and when launched gently from the hand in an inclined horizontal direction it took a circular course, rising to a maximum height of about 20 feet. When the steam was exhausted, it came down, having traversed a distance of about 100 yards.

Fig. 2 shows the machine in mid-air. The photographs were taken by Mr. Gerald Stoney.

Considering the primitive construction of the apparatus, the result clearly showed that flights of considerable distance, possibly some miles, were quite possible with a small economical steam-engine mounted on aeroplanes.

The boiler was also found to be able to steam the engine continuously by using methylated spirits intead of water in the boiler,

and burning the exhaust as fuel; but when in flight, the force of the wind extinguished the flame.

It was clearly seen by the experiment that for practical commercial success of this class of steam apparatus an air condenser is essential, as the weight of water used in a few minutes' run

FIG. 2.—Same engine and boiler as before, attached to two inclined wing planes, and tail. From tip to tip of wings 11 feet; total surface of wings and tail about 22 square feet. Total weight of whole apparatus 3½ lb. Steam raised to 50 lb. per square inch, and started. Length of flight about 100 yards on level; maximum height during flight, about 20 feet. The propelling screw is seen in front and above the frame.

equals the total weight of engine and boiler. Without a condenser, the length of flight must necessarily be limited to a very few miles, and it would seem that the chief problem that workers in this field have to solve, is to obtain an efficient and light dry air condenser.

CHARLES A. PARSONS.

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Experiments on Röntgen Rays.

AFTER examining the fluorescent and photographic action of the rays (X_2) emitted on strongly *heating* a "focus tube," and finding them different to the rays which have been hitherto noticed (X_1), in that the relative transparency of flesh, bone, aluminium and glass differs for the two kinds of rays, it seemed desirable to try the effect of cooling the tube. Solid carbon dioxide and ether, and then solid carbon dioxide alone were employed, with the result that in both cases the fluorescence of screen and tube very rapidly died out and the current apparently failed to pass through the latter; as the tube gradually grew warm again, the fluorescence in it returned, not gradually, but very suddenly, at a temperature not very far below that of the room, the glass lighting up brilliantly, and the shadows of the bones showing on the screen with increasing distinctness. The emission of X_1 rays reaching a maximum at about 12° C. (a rough guess). On further heating X_2 rays begin to be evolved, judging from the increasing opacity of the flesh, whilst at the same time the fluorescence excited on the screen grows rather brighter, until the state recorded in my paper of June 4, is reached. As the condition for the maximum of X_1 rays probably varies to a certain extent with the different forms of tube, and even different specimens of the same kind of tube, with the degree of exhaustion, &c., it seems to follow from these experiments that in some cases warming the tube slightly might be useful in photographing the bones, whilst in others moderate cooling would be better; and from the accounts of various operators such would seem to be the case, though, as will be seen in the light of subsequent experiments, the particular method of heating or cooling is an important factor in the result. Solid carbon dioxide seemed very opaque to the rays when its low density is considered, but the effect may have been partly due to the frost condensed upon it from the air.

Wishing to verify for myself the results of other experimentalists, I next examined the tube for its action on a well-insulated brass plate, at first by connecting it with a sensitive electroscope, and afterwards with one of the standard Thomson's quadrant electrometers. As the experiments were all carried out with great care, it may be worth while to state that, using thin aluminium plate well earthed by soldering to a gas-pipe to screen the plate from all ordinary inductive action, the results were that the rays after penetrating $\frac{1}{16}$" of aluminium, discharged the plate completely, whether electrified positively or negatively, leaving no charge; and that if the plate were uncharged to begin with, it remained uncharged. This result is contrary to that observed by some; but from the delicacy of the instrument used, and the great distance between mirror and scale, there is little room left to doubt the accuracy of this result.

I also tried the effect on a radiometer, making similar experiments with a lampblacked Leslie's cube at about 94° C., and a candle, to see how far radiant energy from these sources was capable of penetrating the large aluminium screens used, in case any heat action might interfere with or mask the effect, and found, as others have, that when perfectly screened from all other action, the radiometer is entirely unaffected by the Röntgen rays, whether they be from a hot or a cold tube. The X-rays are also without action on the blackened face of a thermopile connected with a very sensitive galvanometer.

When the ordinary inductive effects of the tube were *not* screened, I found that the space external to the tube was at a high positive potential, which increased up to contact with the glass of the tube, and was of the same sign all over the bulb part. The cold bulb acted like a positively charged conductor whilst the discharge was passing, and attracted the radiometer arms just as any other charged body would, the effect lasting some time after the discharge stopped. The *unscreened* cold bulb also partly discharged the insulated plate, if the latter were strongly positively charged, it more rapidly discharged it when negatively charged, and left it with a positive charge of the same magnitude to begin with as that left when the plate was strongly positively charged, and lastly in the uncharged plate it developed a positive charge, again of the same magnitude; and this is what would naturally follow from the combination of the Röntgen rays effect with that of ordinary induction.

The X_2 rays seem to discharge a charged plate whether positively or negatively charged, but of this I cannot at present feel quite sure. Aluminium seems so far opaque to them that it is doubtful whether, when a screen is used, any of the rays get through, and when a screen is not used, one cannot feel certain that the effect observed is due to the X_2 rays either wholly or partly. After heating the tube and turning on the current, the whole tube is filled with a whitish, lavender-coloured light, which comes to a focus on the glass behind the kathode, above or below it; and whilst in this state and giving little or no fluorescence on the screen, the tube does *not* charge an *unscreened insulated plate*, but it does rather rapidly drain it of a previously communicated charge, either positive or negative. As the tube cools the lavender light retreats more and more from the kathode till at last it reaches the upper edge of the rectangular anode, when the positive charge, mentioned before, begins to be given to an uncharged insulated plate, but very slowly; as soon as the centre of the anode is bare of the lavender discharge, the potential of the unscreened plate very rapidly rises, and by the time the whole anode is clear of the lavender light the normal positive charge is re-established on the insulated plate. When the lavender glow retires from the kathode, it leaves behind it a space full of almost invisible light, which excites whitish green fluorescence on the glass of the bulb, and it is during this time that most of the rays are X_2, as is shown by the fluorescent screen, and photographs of a hand. I have not yet followed out the changes, relative and absolute, of potential of the anode and kathode, but it would seem almost certain that during the life of the lavender glow the whole tube acts as a relatively good conductor up to the time when the lavender glow crosses the centre of the anode—or the point where the axis of the kathode mirror cuts the anode, when there is an abrupt decrease in conductivity. I intend to investigate this point as soon as possible, and meantime pass on to what I imagine will prove of great use and interest to all who work with these tubes.

During some experiments on the tube with an 18" Wimshurst machine, I noticed that the X_1 rays, *i.e.* those showing the bones best, seemed to be emitted or not according as a brush discharge occurred on the wire leading to the anode of the tube, close to the tube, or not; and that the "electric wind" which blows from the tube as from all charged bodies, seemed also to vary in intensity with the X_1 ray flashes, the X_1 rays being most copiously emitted apparently at the moment when the brush discharge ceased or the wind moderated. I soon found that by making a small brush on the wire near the anode, or drawing

one with the finger from various parts of the tube (but not from all), best from the circular section of the tube in a plane with the edge of the kathode mirror, or in the very immediate neighbourhood of this line, the discharge producing the X_1 rays could be induced at will in a tube which was not otherwise giving them, or at any rate only giving them very feebly. Thinking, therefore, that the production of the X_1 rays must be in some way connected with intermittent leakage of the charge which resides on the outside of the tube (a continuous drain stops fluorescence and the emission of any rays capable of exciting my fluorescent screen altogether), I tried various ways of drawing off this charge intermittently, with several curious results; but the plan I find to work best is to place a ring of plain copper wire round the tube in the plane of the kathode mirror's edge, not touching the glass, but very near it, and then to cause a very rapid but intermittent discharge by bringing a wire connected to earth within a *very small* distance of some part of this ring, so far I cannot discover any particularly favourable position. The sparks between this ring and the earth wire are very small, but the effect on the fluorescent screen exceedingly striking.

What is still more interesting is that not only is the discharge of X-rays made much more regular (when the adjustment of the ring and wire is carefully made), but *the X-rays can thus be induced in a tube with a far weaker current;* the weakest current capable of inducing sparks between the ring and conductor seems capable of giving the X-rays, though they are more copiously emitted with a stronger current.[1] And not only so, but the tubes I have experimented with seem to show as yet no symptoms of growing fatigued. I have caused a brilliant emission of the X-rays from a tube which was before "fatigued"—at least, my coil seemed too weak to excite it, and the emission of X_1 rays has been sustained for over two hours with but a few short intervals, without showing any signs of diminution, judging by the screen effects; but on the withdrawal of the ring and wire, it at once failed to give any. This seems an important result, for it must greatly shorten the exposure and fatigue necessary for the photography of thick objects, and also greatly save the expense of the operations. Even breathing very gently, or blowing gently for a moment on the tube, specially on the parts mentioned, produces a marked bright flash which on examination will prove very rich in X-rays (a fact first noticed by Mr. P. H. Walter, my assistant). It would seem to follow from this that the "fatigue" is not altogether due to the diminution of the number of free particles in the tube, but to a kind of polarisation in which the glass acts as the dielectric separating a negative charge inside from a positive outside, the X-rays and fluorescence being dependent in some way on the oscillations consequent on the intermittent discharge of this condenser. I find that the tube also gives X-rays plentifully (though not so plentifully as when *both* terminals of the secondary circuit are used), when the positive terminal of the coil is connected in the usual way, and a wire from earth leads to what is usually the kathode; but only, so far as my experiments go, when the ring and other earthed wire are used. In this experiment the negative terminal was *not* connected with the earth, but insulated. The tube did not give X-rays, scarcely indeed any sign of the passage of electricity when the kathode wire only was retained in its usual position. The positive anode therefore seems in some respects to govern the emission of these rays.

In one experiment I placed a ring round the glass in the plane of the concave mirror of a Crookes' tube showing the "independence" of the positive pole from which I could not get any X-rays, and found on extracting a series of small sparks from it, with a wire leading to earth, a very decided increase in the still general fluorescence of the tube, but it gave no rays. Incidentally it was noticed that when a wire brush connected to earth was pressed lightly against the glass over the dark spot opposite the kathode, in every place touched by the wire, a most brilliant green fluorescence was excited, which faded away very quickly when the brush was withdrawn. It is therefore certain that much may yet be done to increase the efficiency of the tubes used for the production of X-rays by a further study of the action of neighbouring conductors upon them, and it seems that such a study cannot fail to throw light upon the cause of these hitherto unexplained phenomena.

Eton College, June 8. T. C. PORTER.

[1] I have succeeded in eliciting feeble X-rays from a Newton's focus tube with a small coil giving only 1/3rd of an inch spark—using the ring and earthed wire or finger.

Addendum, June 13.—After trying various forms of conductor, coating different parts of the X-ray tube with Dutch gold, and aluminium leaves, I find the following a most effective plan, and feel no hesitation in recommending it. First coat the external part of the tube between the kathode wire loop and the afore-mentioned plane of the edge of the kathode mirror, with any conducting metallic leaf; being careful that none of it projects beyond the trace of this plane on the glass of the tube. Next coil a stout piece of copper wire into a circular loop with a stem, and place it so that whilst the loop is in the plane of the edge of the kathode mirror, it does not touch either the glass of the tube or the metallic coating—I find an interval of about the $\frac{1}{16}$th of an inch answers excellently; and lastly, instead of using a wire to earth, bring the stem of the looped wire, or better still, a more pliable piece of wire connected with the loop stem, within a very short distance of the part of kathode wire from the coil close to the tube. The adjustment is easily made in practice, and the emission of X_1 rays which follows will, I think, be found satisfactory, to say the least, especially when it is remembered that without the looped wire the tube may be giving no X-rays at all.—T. C. P.

Koch's Gelatine Process for the Examination of Drinking-Water.

I DO not find that Dr. Percy Frankland advances any substantial evidence in his letter of May 12, in support of his broad and unqualified claim that he was the first person in this country who adopted the Koch method and applied it to the London water supply.

Dr. Percy Frankland states that he has "failed to find in Dr. Angus Smith's publications any mention whatsoever of cultivation on plates or their equivalents in any shape or form," and which he "holds to be the essence of the process which bears the name of Koch, and to which modern bacteriology is so profoundly indebted."

Now if Dr. Percy Frankland will turn to page 28 of Dr. Angus Smith's report to the Local Government Board, he will find Dr. Angus Smith writing as follows:—"It may be better to give up test-tubes entirely—equally good results have been obtained by using other vessels." As a matter of fact, photographic glass-plates were used in some of Dr. Angus Smith's experiments, also flat-bottomed flasks, desiccators, &c.; consequently if Dr. Percy Frankland's contention is correct, that the essence of the process which bears the name of Koch consists in the use of plates or their equivalents, Dr. Angus Smith at all events can be credited with having adopted the essence of the process. The main value, however, of Dr. Koch's invention was in the use of gelatine for preserving, as Dr. Angus Smith said, "the indications of organic vitality, and of affording an opportunity for the expansion of living germs in water, keeping a record for a time both of the quality and intensity of life in the liquid, and enabling the smallest points to exert their energies, and, as it were, to build their structures, the size and numbers of which can to some extent be measured and counted"

Dr. Koch was the first to use gelatine, and it was from him Dr. Angus Smith learned its use; for he says, "I seized on the use of gelatine with great earnestness, and soon satisfied myself that there was much to be gained by its use. . . . Dr. Koch has himself informed me that he is glad I have taken up the subject . . . a subject being more fully developed under Dr. Koch by Dr. Rozahegyi, and chemists must prepare for a new condition of things."

With regard to Dr. Percy Frankland's statement that Dr. Angus Smith distinctly deprecated rendering the medium more nutritive, I do not agree with it, inasmuch as Dr. Angus Smith clearly stated that "experience must discover whether this is an advantage . . . the use of sugar in addition to the gelatine renders the examination of water by this method less dependent on the opinion of the operator, and a photograph may be taken of each specimen, and the result preserved as evidence."

Whilst wishing in no way to detract from the value of the work which has been done by the use of the modified Koch's process, and from developments of bacteriological methods since the investigation of Dr. Angus Smith, I believe that I have quoted sufficient evidence to show that Dr. Angus Smith was the first chemist in this country who "seized on" and applied to practical purposes Dr. Koch's gelatine process of 1881; and his name will ever be associated with the historical development and application of Koch's gelatine process in this country; and

as the pioneer worker in the bacteriological method for the examination of drinking-water involving the use of solid culture material, viz. gelatine. FRANK SCUDDER.

Ellerslie, Alderley Edge, June 5.

A Prognostic of Thunder.

As the thunderstorm season has now set in, may I call the attention of weather observers to what seems to me an almost infallible prognostic of thunder, which was described in a letter in NATURE of July 5, 1888.

It consists in the formation of a small group of *parallel streaks* of cloud, seldom more than three or four in number, definite in form, and limited in extent and duration, appearing either as white streaks on the blue, or more rarely as darker streaks against nimbus or cumulo-nimbus.

I have very rarely seen these "parallel bars," as I have come to call them, without their being followed by thunder within twenty-four hours.

As the value of the prognostic seems to depend on the definiteness, small magnitude, and short duration of the "bars" (since one may sometimes see a large portion of the sky covered with rippling clouds which are followed only by rain without thunder, or not even by rain), their connection with thunderstorms seems to be explicable by the view that they are "interfret clouds" of very limited extent, indicating the superposition of atmospheric strata of very unequal temperature or humidity, with a *restlessness* which shows itself in local and temporary irruptions from one stratum into the other; an irregular condition very likely to be associated with electrical disturbance.

I may add that these "bars" are very readily detected after being once seen, and very easily noted; and they deserve, I think, more attention from meteorologists than they have received. B. WOODD-SMITH.

Hampstead Heath, N.W., June 10.

Tufted Hair.

I HAVE had, within the past few days, my first opportunity of examining closely the living head and hair of the African Negro, on several "Kru boys" from the West Coast. Their hair, which was cut moderately short, presented the usual appearance of a congeries of tufts arranged in a more or less linear manner, but when closely investigated it was found to be uniformly distributed over the scalp—each cork-screw tuft, resulting from the separate hairs on amall adjacent areas, intertwisting together and forming a silky compressed curl. In New Guinea I investigated the manner of growth of the hair on a large number of natives from widely distant regions, on many of whom the body was also covered with, to all appearance, little distinct spirals. On close scrutiny, and with a little trouble, these "cork-screws," both on head and body, could be perfectly uncurled and separated out into individual hairs growing from roots as nearly as possible equidistant from a central hair, round which the others coiled themselves, each hair being in fact a twining-plant-like structure, laying hold of a neighbouring hair as a supporting stake. Both on body and head the hair follicles were evenly distributed. These facts, as regards the African, are already quite well known from the investigations of Prof. Virchow and others; but it may not be without interest if I record, after this opportunity of comparing the Melanesian with the Negro, that the growth of their hair in both races is identical.

The Museums, Liverpool, June 14. HENRY O. FORBES.

LORD KELVIN.

AS these words are being printed, the Jubilee of Lord Kelvin's professorship is being celebrated in the most enthusiastic and magnificent manner at Glasgow. Delegates from all parts of the world are present, and among them are many of the most eminent representatives of science at home and abroad. From Paris to Moscow, Canada to Mexico, India to Australia, the whole civilised world unites in congratulating Lord Kelvin on the great work for science and the good of his fellow men which he has achieved, and in offering good wishes that he may have health and strength for the continuance of his glorious career. Though for fifty years he has been Professor of Natural Philosophy at Glasgow, has seen pass through his classes several generations of students, has been one of the greatest leaders in what has been pre-eminently a century of scientific discovery and advancement, has worked as few men can work, and withal has taken the keenest interest in all that ought to interest the true citizen of a great country, yet is his eye not dim, nor his natural force abated. It is the hope of all his friends, and of all the great army of scientific workers, who now are unanimous in doing him honour, that he may have before him many long years of happy and successful work.

Lord Kelvin, though born in Ireland in 1824, began his connection with Scotland and with the University of Glasgow at a very early age. His father, Professor James Thomson, still remembered by many alumni of Glasgow as a remarkably skilled and successful teacher, was appointed to the chair of Mathematics in 1832, so that when only eight years of age, William Thomson began his residence at the University of Glasgow. Only two or three years later he began to attend University classes, and soon attracted attention by a brilliance of intellect very remarkable in one so young. His proficiency in mathematics and natural philosophy was very great, but other studies were by no means neglected, and, under the careful supervision of his father, he received a thoroughly all-round and complete education. It may be mentioned here, that of the importance of giving its due place to science in any good scheme of liberal education, no one could be more convinced than Lord Kelvin, but that no one values more highly than he does the Old Humanities, and the importance of a sound logical and linguistic training.

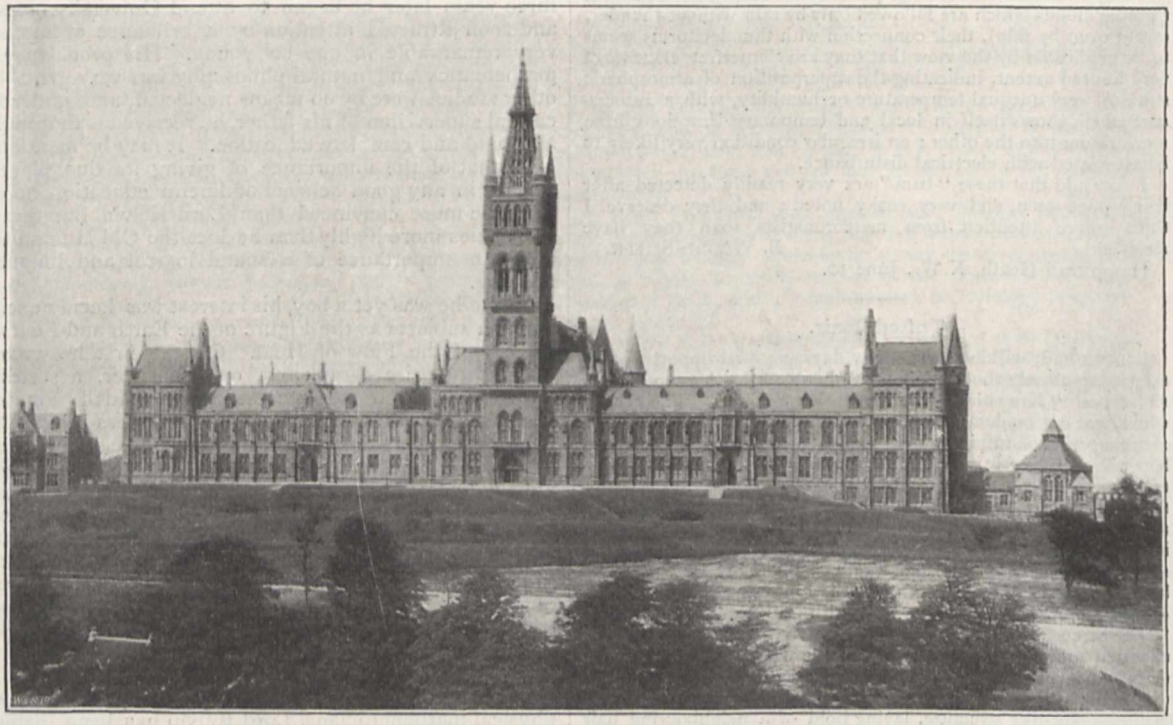
While he was yet a boy, his interest was keenly excited by such subjects as the Figure of the Earth and Fourier's Theory of the Flow of Heat. On the first he wrote a University prize essay, and, on the latter, a series of papers in which he successfully defended Fourier's researches from a charge of unsoundness which had been brought against them, through some strange misconception, by a very competent writer who had graduated a few years before with the utmost mathematical distinction. It is worth relating, as indicating the promise and power of the youthful natural philosoper, that when only fourteen or fifteen years of age he read Fourier's great treatise through in the intervals of travelling about, during a fortnight's visit to Germany. That he did so to some purpose is shown by the papers in defence, explanation, and extension of Fourier's results, which soon after flowed from his pen.

There can be no question that, like many other eminent physical mathematicians, Lord Kelvin has been inspired and directed by his early study of Fourier and the other great French mathematical writers of the end of the eighteenth and the beginning of the present century. But he has always fully and gratefully acknowledged the helpful and interest-exciting influence of some of his old teachers at the University of Glasgow. To mention only one, Dr. J. P. Nichol, formerly Professor of Astronomy in the University, the compiler and, to a great extent, the author of Nichol's "Cyclopædia of Physical Science," and a most delightful lecturer on astronomical and physical subjects.

The tale of Lord Kelvin's achievements at Cambridge has been often told—how he won the first Smith's Prize and the Colquhoun Sculls, and was known as one of the most promising original mathematicians of the time. He returned to the University of Glasgow as Professor of Natural Philosophy in 1846, and from that day to this the history of his life-work has been in no small measure the history of the progress of physical science. There is no department of physical science which he has not enriched and extended by his discoveries. There is hardly any theory in dynamics, heat,

or electricity, of which his theorems, experimental discoveries and views, do not form a great and fundamental part, and in the domain of physical optics he has recently shed much light on some of the most recondite and disputed questions by his lectures and papers on the subject of the dynamics of systems, of molecules, and the constitution of the ether. To discuss his career in detail would take us too far at present, and we must refer our readers to the article in our "Scientific Worthies" series, which appeared in vol. xiv., p. 385, 1876, and defer an account of his later scientific work to another opportunity.

The accompanying engraving of the University of Glasgow shows the scene of the Jubilee Celebration. The part between the main entrance and the western gateway on the left is the physical laboratory, and the gable of Lord Kelvin's house is shown on the extreme left. A great suite of rooms, all on one level, consisting of the University Library, the Hunterian Museum, the



New Buildings of the University of Glasgow. Gable of Lord Kelvin's House on extreme left. Natural Philosophical Class-room Window over Western Gateway. Physical Laboratory to right of Western Gateway.

Bute and Randolph Halls, and the Senate Room Lobbies and Examination Hall, give perfectly unique soirée accommodation, in which about 2000 guests assembled on Monday evening. In the Library has been arranged an interesting exhibit of Lord Kelvin's inventions and instruments, with the diplomas and certificates of membership which he has received from learned societies at home and abroad. There are no less than eighty or ninety of these diplomas displayed, among them some of the most illustrious distinctions, such as that of Foreign Associate of the Institute of France, to which it is possible for any scientific man to attain, a striking testimony of the universal appreciation which Lord Kelvin's work has received wherever science is cultivated or learning flourishes. The Anglo-American Cable Co., the Eastern Telegraph Co., and the Brazilian Submarine Cable Co. sent addresses of congratulation, and exhibited instruments and objects of interest as illustrating the all-important share which Lord Kelvin's discoveries, his personal services, and inventions have had in the development of ocean telegraphy. Instruments in these exhibits were during the conversazione in communication with all parts of the world, and were employed in receiving addresses of congratulation. A warm letter of congratulation was sent by the Prince of Wales, and addresses were presented by representatives of the principal universities, learned societies, and other institutions throughout the world. All the universities and almost every college in the United Kingdom and Ireland sent delegates and addresses. The addresses were publicly presented to Lord Kelvin, and Lord Kelvin himself and several of the most distinguished foreign delegates received honorary degrees at a congregation of the University specially held in the Bute Hall on Tuesday for these purposes.

A grand banquet, to which the delegates and other distinguished guests were invited by the Corporation of Glasgow, was held on Tuesday evening in the St. Andrews Hall, and at the opening of the banquet the Lord Provost read a gracious message of congratulation received from the Queen. The celebration closed by a special excursion on the Firth of Clyde, up Loch Long and round the Island of Bute, given by the University authorities.

This brief summary of the events of the celebration we hope to replace next week by a fuller account of what has been undoubtedly one of the most unanimous and enthusiastic tributes of admiration which it has ever fallen to the lot of a scientific worker to receive. That such admiration for the achievements and the personal qualities of even the most illustrious man of science has been forthcoming in no unstinted measure, is a happy augury that peace may still have its triumphs, and good work done receive its due meed of reward.

A. GRAY.

THE APPROACHING TOTAL ECLIPSE OF THE SUN.

SINCE our last note on this subject, H.M.S. *Volage*, with the instruments belonging to Mr. Norman Lockyer's party which is to observe, if possible, on the south side of the Varanger fiord, has been detached from the Training Squadron to repair a slight damage. It is expected that she will be able to leave the Portsmouth Dockyard in a few days' time, and no alterations will be made in the arrangements already published.

The accompanying map (Fig. 1) shows the possible stations south of the fiord, with the duration of totality at each.

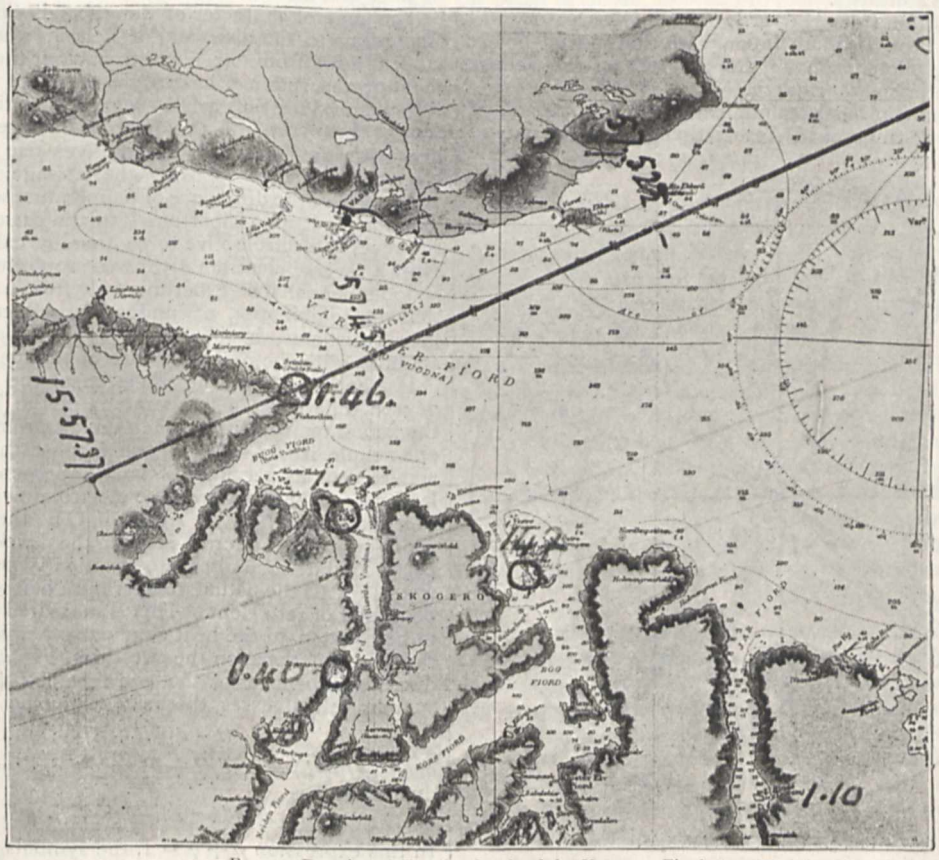


FIG. 1.—Duration of Totality South of the Varanger Fiord.

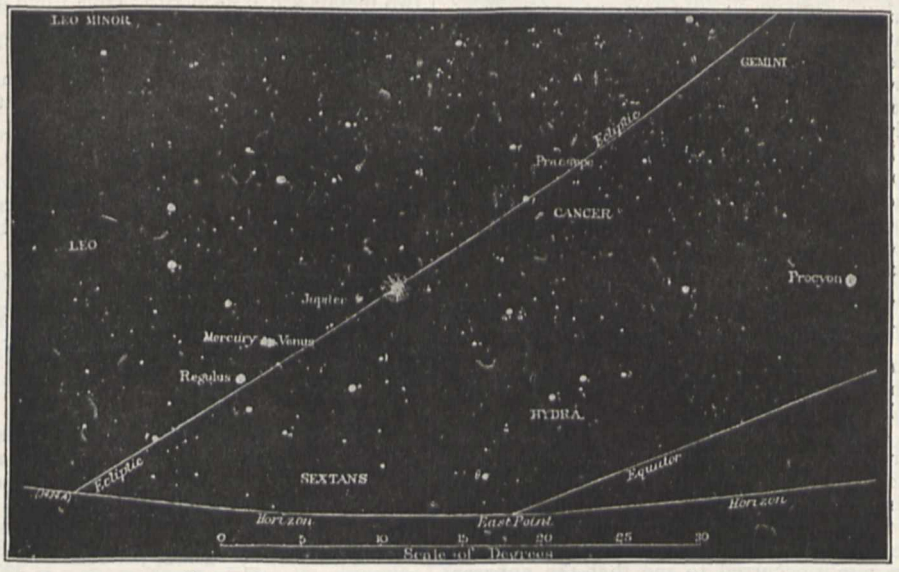


FIG. 2.—Stars and Planets near the Sun at the Time of Totality.

It has been announced that all the ships of the Training Squadron will proceed to the neighbourhood of the Varanger fiord to observe the eclipse.

Owing to the offer of Sir George Baden-Powell to take an observing party to Novaya Zemlya in his yacht, it is quite possible that that station may be occupied by English observers as well as by the expeditions sent by the St. Petersburg Academy of Sciences and the Kasan Society of Naturalists.

An expedition from Harvard College Observatory will accompany Prof. Todd to Japan, with the special object of obtaining photographs of the progress of the eclipse with a large prismatic camera.

Mr. Crommelin has communicated to the *Journal* of the British Astronomical Association a reduced map of

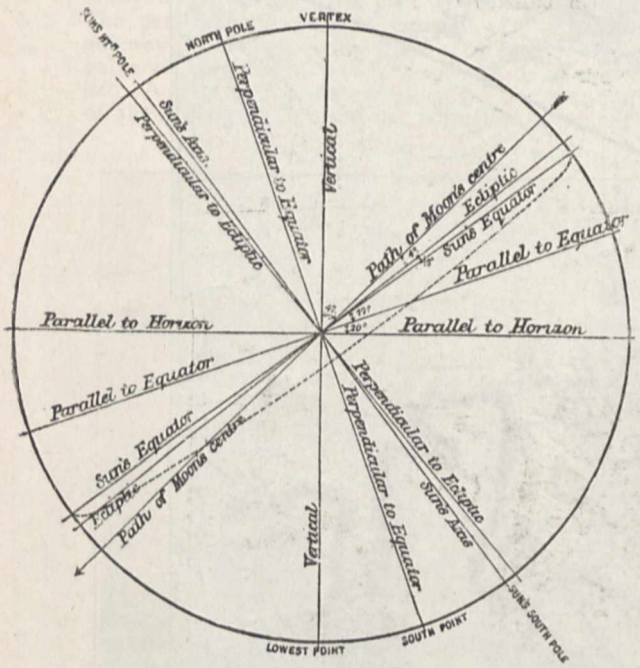


FIG. 3.—Conditions of Eclipse.

the stars and planets near the sun at the time of totality (Fig. 2), and a diagram showing the relation of the sun's axis and equator, and the path of the moon's centre to the horizon at Vadsö (Fig. 3). These, by the courtesy of Mr. Crommelin, we are enabled to reproduce.

According to Prof. Mohn, the weather chances in Lapland are vastly superior to those in Japan. We are glad also to learn that many lovers of nature are taking advantage of the opportunity of seeing one of the grandest of natural phenomena under the favourable conditions afforded by modern travel, not forgetting that the eclipse takes place in a region of beautiful scenery and in the holiday season of the year.

THE ELECTRICAL RESISTANCE OF ALLOYS.

THE recent researches of Profs. Dewar and Fleming upon the electrical resistance of metals at low temperatures have brought into strong relief the difference between the behaviour of pure metals and of alloys. In the former case the resistance shows every sign of tending to disappear altogether as the absolute zero of temperature is approached, but in the case of alloys this condition of things is widely departed from, even when the admixture consists only of a slight impurity.

Some years ago it occurred to me that the apparent resistance of an alloy might be partly made up of thermo-electric effects, and as a rough illustration I calculated the case of a conductor composed of two metals arranged in alternate laminæ perpendicular to the direction of the current. Although a good many difficulties remain untouched, I think that the calculation may perhaps suggest something to those engaged upon the subject. At any rate it affords *à priori* ground for the supposition that an important distinction may exist between the resistances of pure and alloyed metals.

The general character of the effect is easily explained. According to the discovery of Peltier, when an electric current flows from one metal to another there is development or absorption of heat at the junction. The temperature disturbance thus arising increases until the conduction of heat through the laminæ balances the Peltier effects at the junctions, and it gives rise to a thermo-electromotive force opposing the passage of the current. Inasmuch as the difference of temperature at the alternate junctions is itself proportional to the current, so is also the reverse electromotive force thereby called into play. Now a reverse electromotive force proportional to current is indistinguishable experimentally from a *resistance*; so that the combination of laminated conductors exhibits a false resistance, having (so far as is known) nothing in common with the real resistance of the metals.

If e be the thermo-electric force of the couple for one degree difference of temperature of the junctions; t, t' the actual temperatures; then the electromotive force for one couple is $e(t - t')$. If we suppose that there are n similar couples per unit of length perpendicular to the lamination, the whole reverse electromotive force per unit of length is $n e(t - t')$. Again, if C be the current corresponding to unit of cross-section, the development of heat per second at each alternate junction is per unit of area $273 \times e \times C$, the actual temperature being in the neighbourhood of zero Cent. This is measured in ergs, and is to be equated to the heat conducted per second towards the cold junctions on the two sides. If k, k' be the conductivities for heat of the two metals, l and l' the corresponding thicknesses, the heat conducted per second is

$$(t - t')\{k/l + k'/l'\};$$

or if $l/(l + l') = p$, $l'/(l + l') = q$, $l + l' = 1/n$, the conducted heat is

$$n(t - t')\{k/p + k'/q\}.$$

In this expression $p + q = 1$, the symbols p and q denoting the proportional amounts by volume in which the two metals are associated. Thus when a stationary state is reached,

$$273 \times e \times C = n(t - t')\{k/p + k'/q\}.$$

This determines $(t - t')$ when C is given; and the whole back electromotive force per unit of thickness is rC, where

$$r = \frac{273 \times e^2}{k/p + k'/q}.$$

This is the expression for the false resistance per unit of thickness, which, it should specially be noted, is independent of n, the number of couples. The number of couples which co-operate is indeed increased by finer lamination, but the efficiency of each is decreased in the same proportion by the readier conduction of heat between the junctions. It is scarcely necessary to point out that the false resistance is called into play only by currents which flow *across* the laminæ.

In my original calculation the metals chosen for illustration were iron and copper. In this case (Everett's C.G.S. system of units, p. 192) $e = 1600$. The conductivities are to be measured in ergs. For iron, $k = \cdot 164 \times 4{\cdot}2 \times 10^7$; for copper, $k' = 1{\cdot}11 \times 4{\cdot}2 \times 10^7$. Thus, if the metals are in equal volumes ($p = q = \frac{1}{2}$),

$$r = \frac{2 \times 273 \times 1600^2}{4{\cdot}2 \times 10^7 \times 1{\cdot}27} = 26{\cdot}2.$$

This is the thermo-electric addition to the true specific resistance, and is about 1½ per cent. of that of copper. Such an addition may seem small; but it should be re-

membered that for the more distinctively thermo-electric metals e is much larger, and that it enters by its square. In any case it seems desirable that this complication should be borne in mind. The consequences which follow from recognised laws for laminated structures, however fine, must surely have some bearing upon the properties of alloys, although in this case the fineness is molecular. RAYLEIGH.

NOTES.

THE De Morgan Memorial Medal has been awarded this year by the Council of the London Mathematical Society to Mr. Samuel Roberts, F.R.S. The medal is awarded every three years. Mr. Roberts was one of the earliest members of the Mathematical Society, and his first mathematical papers were contributed to the Society over fifty years ago. Since then he has continued, in the intervals of a busy professional career, to interest himself in the study of higher mathematics, and has published numerous papers, many of them of great value. The presentation of the medal will be made at the annual meeting of the Society in November next.

THE Council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a gold medal, or a prize of £20. The medal, under the conditions laid down by the testator, is to be given "for any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means." Intending competitors should send in descriptions of their inventions not later than December 31, 1896, to the Secretary of the Society of Arts, Adelphi, London, W.C.

ON Thursday last, a preliminary meeting was held in the Board Room of the Museums, William Brown Street, Liverpool, for the purpose of taking steps for the establishment in that city of a Zoological Garden on a scientific basis, and on the model of that in Regent's Park, London. On the motion of Prof. Herdman, seconded by Dr. Forbes, the following resolution was unanimously adopted:—"That in the opinion of this meeting it is desirable, in the interests of science and education in this city, to establish Zoological Gardens, containing a collection of living animals, and that those present form a Committee, with power to add to their number, for the purpose of advancing this object." The question of a site was considered, and it appeared that there was just now a favourable opportunity of securing land in a central position very suitable for the purpose. It was resolved that the following gentlemen be asked to form a sub-Committee to inquire fully into the matter, and prepare a report:—Prof. Herdman, Dr. Forbes, Messrs. A. L. Jones, A. A. Paton, A. S. Hannay, W. H. Picton, W. E. Willink, F. J. Leslie, and F. Radcliffe.

PRESIDENT CLEVELAND has appointed a scientific commission to investigate the condition of the fur seals in the North Pacific and Behring Sea. The members of the Commission are Mr. Jordan, of Stamford University (President), Lieutenant-Commander Moser, commanding the Fish Commission steamer *Albatross*, Dr. Stejneger and Mr. Lucas, both of the U.S. National Museum, and Mr. Townsend, Fish Commissioner.

THE recent electrical exposition in New York City proved so successful, pecuniarily as well as otherwise, that the managers have decided to establish a permanent exhibition. A revised estimate of the distances covered by the long-distance telegraphing at the exhibition on May 16, is 42,000 miles for the message to Tōkiō and back, covered in 47½ minutes, and over 15,000 miles for the double crossing of the North American continent and the Atlantic ocean, covered in four minutes.

THE Division of Forestry of the United States Department of Agriculture calculates the annual loss by fire to the forests in the States to amount to twenty-five million dollars.

AMONG the subjects of prizes for essays offered by the Royal Academy of Sciences of Denmark are:—Morphological and physiological researches on the asci of the Ascomycetes; the Danish species of Nematoids and Anguillulinæ; and the life-history of those Sphæriaceæ which are destructive to cereal crops.

IN the *Berichte* of the German Botanical Society, Herr A. Schober gives the result of some experiments on the effect of the Röntgen rays on the germination of the oat. He concludes that they differ from ordinary light rays in having no power of producing heliotropic curvatures, even in organs so sensitive to light as the axis of a growing seedling.

DR. Q. MAJORANA and Dr. A. Sella continue their researches on the effect of Röntgen rays and ultra-violet light on the discharge of electric sparks in air. In their latest communication to the Reale Accademia dei Lincei, they consider the manner in which the nature of the discharge is affected both by the action of these rays and by varying the sparking distance. Their present contribution includes a figure and description of the apparatus illustrated in their recent letter to NATURE, as well as of another arrangement by which the phenomena are well shown.

THE July number of the *Leisure Hour* is to contain a series of portraits of the Presidents of the Royal Society from its foundation, in 1662, to the present day. The portraits, thirty-four in number, occupy six pages of royal octavo, and form, so far as we know, an unique series. Of the thirty-six Presidents, two only—James West and Sir Cyril Wyche, neither of them very eminent men from a scientific point of view—are wanting. The accompanying article, on the Presidents of the Royal Society, has been been written by Mr. Herbert Rix, late Assistant Secretary to the Society.

THE earth-tremors and sounds produced by the Niagara Falls have been often referred to, in most cases probably with some exaggeration as regards their intensity. In a paper published in the *Yale Scientific Monthly* for last May, Mr. W. H. Brewer describes some careful observations made at various times during the last forty-five years. During one year spent at Lancaster, a village twenty-seven miles from the Falls, sounds, possibly due to the Falls, were heard on three occasions, but it was uncertain whether they might not have come from Buffalo, which is hardly ten miles distant. The tremor observations were made within a few miles of the Falls, and show that the vibrations are extremely irregular, varying both in amplitude and period. Sometimes they stop for an instant, then steadily increase in intensity, reaching one or several maxima, afterwards steadily declining. The momentary pauses do not, however, recur at regular intervals.

THE *Board of Trade Journal* reports that the Pharmaceutical Society of Prague will celebrate its twenty-fifth anniversary this year by an international exhibition of pharmacy, to be held from August 15 to September 15, at Prague, and to include the following groups:—Scientific apparatus and articles used in pharmaceutical work, and the literature having reference to same; machinery and various apparatus serving for the manufacture of pharmaceutical articles, pharmacy fittings, &c.; products and drugs used in pharmacy; manuscript books, statistics, and tables concerning the historical development of pharmacy; hygiene, and the care of invalids. There has been

no important exhibition of pharmacy in Europe since 1883, and the forthcoming one at Prague this year is to include all features of progress in the pharmaceutical branch and its ramifications. Meetings of various pharmaceutical societies will be held at Prague during the exhibition. Particulars may be obtained from Dr. Charles Fragner, Pharmacien, Président du Comité Exécutif, à Prague.

IN connection with the cloud observations to be made during the international cloud year commencing May 1, *Science* of May 29 has some interesting notes by Mr. R. De C. Ward, of the Harvard University, on scientific kite-flying under the superintendence of the Washington Weather Bureau, and the Blue Hill Observatory. Instead of being flat and tapering at the lower end, the kites used are box-shaped, with their ends open and their sides partly covered with cloth or silk, and when fine piano wire is used, instead of twine, they are found to be splendid flyers. Recent ascents have reached altitudes of nearly a mile above sea-level, and excellent results have been obtained by means of a self-recording instrument made by Mr. Fergusson, of the Blue Hill Observatory, which gives automatic readings of temperature, pressure, humidity, and wind velocity. Among the most important matters that have hitherto been noted is the presence of cold waves and warm waves at considerable elevations some hours before the temperature changes are noted at the earth's surface. The prospect of improving weather forecasts by such means and by the use of small pilot balloons, which can be made at slight expense, and can reach considerable altitudes, is considered to be very encouraging.

IN a paper in the *Photographische Mitteilungen*, Jahrgang 33, Hefte 1 and 2, entitled "Über chromatische Homofocallinsen und über meine chromatische Planparallelplatte," Dr. Hugo Schroeder gives an account of the uses that may be made of a compound lens of which the external surfaces are plane and parallel, while the component lenses join internally at surfaces of any convenient curvature. The simplest form of a double lens of this kind may be derived from an ordinary plano-convex achromatic objective by grinding the front (convex) surface of the crown lens to a plane. Such a lens would evidently have almost exactly the same chromatic and spherical aberrations as the removed plano-convex portion, but with the opposite signs. By substituting crown glass for flint, and *vice versa*, the character of the lens may be reversed. Inserted in the cone of rays coming from an achromatic object-glass, a suitable plane lens of this kind shows what would be the effect of altering the curvatures of the surfaces of the object-glass. For this kind of lens Dr. Schroeder proposes the name of "Corrector." Again, by the use of such a corrector an ordinary achromatic telescope may be fitted for photographic work, and this can be done without greatly changing the place of the focal plane. By moving the corrector along the axis, different groups of rays may be brought together to suit the photographic method employed. As independently pointed out by Prof. Keeler and Mr. Newall, one difficulty, however, cannot be overcome: the available field of view will always be very restricted; unless, indeed, the correcting lens is made so large as to become practically an extra member of the object-glass.

FROM an artesian well, 188 feet deep, recently bored at San Marcos, Texas, there were expelled more than a dozen specimens of a remarkable batrachian, together with numerous crustaceans. The latter are described by Mr. Benedict, and the batrachian by Dr. Stejneger (*Proc. U. S. Natl. Mus.*, vol. xvii., 1896). From the *American Naturalist*, it appears that the crustaceans comprise numerous shrimps (one new species, *Palæmonetes antrorum*), a lesser number of Isopods of a new genus (Cirolanides), and a very few Amphipods. All the species are white, blind, and have unusually long, slender feet and antennæ. The batrachian, for which Stejneger creates a new genus, is described under the name *Typhlomolge rathbuni*. It belongs to the family Proteidæ, and is more nearly allied to Necturus than to Proteus. Like the crustaceans, it is blind. The most remarkable external feature is the length and slenderness of the legs. In commenting on this peculiarity, Dr. Stejneger says: "Viewed in connection with the well-developed finned swimming tail, it can be safely assumed that these extraordinarily slender and elongated legs are not used for locomotion, and the conviction is irresistible that in the inky darkness of the subterranean waters they serve as feelers, their development being thus parallel to the excessive elongation of the antennæ of the crustaceans." The gills are external, its colour nearly white, having the upper surfaces densely sprinkled with minute pale grey dots, and its total length measures 102 mm.

YET another method or the separate identification of the colon from the typhoid bacillus has been furnished to the bewildered bacteriologist by Dr. Piorkowski from Berlin. Recognising the fact, now established by so many investigators, that both the colon and typhoid bacillus are frequently found in urine, and that the former is regarded as undoubtedly intimately associated with various processes of inflammation, Dr. Piorkowski has compared the growth of these two micro-organisms in broth, gelatine, and agar, to which he made additions of urine. He states that whereas the typhoid-bacillus cultures, both in colonies and tubes, exhibited fine hairy extensions resembling in the case of the colonies the well-known medusa-head-like appearance so characteristic of the anthrax bacillus, the colon bacillus never forsook its compact form of growth, and only occasionally were very small, short hairy extensions visible in the contour of the colonies. We agree with Dr. Piorkowski that his method of diagnosis is easily applied, but we are not altogether convinced as to its efficacy. Colonies of the colon bacillus may also exhibit very characteristic whip-like extensions under circumstances which at present we are not in a position to exactly determine, but these so-called abnormal colonies were obtained from colon bacilli derived from a sample of cystitis-urine. Already the catalogue of comparative tests is considerable through which typhoid and colon bacilli are required to be passed, and unless a decided advance can be recorded on these, we think it is unnecessary that the bacteriologist should add to his burdens by adopting any more.

THE artesian water question continues to largely occupy the attention of Australian geologists and engineers. We have received an abstract of Mr. J. P. Thomson's presidential address to the Royal Geographical Society of Australasia, on the alleged leakage of artesian water. The address seems to have been called for by the too ready acceptance by local writers of Mr. R. L. Jack's tentative suggestion that the artesian water of the porous Lower Cretaceous beds might largely leak away to the sea. Mr. Thomson considers there is no evidence of such leakage: it is true that at various places off the coast fresh water is known to rise through the sea-water from below, but there is no evidence to associate such submarine springs with Lower Cretaceous outcrops—the water may more probably be derived from the Tertiary beds which form the actual coast. On the other hand, the geological structure of the continent seems to prevent the possibility of an unbroken flow of water to a submarine outcrop, if such outcrop exists. Referring to the asserted great excess of the rainfall over the river-flow, which had been put forward as evidence of the artesian leakage, he points out on the one hand the enormous evaporation in such a climate as that of Central Australia (quoting some striking instances of this), and on the other hand, that there has hitherto been no systematic gauging of the flow of the Australian rivers.

PROF. J. S. BASSETT, in his "Slavery and Servitude in the Colony of North Carolina" (*Johns Hopkins Univ. Studies in Hist. and Polit. Sci. Studies*, 14th ser., iv.-v.), has recently published a valuable study on the history and sociology of slavery in North Carolina. In the West Indies the Spaniards early destroyed the native population, and so they imported the negro, and established colonies of slaves, driving them to the fields and back to the barracks, and treating them much as the Romans did their slaves. The ideal of the Virginian planter was that of an English county gentleman: he wanted to group his slaves around him, and deal personally with them. There were, however, two main obstacles: (1) the Indians must be either exterminated or driven into the interior, for fear of massacres; (2) the white population must become dense enough to resist any insurrection among the negroes, hence large numbers were not introduced at first. About 1712, these obstacles were practically removed. The first slaves in America were Indians; but as they were fierce and caused trouble, they were never very numerous. The first labourers the English took to the New World colonies were whites; these consisted of indented servants, transported felons, and kidnapped persons, usually children. From 1661–1671 the conscience of the English public was awakened, so that only properly registered emigrant servants could be taken across the Atlantic; besides, negro slaves were found to be cheaper than white servants. It was the survival of the fittest. Both Indian slavery and white servitude were to go down before the black man's superior endurance, docility, and labour capacity.

DR. BASSETT'S account of the social conditions of the natives is also interesting; nor is the history of the attitude of religion to the slave question less so. At first, at all events, the planters were unwilling to allow the conversion of negroes, there being a doubt in their minds whether conversion would not enfranchise them. When the negroes happened to be professed Christians they might join any church they liked, but till 1741 they were not allowed to have a church organisation or building among themselves. With the exception of the Society of Friends, who became unanimous on this point in 1776, none of the sects opposed the ownership of slaves.

A TRANSLATION of Dr. Carl Freiherr v. Tubeuf's "Diseases of Plants due to Cryptogamic Parasites," by Dr. W. G. Smith, is about to be published by Messrs. Longmans.

DR. J. DOERFLER, of Vienna, has published his *Botaniker Adressbuch*, a guide to botanists throughout the world. It contains upwards of 6000 addresses of botanists, as well as those of botanical gardens, botanical institutes, societies, and journals.

WE have received vol. iii., No. 4, of the "Bulletin from the Laboratories of Natural History of the State University of Iowa," containing several papers on the fauna and flora of Iowa, as well as of Mexico, Arizona, and Nicaragua. The *Botanical Gazette* has long been urging American naturalists to compile their local faunæ and floræ on some more satisfactory lines than the often very arbitrary division-lines between the States.

M. J. DAVEAU describes, in the *Journal de Botanique*, a remarkable example of proterandry extending over a whole season, in the case of a palm (species not given) belonging to the genus *Kentia* (*Howea*) grown in the open air in the Botanic Garden at Lisbon. The flowers are grouped together in clusters within the spathe, each cluster consisting of three flowers, two male and one female. The female flower in each cluster is only in a very rudimentary condition, even after the male flowers have shed their pollen and dropped; they remain in this condition through the autumn and winter, and expand only at the same period in the next summer, when the male flowers in other newly-formed inflorescences are discharging their pollen.

SCIENTIFIC book-hunters will be glad to have their attention called to two lists just issued. One comes from Messrs. Macmillan and Bowes, Cambridge, and contains the titles of more than seventeen hundred books and papers on pure and applied mathematics, astronomy, meteorology, chemistry, and other branches of physical science, from the libraries of the late Prof. Henry Smith and Mr. Cowper Ranyard; the other contains the titles of 341 works on branches of natural science, offered for sale by Messrs. Williams and Norgate.

MESSRS. J. B. LIPPINCOTT CO. have published a second edition of "A Manual of North American Birds" by Mr. Robert Ridgway. The work now runs into 653 pages, and is illustrated by 464 outline drawings of the generic characters. The knowledge of North American birds gained since the publication of the work in 1887, has been fully utilised in the preparation of the new edition; and the new species and sub-species added since that date are given in an appendix. Ornithologists, and particularly those in the United States, will be glad to have this carefully revised edition of a valuable manual.

OBSERVATIONS of local meteorology carried on in a systematic way, as they are in the Observatory of the Southport Town Council, furnish data of more than local value. The report of Mr. Joseph Baxendell, Meteorologist to the Corporation, upon the results of observations made in 1895 at places within and around the borough of Southport, has just been received, and it testifies to a large amount of careful work. In the course of his introductory remarks, Mr. Baxendell refers to "the serious differences between the indications of the Campbell-Stokes Standard and the Jordan Photographic Sunshine Recorders." It is hardly satisfactory that the duration of sunshine should be recorded so differently by the two classes of instruments.

THE Royal Cornwall Polytechnic Society has published its sixty-third annual report, being for the year 1895. For many years the Falmouth Observatory, in connection with that Society, has been one of the principal stations of the Meteorological Council, and in addition to the records of the photographic and other self-recording instruments required by that body, it publishes results of magnetic and sea temperature observations. During the year in question, Prof. Rücker spent some time at the observatory for the purpose of comparing the magnetic instruments with those at Kew, and his report bears testimony to the skill and accuracy of the observer, and to the thoroughness of the work done. The Society holds an annual exhibition, when any special features are introduced by which industry may be encouraged, and visitors interested and instructed. The report contains accounts of interesting lectures on the old Falmouth Packet Service, by Mr A. H. Norway, and on some senses in fishes, by Mr. M. Dunn

UNDER the title "Lloyd's Natural History," Messrs. Edward Lloyd (Limited) is issuing in parts the works which Messrs. W. H. Allen and Co. have for the past two or three years been publishing as "Allen's Naturalist's Library," and which is itself a revised and enlarged edition of "Jardine's Naturalist's Library." The first part of this *réchauffé* series has just been received, and we may be pardoned a little surprise at finding that no reference is made in it to the original edition, so that to the general public "Lloyd's Natural History" appears as a new work. The present part comprises 112 pages and eleven coloured plates, and is a section of one of the volumes on "British Birds" contributed by Dr. Bowdler Sharpe to "Allen's Naturalist's Library." We are glad to see the issue of this series in parts, notwithstanding the information withheld as to the origin of it. In spite of the many unsatisfactory figures, the work is sound and methodical, and its serial publication wil undoubtedly increase the number of students of natural history.

SEVERAL parts of the very fine "Illustrations of the Zoology of H.M. Indian Marine Surveying Steamer *Investigator*," under the Commander, A. Carpenter, the late Commander, R. F. Hoskyn, and Commander C. F. Oldham, have lately been received. The plates are splendid examples of photo-etchings, and they will be treasured by marine zoologists. Fishes are represented upon sixteen plates, Crustacea upon fifteen plates, and Echinoderma upon five plates. The illustrations are only accompanied by brief explanations, the descriptions of the various species having appeared in the *Annals and Magazine of Natural History*, and in the *Journal of the Asiatic Society of Bengal*. Mr. A. Alcock is responsible for the fishes described and figured, and, in conjunction with Mr. A. R. S. Anderson, for the Echinoderma. The Crustacea have been mostly done under the direction of the late Mr. J. Wood-Mason.

NEARLY a year ago (NATURE, vol. lii. p. 290), the second volume of the second edition of Dr. George Lunge's treatise on "The Manufacture of Sulphuric Acid and Alkali" (Gurney and Jackson) was reviewed in these columns, and the value of the work to investigators and industrial chemists as a standard work of reference on alkali manufacture was pointed out. The third volume, completing the second edition of the book, has now been published, and the words of praise applied to the second volume are just as fully deserved by the present one. The amplification of the original text has been so considerable, and the revision so thorough, that the work has grown beyond recognition. Only a few chapters resemble those of the first edition, and the chapters on ammonia-soda, on the more recent soda-process, on the Deacon process, and the other chlorine processes, have been entirely rewritten; while a section on the preparation of alkalis, chlorine, and chlorates by electrolysis, appears for the first time. The second edition of the complete work is half as large again as the first; it is well up to date, and forms a most serviceable survey and digest of the whole ground of alkali manufacture.

THE meteorological and magnetic observatory of the University of Odessa has for its functions not only the reading of the numerous instruments with which it is equipped, and the discussion of the results observed and registered, but it is intended also to serve as a high school where students of the faculty of physics and mathematics can be trained in the work of meteorology and physical geography. In order to give more importance to this course, Prof. Klossovsky has drawn up a syllabus, which is printed in the 1895 volume of the "Annales" of the Observatory at Odessa. The course is divided into three parts, the first two of which are devoted to fundamental observations, to the installation and study of instruments used in meteorology and terrestrial physics, and to the determination of various elements. The third course is intended for those who propose to take up physical geography or meteorology as a special subject. The programme is an admirable outline of the work of meteorology and terrestrial physics, and but for limit of space we would give a full translation of it. Schools in meteorology are so few, that the development of the curriculum of the Imperial University at Odessa will be welcomed by all who think that trained investigators and experimental work are needed for the advancement of the science.

THE additions to the Zoological Society's Gardens during the past week include a Hoolock Gibbon (*Hylobates hoolock*, ♀) from Assam, presented by Mrs. Firman; two Fat Dormice (*Myoxus glis*) from Austria, presented by Mr. John G. Haggard; a Short-toed Eagle (*Circaetus gallicus*) from Egypt, presented by Dixon Bey; a Vulturine Eagle (*Aquila verreauxi*) from South Africa, presented by Mr. J. Clark; two Short-eared Owls (*Asio brachyotus*) from Ireland, presented by Captain R. A. Ogilby; five Cormorants (*Phalacrocorax carbo*) from the Isle of Mull, presented by Maclaine of Lochbuie; three Dwarf Chameleons (*Chamæleon pumilus*) from South Africa, presented by Miss Jessie M. Hudson; eight Natterjack Toads (*Bufo calamita*), two Common Toads (*Bufo vulgaris*), British, presented by Mr. Stanley S. Flower; two Axolotls (*Siredon mexicanus*) from Mexico, presented by Mr. W. Temple; nine Green Turtles (*Chelone viridis*) from Ascension, presented by Mr. J. C. Adlam; a Hoolock Gibbon (*Hylobates hoolock*, ♀) from Assam, an Indian Chevrotain (*Tragulus meminna*), two Indian Drongos (*Chibia hottentota*), two Tigers (*Felis tigris*, ♂ ♀) from India, a Javan Chevrotain (*Tragulus javanica*) from Java, a Harnessed Antelope (*Tragelaphus scriptus*, ♂) from West Africa, deposited.

OUR ASTRONOMICAL COLUMN.

PHOTOGRAPHS OF STELLAR SPECTRA.—Dr. F. McClean is now engaged on a photographic investigation of the spectra of the northern stars down to the third magnitude. About 160 stars will thus be included in the survey. Some of the results, which have been recently communicated to the Royal Astronomical Society, comprise the spectra of twenty-three characteristic helium stars, and photographs of the spectra of six stars of the third magnitude showing the transitions from one type to another (*Monthly Notices*, vol. lvi. p. 428). The instrument used is a photographic telescope of 12 inches aperture and 11 feet 3 inches focal length, having an objective prism of the same aperture placed in front of the object-glass. The refracting angle of the prism is 20°. The prism is mounted on a hinged frame, and the cell containing it can be rotated within the frame, so that all necessary adjustments can be effected with facility.

THE NATAL OBSERVATORY.—Two reports which have recently been received from Mr. Nevill, the Superintendent of the Natal Observatory, indicate considerable astronomical activity at this southern station. "The principal series of observations in progress is the comparison of the declination deduced from observations made at the observatories in the northern and southern hemispheres by a comparison by Talcott's method of the zenith distance of northern zenith stars and southern circumpolar stars at upper and lower culminations." Over a hundred pairs of stars are under observation. The publication of the Greenwich observations of Mars during the opposition of 1892 renders it possible to utilise the corresponding Natal observations for the determination of a new value of the solar parallax, and this work will be undertaken. During the opposition of Mars in 1894 the weather proved very unfavourable, and no observations of value were secured. A great mass of important work done at the observatory awaits facilities for publication. The entire staff amounts to only four observers and computers, and the instrumental equipment is equally small. The system of time signals and meteorological work were carried on as in former years.

POSSIBLE CHANGES IN THE EARTH'S ROTATION.—As the result of a recent investigation (*Comptes rendus*, June 1), Prof. Newcomb makes the startling suggestion that the earth's rotation is not perfectly uniform. The discussion was undertaken in connection with the long-period inequalities in the moon's mean motion, which so far have not been satisfactorily explained. The possibility of a variation in the earth's rotation period being admitted, and consequently of an error in our mode of reckoning time, it becomes necessary to employ some method of measuring time which shall be independent of the earth's rotation. This appears to be best furnished by observations of the transit of Mercury. Prof. Newcomb has accordingly discussed all the November transits since 1677, and has compared the observed times of ingress and egress with those computed on the basis of his new tables for the sun and Mercury. Although in many cases the residuals may not be greater than the probable errors, there is a significant systematic character about them, as shown when the observations are grouped as follows:—

Transits.	Residuals. s.	s.
1677—1769	−5·4	± 2·5
1789—1861	+6·4	± 1·5
1868	−1·5	± 3·5
1881—1894	−3·1	± 1·6

It is concluded that "the observations of transits of Mercury clearly indicate small variations in the rotation of the earth, of

which the integral amount, during long periods of time, probably reaches five, or even ten seconds. In particular it seems that between 1769 and 1789 a retardation of the earth's rotation took place, and another between 1840 and 1861. Towards 1862 this slackening was followed suddenly by a well-marked acceleration, which possible persisted up to 1870."

It may be added that the supposed variation does not seem to account for the lunar inequalities to which reference has been made.

THE LADIES' CONVERSAZIONE OF THE ROYAL SOCIETY.

THE second of the two annual conversaziones of the Royal Society—the one to which both ladies and gentlemen are invited—was held in the rooms of the Society at Burlington House, on the evening of Wednesday in last week. As many of the scientific novelties exhibited were shown at the conversazione held in May, and have already been described in these columns (May 14), it is unnecessary to refer to them again. Only the new exhibits are therefore described in the present report.

In addition to Mr. Herbert Jackson's demonstration of the various degrees of phosphorescence of different subjects under the action of Röntgen rays, several other exhibits were devoted to methods used and results obtained with the rays. Prof. S. P. Thompson showed the production of electric dust-shadows by Röntgen rays. When the rays are allowed to fall upon an electrified sheet of aluminium placed above a plate of ebonite, they carry electric charges to the plate and electrify it. If objects of metal are laid on the ebonite sheet they intercept the Röntgen rays, and the part of the ebonite surface immediately shaded by them does not become electrified. On removing the ebonite plate and dusting upon it Lichtenberg's powders (mixed sulphur and red lead), the electric shadows become visible.

Prof. Thompson also showed a number of experiments on Röntgen's rays, viz.: (*a*) Cryptoscopic use of luminescent screens (revealing contents of packages, bones of hand, &c.) by employment of focus tube (Jackson's pattern); (*b*) discharge of electroscope by Röntgen rays; (*c*) new forms of X-ray tubes, including one for insertion in mouth; (*d*) apparatus of Ebert for producing luminescence by electric oscillations; (*e*) stereoscopic Röntgen-ray photograph of rabbit.

Electric discharges in vacuum was the subject of exhibits by Messrs. Siemens, Bros., and Co. The exhibits were (1) a facsimile of Dr. Wm. Watson's vacuum tube of 1751. This was the first apparatus ever constructed for experiments on the electric discharge in a vacuum. The discharge from a Leyden jar passed through ten inches, and that from a frictional machine through three feet, the whole length of the tube. (2) Facsimile of Lord Cavendish's double barometer of 1751, used by Dr. Wm. Watson in his researches. (3) Facsimile of Dr. Wm. Morgan's shortened barometer of 1785. Dr. Morgan, by long-continued boiling of the mercury in a barometer tube, produced a vacuum of such excellence that no discharge would pass, and equal, therefore, to that in a Hittorf or Crookes' tube of the present day. It is probable that it would have sufficed for the production of Röntgen rays. (4) Apparatus for showing electric discharges at different degrees of exhaustion from 70 mm. to 0 mm. (5) Photographs obtained by means of Röntgen rays, showing relative transparency of different kinds of wood, minerals, and glass.

A series of striking Röntgen photographs was shown by Dr. Macintyre. The marvellous advance made in Röntgen photography will be understood from the following statement of the subjects of Dr. Macintyre's pictures: (1) *Hard Structures.*—Life-sized photographs of different parts of the human skeleton, including the spine, ribs, shoulder, elbow and other joints of the body. Some of the negatives were 24 by 20 inches. (2) *Animal Kingdom.*—A series of the animal kingdom, such as the fish, frog, adder, &c. (3) *Soft Tissues of the Body in Health and Disease.*—Human heart in the living adult subject. The same in health and disease, also the tongue, tissues of the neck, including the larynx, &c. (4) *Instantaneous Photographs of Different Objects.*—The time of exposure was unknown, but the most rapid picture shown was taken with a single flash of the tube, due to one vibration of the interrupter of a ten-inch spark coil.

Mr. J. J. H. Teall exhibited a series of photographs of the electric discharge at various stages during the exhaustion of a Crookes' bulb of the Jackson type.

A small dynamo for measuring the permeability and hysteresis of iron was exhibited by Prof. W. E. Ayrton and Mr. T. Mather. The specimen to be tested, which may be in the form of a round bar or a bundle of thin plates, forms the yoke of the dynamo, and through a coil surrounding it is passed the magnetising current, the winding of this coil being so arranged that the current in amperes is numerically equal either to the magneto-motive force per centimetre of the bar, or to one-tenth of that value. When the armature is run at a speed of 1150 revolutions per minute, the induction per square centimetre in the bar is approximately equal to 10,000 times the E.M.F. in volts produced. Hence not merely the magnetising current but also the induction is measured by a *steady* deflection, and not, as is usual, by the *instantaneous* swing of a ballistic galvanometer. The magneto-motive force required for the air-gap and joints is determined experimentally by the use of a standard bar whose B H curve is accurately known.

Mr. J. Frith demonstrated the different effects produced by superimposing a small alternating current on a direct current arc according as cored carbons or solid carbons are employed. When a small alternating current is superimposed on a direct current arc formed with *cored* carbons, the oscillations of potential difference and current are in the *same* direction for all frequencies higher than about 1½ periods per second. On the contrary, if the carbon be *solid*, the oscillations of potential difference and current are in the *opposite* direction for all frequencies tried up to 256 periods per second. This difference was exhibited by the visible motion of ammeter and voltmeter needles.

Microscopic internal flaws inducing fracture in steel axles, rails, and propeller shafts were shown by Mr. T. Andrews. This exhibit consisted of a series of accurate micrographs taken at a high magnifying power, illustrative of the microscopically visible and tangible micro-flaws, almost invariably present in considerable number, in steel railway axles, rails, tires, propeller shafts, &c. The presence of these germs of metallic disease in steel (mostly due to sulphur and other impurities) greatly influences the deterioration by fatigue of the metal, and they are a potent factor in inducing the sudden fracture of engineering constructions in steel.

Mr. J. Macfarlane Gray exhibited a multiplication frame. In this contrivance, for obtaining the product of two multidigital numbers, product cards, as on "Napier's rods," are set for one of them upon a sole frame, and sliders on a grid are shifted to set up the other. Each slider has a pane of plass at mid-length. The grid is fitted to the sole frame upon a pair of stepped guides, and is slid along over the cards one figure at a time. At each step the component products in one of the vertical columns of the common multiplication rule are exhibited at the panes and added mentally. In this way the final product is obtained without transcribing the intermediate products.

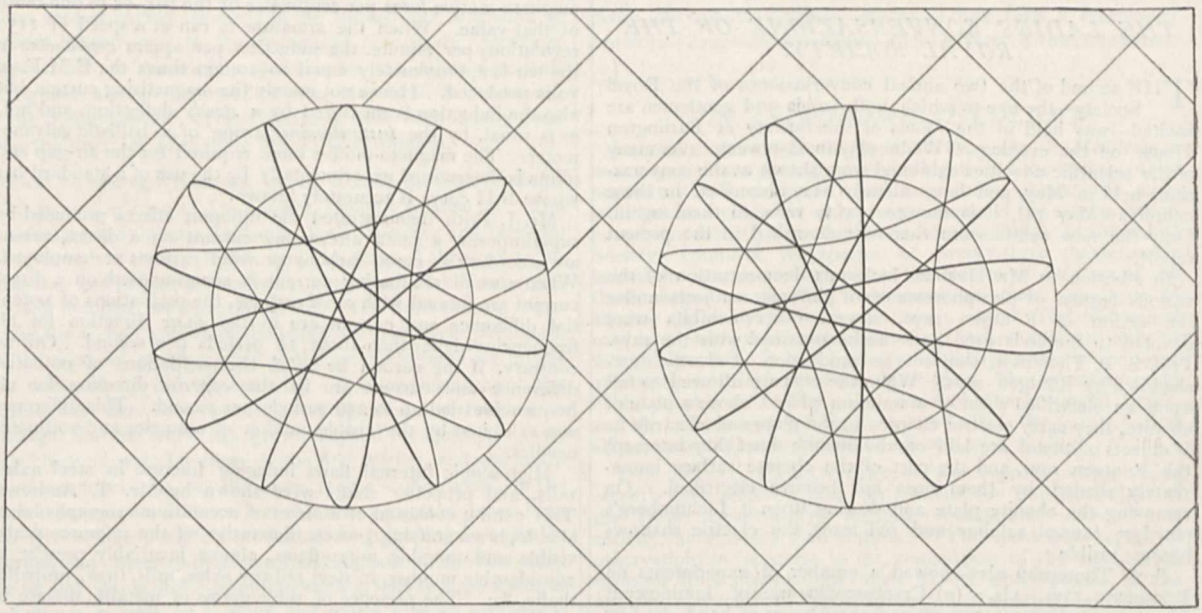
Exhibits illustrative of applications of the mathematical theory of frequency were shown by the Applied Mathematics Department of the University College, London. They included: (1) Diagram illustrating the relative variation of different organs in men and women of diverse races, by Miss Alice Lee, G. U. Yule, and K. Pearson. (2) Diagrams showing that 25 per cent. of the married population produce 50 per cent. of the next generation—Reproductive Selection, by K. Pearson. (3) Diagrams illustrating barometric frequency over the British Isles, by Miss Alice Lee, C. Jakeman, and K. Pearson. (4) Frequency recording barometer, by G. U. Yule and Cambridge Instrument Co. (5) Amplified integrator for finding mean, mean square and mean cubic deviations, and frequency skewness, by Amsler-Laffon. (6) Prof. Ranke's craniophor, used in comparing variation of skulls, as determined by English and German methods, by A. Martin-Leake and K. Pearson. (7) Skew binomial machine, by G. U. Yule. (8) Model of contour-tracer for finding areas of section of small objects.

Stereoscopic views of algebraic spherical catenaries and gyrostat curves were exhibited by Prof. A. G. Greenhill and Mr. T. I. Dewar. The mathematics of the spherical catenary are discussed in a paper by Prof. Greenhill in the volume of the *Proceedings of the London Mathematical Society* for the current year, and a diagram of a closed algebraical one with five

loops is there given. This was the first case in which it had been found possible to express the integral

$$\int \frac{A dz}{(1 - z^2)\sqrt{Z}}$$

algebraically, where $Z = (1 - z^2)(h - z)^2 - A^2$, and A and h are constants. The accompanying diagram is for the next possible case of seven loops, and has been made by Mr. T. I. Dewar. The circle in the lower hemisphere shows where the pressure of the chain on the sphere becomes zero; below that, the chain is supposed to rest on the interior of the hollow sphere. The tesselated pavement indicates the position of the *directrix-plane*. The tension at any point of the catenary is the same as in a chain hanging vertically to this plane, like a similar property in the plane catenary. A great many other cases with different numbers of loops have been examined, but the results turn out to be imaginary



Mr. Robert L. Mond exhibited the following apparatus intended for the Davy-Faraday Research Laboratory of the Royal Institution: (1) Kilogram automatic balance (Rueprecht, Vienna). (2) Prism automatic spectroscope (Kruss, Hamburg). (3) 1-inch spectrometer after Landolt and Brühl (Hildebrandt, Freiberg). (4) Hüfner photo-spectrometer (Albrecht, Tübingen). (5) Large polariscope 6-inch Landolt. (6) Small Landolt polariscope (Schmidt and Haensch). (7) Berthelot platinum bomb (Golaz, Paris). (8) Glass scale cathetometer (R. Fuess, Berlin). (9) Petrographical microscope (R. Fuess, Berlin). (10) Millivolt meter reading Centigrade degrees for Le Chatelier Thermophile (Keiser and Schmidt, Berlin). (11) Compensation box of Physikalische Reichsanstalt, Berlin (Wolff, Berlin). (12) Set of standard resistances (Wolff).

Prof. Dewar showed a portable apparatus for the production of liquid air and oxygen. A working model of support for large specula, designed to leave the line of collimation undisturbed, was exhibited by Dr. G. Johnstone Stoney.

Mr. F. McClean exhibited (1) photographic stellar spectra of Type III., including spectra of o Cetus (showing bright lines $H\gamma$ and $H\delta$), α Taurus, α Orion, α Scorpio, β Andromeda, α Cetus, δ Ophiuchus, μ Gemini, δ Virgo, β Pegasus, α Hercules. (2) Photographic spectrum of Secchi's Type IV. This was a spectrum of the star 152 Schjellerup ($5\frac{1}{2}$ magnitude), compared with spectrum of α Orion. (3) Series of photographic spectra of the variable star β Lyra, compared with spectra of β Orion and δ Taurus.

A new form of stereoscope was shown by Sir David L. Salomons. This stereoscope has been designed to suit the vision of all persons, without straining the eyes. Many individuals who are unable to use the ordinary stereoscope have been able to obtain the solid effects with this instrument. The lenses may be angled, and moved to and from the centre at will. Also the distance can be varied between the picture and the lenses. The distance between picture and lenses is greater than usual, to allow a wider mirror, which is advantageous.

A number of cloud photographs taken in different parts of the ocean world were exhibited by Captain D. Wilson-Barker; and Mr. F. H. Worsley-Benison exhibited a series of seascape photographs. The photographs were enlargements in carbon. The whole picture in each subject was the result of one exposure only.

Coming now to natural science: Models of the flowers of *Aristolochia gigas* from Brazil, and of *Stapelia gigantea* from Natal (made by Miss Emett for the Museums of the Royal Gardens, Kew) were exhibited by the Director, Royal Gardens, Kew. Flowers with livid colouring and exhaling indol or some allied body occur in different families of the vegetable kingdom. Kerner ("Natural History of Plants," translated by F. Oliver, vol. ii. pp. 197–200) thus describes them; "Flowers provided with indoloid scents resemble animal corpses in their colouring, having usually livid spots, violet streaks and red-brown veins on a greenish or fawn-coloured background." "Such flowers . . . are always visited by carrion-flies or dung-bettles in abundance."

The Director of the Royal Gardens also showed photographs of Hæmatozoa of fly disease of South Africa (exhibited on behalf of the Government of Natal). For the last half-century the Tsetse-fly has been notorious as a terrible scourge to live-stock, and the most formidable of impediments to colonisation in Equatorial and South Africa. Surgeon-Major Bruce has now discovered that the fly is itself innocuous, and is only fatal to animals when it is the carrier of a flagellated infusorian (*hæmatozoon*) which it introduces into their blood.

Two coloured casts of the New Zealand lizard, Hatteria or Sphenodon, were exhibited by Prof. Ray Lankester. The casts were taken at the Zoological Society's Gardens from a full-grown specimen immediately after death, and painted by Prof. Lankester, so as to give the natural colours. Stuffed specimens of lizards' skins are very difficult to prepare with any approach to natural form and folding of the skin. Such casts as those shown are useful as preserving form and pose.

Mr. Frederick James exhibited examples of British Lepidoptera (*Rhopalocera*) denuded of scales to illustrate their neuration. In each specimen the scaleless left fore and hind wings illustrated the neuration of the genus.

An experiment to ascertain the period at which larvæ are sensitive to surrounding colours, formed the subject of an exhibit by Prof. Poulton. The larvæ of *Amphidasis betularia* were, after hatching, surrounded with green leaves and shoots. During

each of the stages of growth a batch of larvæ was removed and surrounded by dark twigs, and at the end of the stage restored to the green leaves. By comparing the colours of the mature larvæ in the different batches, it is possible to determine the period of larval susceptibility.

The following forms of variation in butterflies of the genus *Heliconius*, of Tropical America were exhibited by Mr. W. F. H. Blandford. (1) Variation in *Heliconius erato*, L. There are three main types with the basal patch of the hind-wings, respectively, red, blue, or green. The green form is dominant in Panama; it occurs throughout Central America, but not in South America, except sparingly in Colombia and Venezuela. At Sao Paulo, on the Upper Amazons, the blue form alone occurs, or the basal patches may be obsolete. (2) Variation in *Heliconius thelxiope*, Hübn., and *Heliconius vesta*, Cram. Both forms occur together, and are very variable in Cayenne and the Lower Amazon Valley. Further west definite parallel geographical races occur of both. *Heliconius thelxiope* is connected by intermediate forms in Cayenne with *Heliconius melpomene*, L., a widely distributed species, which occurs in the Amazon Valley at Santarem and Obydos only, and is not found in the humid forest. In Bolivia *Heliconius vesta* merges into *Heliconius phyllis*.

Mr. W. Saville Kent showed interesting photographs and specimens illustrating the natural history and ethnology of Australia. The Hon. Walter Rothschild exhibited a group of recently described and other rare Birds of Paradise and Bower-birds.

During the evening four lantern demonstrations were given in the meeting room of the Society. Prof. A. C. Haddon showed a series of slides illustrating the evolution of the cart, and another which illustrated the evolution of the Irish jaunting-car. The Altels avalanche, which occurred in September 1895, was described with photographs by Dr. Tempest Anderson, and Prof. Herkomer gave a demonstration of his new gravure process. Prof. Dewar dealt with liquid air, and showed the following experiments illustrative of low temperature effects:—Filtering liquid air; vacuum vessels boiling at 350° F. below the freezing point; colour and absorption spectra; spheroidal state; solid alcohol; frozen soap-bubble; distilling mercury and phosphorus; liquefaction and solidification of gases; fusible metal spring; brittle indiarubber and its expansion by cold; the diamond burning in liquid oxygen; magnetic oxygen; photographic action and phosphorescence; ignition by means of a lens of liquid air; cooling a vessel 380° F. below the freezing point, until the air of the room condenses on the surface to the liquid state.

The Lords of the Committee of Council on Education have arranged for the public exhibition, in the Western Galleries of the Science Museum at South Kensington, of a number of the objects shown at the soirée. The exhibition will remain open to the public for about a fortnight.

ON THE ROTATION OF THE EARTH.[1]

THE recent discovery of periodical variations of terrestrial latitudes demands a revision of the actual theory of the rotation of our planet. This theory, based upon the hypothesis of the absolute rigidity of the earth, admits of variations of this kind, but very different in their laws from those of the observations. The period of revolution of the terrestrial poles given by the theory is one of about ten months. That which the observations give us lasts nearly fourteen months. Still further, the attentive analysis of the observations of the latitudes, executed of late by Mr. Chandler, shows us that the movement of the terrestrial poles is compounded of two others, of which the periods are, the one of 430 days, and the other of twelve months.

Following the order of the ideas established in the science by the celebrated cosmogenic hypothesis of Laplace, we ought to attribute this disagreement of the theory and the observations to the interior fluidity of the earth. But the illustrious physicist, Lord Kelvin, does not admit that the fluid nucleus of the earth may be of considerable enough dimensions. The greatest part of the astronomers of our day adhere to this opinion. They refer the said discordance to the terrestrial globe being elastic.

In considering the hypothesis of a thin rigid crust of the earth as contrary to all given physics, the celebrated English physicist affirms in his memoir "On the Rigidity of the Earth," *Phil. Trans.*, 1863, and in the first edition of the "Treatise on Natural Philosophy" (§§ 847 and 848), that this hypothesis is also incompatible with the observations of the precession and of the nutation. On subsequently withdrawing certain of these astronomical objections, he has replaced them by some others.

To be able to appeal to objections of this kind, the theory of the rotation of the earth considered fluid in its interior ought to have been previously established. Lord Kelvin has not done it. He has limited himself to enunciating in general terms the principal propositions of this theory. To be able to judge of the said objections of the celebrated English physicist, the theory in question must be previously established.

The problem of the rotation of the earth—supposed fluid in its interior—was approached by W. Hopkins in 1839 (*Phil. Trans.*, 1839-40-42); but the state in which hydrodynamics then was found, did not permit the English savant to treat the matter in a satisfactory manner. The more recent attempts to solve this difficult problem have not been more successful.

We shall endeavour in the present article to give a more perfect solution of this important problem. To render this task more easy, we shall assume that the nucleus of the earth is homogeneous, and of the form of a planetary ellipsoid.

The success of our task is assured by the beautiful researches of our clever geometrician, Prof. N. Joukovsky, relative to the movement of a solid body with cavities filled with an incompressible homogeneous fluid. We have only to apply these researches to our special problem. We hope to lessen the difficulties of this application by the supposition that the rotatory motion of the entire terrestrial mass differs very little from the uniform rotation. The proposition of the celebrated Laplace, relative to the effect of friction of the fluid parts of the earth upon its rotatory motion, affords us a solid foundation for the said supposition ("Œuvres Complétes de Laplace," tome v. p. 283).

We shall commence our article with an abridged exposition of the theory of the rotation of a solid body, which has a cavity filled with an incompressible homogeneous fluid. In the development of the principal formulæ of this theory we shall employ the most simple method, that of the illustrious Poisson. We shall equally profit by them in our transformations of the hydrodynamical equations.

(The final paragraphs, after thirty large octavo pages of intricate mathematics, are as follows.)

We have taken our problem with some considerable restrictions relative to the form, to the position, to the structure, and to the movement of the terrestrial nucleus. This renders almost useless the detailed comparison of our results with the given astronomical ones. We will only say some words relative to one of these results, of which the generality is indubitable.

The hypothesis of a fluid nucleus of the earth being admitted, and the exterior forces neglected, the movement of the terrestrial poles ought to be composed of two periodic movements. The period of the former of these movements is perhaps of twelve or fourteen months, that of the second ought to be pretty nearly a day.

The astronomical observations do not show us this second movement of the poles. Is not this a reason for taking exception to the hypothesis of the fluidity of the earth in its interior? By no means. It is in the first place possible that the smallness of the amplitude of the movement in question may make it unrecognisable. The smallness of the factors μ_2, ν_2, renders this supposition probable. Secondly, it may also be admitted that the want of the appropriate observations causes us to ignore for the present this movement, although its amplitude may be appreciable. One may also suppose that the period of the movement in question, from the usual order of astronomical observations, appears to us to be a period of twelve or of fourteen months. For instance, should the said period be equal to twenty-four sidereal hours exactly, and the observations of the latitude of any astronomical observatory be made every midnight during a good many years, the result of them will be the period of twelve months.

This last supposition appears to us worthy of attention, because according to our opinion the explanation of the period of twelve months by meteorological causes, as is adopted at present by some astronomers, wants probability.

[1] Abridged translation of a paper by Th. Sloudski, Professor at the University of Moscow (*Bulletin de la Société Impériale des Naturalistes de Moscou*. Année 1895, No. 2).

THE ANKLE-JOINT IN MAN, AND THE INHERITANCE OF ACQUIRED CHARACTERS.

PROF. RETZIUS has lately published an account of certain observations on the fœtus of Swedes, which, in connection with similar observations recorded by Surgeon Havelock Charles on the Punjabite, he believes to support the Lamarckian view that acquired characters are inherited. He endeavours to show that the evidence in support of the theory is to be found in our own skeletons.

Some years ago, Prof. Arthur Thomson pointed out that in certain races of men who habitually adopt a "squatting position," the tibia and astragalus present additional articular facets, allowing greater flexure of these bones upon one another, than is possible (or at any rate normal) in Europeans and other civilised races who have given up squatting, and in which these facets are absent. Accompanying these facets there is a retroversion of the head of the tibia. Both these characters are present in apes and in certain prehistoric races, and Surgeon Havelock Charles described, a year or two back, a series of instances of their presence not only in the adult Punjabite, but in the fœtus. At the meeting of the British Association at Oxford, Prof. A. Macalister exhibited these specimens, as well as similar specimens taken from British infants, and a discussion followed on the meaning of these peculiarities. Now Retzius ("Ueber die Vererbung erworbener Eigenschaften," *Biol. Untersuch*, n.f. vii.) records these same characters in fœtal Swedes, from an early age, even up to eight months; and reviewing the facts, he comes to the conclusion—in which I think most of us would agree—that the presence of these characters, viz. the retroversion of the head of the tibia and "Thomson's facets" is a more primitive condition than their absence in normal Europeans of the present day; that they have been inherited from early times; and in those peoples which habitually adopt the "squatting" position they have become gradually further developed. This last conclusion is perhaps open to question; it is quite possible that even in these races they are less developed than in ancestral forms. But Retzius proceeds to contend that Europeans have undergone gradual change in their skeletons from generation to generation; they no longer sit on their haunches, and have gradually lost the power to do so, and as a consequence "Thomson's facets" have disappeared; and he concludes that "it is, therefore, we Europeans who, on account of changed habits, have undergone changes, and it is in us that these changes have gradually been inherited."

But here, it seems to me, that Darwinians would join issue with Retzius. His own and other observations show that the *changes* are not inherited; for the characters of the bones are inherited from the ancestral ape-like forms, and it is, surely, only on account of individual habit that the peculiarities are not present in the adult.

It is by no means clear what is the "acquired" character on which Retzius hangs his views. Is it the osteological peculiarity, or the habit of using chairs to sit upon, instead of employing the squatting posture? His own researches show that the osteological characters are *not* acquired, whilst the habit of walking upright and sitting on chairs is distinctly acquired, and it is in relation to this acquirement that the osteological peculiarities cease to be evident. Young children, as we know, can and do sit upon their haunches, and can move their legs and ankles in a way that an adult, unless he is fairly athletic, finds it impossible to do; and it appears probable that the disappearance of the facets in the adult is closely connected with the ossification of the bone, which will obliterate the facets now no longer brought into use. It would be interesting to examine in this connection the leg-bones of "contortionists" and others who make a free use of their legs and ankles, for a very little practice enables even civilised men to employ exaggerated movements of their limbs.

Another point to which attention might be directed (which indeed may have been looked into) is the character of the articulation of the bones of the great toe in those races which make use of this digit. A casual observation on the skeleton of an Andaman shows that the articular surface of the first metatarsal with the entocuneiform is distinctly more rounded than in a European; a feature in which there is an approach to the condition in the apes. It might have been presumed that some difference, similar to that in Europeans and Punjabites, would be found in digitigrade and plantigrade mammals; but the result of a brief examination of skeletons of such forms is sufficiently surprising to be referred to; for instance, in the lion there is a facet of the same kind as, but not really homologous with Thomson's facet, at the lower end of the tibia. This is absent in the bear and the dog; it is also absent in the sea-otter. It is present, however, in the beaver and other rodents; it exists in some ruminants, as well as in the horse, but is only slightly developed in the tapir, and is absent in the Suidæ.

THE PARIS OBSERVATORY.

M. TISSERAND'S report on the work accomplished in the Paris Observatory during 1895 has come to hand. The principal points referred to are indicated in the subjoined summary.

The revision of the right ascensions of the fundamental stars of the Paris Catalogue is completed, and the revision of the polar distances was commenced in May of last year.

During the year, MM. Henry obtained 319 plates for the photographic star catalogue, which number brings the total up to 1155. Eighty-eight plates, containing 35,814 stars, were measured under the direction of Mlle. Klumpke, and the measures of 13,663 stars upon forty-three plates previously obtained were reduced for the catalogue of the photographic chart.

The great Coudé equatorial has been used whenever possible in lunar photography, in order to complete the series of photographs of the moon required to make a large-scale map of our satellite. The photographs already obtained have been enlarged and reproduced by heliogravure by MM. Fillon and Heuse. The first fasciculus of the photographic chart of the moon, which MM. Lœwy and Puiseux have in hand, containing six sheets, five of which will represent parts of the moon on a scale of 2·60 metres to the lunar diameter, will shortly be issued. The present report contains a heliogravure representing an unenlarged photograph of the moon obtained in February 1894. The picture is a most striking one, reproducing faithfully and beautifully the chief features of the lunar surface.

M. Deslandres has continued his photography of the solar chromosphere. He has also investigated the subject of the displacement in the lines of the spectrum of Jupiter, produced by the planet's rotation. A note upon this subject appeared in NATURE in March 1895 (vol. li. p. 443). In the first measures made by M. Deslandres, the equator of the planet was allowed to lie along the slit of the spectroscope, and the inclination of the lines produced by approach and recession of opposite ends of the equatorial diameter were determined. The method now followed consists in measuring the inclination of the lines in the planet's spectrum with reference to neighbouring lines of terrestrial origin, The mean of the measures thus made gives 48 ± 1 kilometres as the difference of velocity of two opposite points on Jupiter's equator. From the known time of rotation of the planet, and the length of the equatorial diameter, the velocity deduced is 49·6 kilometres. The same method has been applied by M. Deslandres to Saturn's disc and rings.

Reference is made to the spectroscopic photographs of the velocity of Altair in the line of sight. The photographs give evidence of differences in the radial velocity, even when the mean error of observation is considered. These variations have a period of about forty-three days, and a secondary period of about five days. The conclusion arrived at from an examination of the spectra is that Altair is in orbital motion under the influence of one or more unknown bodies. The star β Ursæ Minoris also shows variations of velocity in the line of sight which cannot be accounted for by errors of observation.

In addition to the matters referred to in the foregoing, the usual meridian work, and observations of comets and minor planets, as well as meteorological observations, were carried on during 1895, and the chief results obtained are stated in the report.

CABLE LAYING ON THE AMAZON RIVER.[1]

WHEN it had been decided to connect Belem, the capital of the State of Pará, by means of a subfluvial cable with Manaos, the capital of the State of Amazonas, a preliminary journey became necessary, during which landing-places at the various intermediate stations had to be selected, some reaches of the river explored, as no trustworthy charts exist, and various

[1] Abridged from a discourse delivered at the Royal Institution by Mr. Alexander Siemens.

other details ascertained in order to facilitate the laying of the cable.

This preliminary survey took place in October of last year during the hottest season, when the river was at its lowest; while the cable was laid during January and February of this year, when the rainy season had commenced and the river was rising.

It is extremely difficult to realise the true proportions of this river, but the subjoined comparative table, in which the dimensions of the principal rivers of the various continents are contrasted with those of the Amazon, will help to show the importance of this great system of natural waterways.

With several other large rivers the Amazon shares the fate that its name changes several times during its long course, and that at various times different affluents have been considered to be the true source of the main stream.

Most geographers, however, regard the Marañon as the principal river, a branch of which, called Tunguragua, rises in Lake Lauricocha in Peru in 10° 30′ S. lat., and 76° 10′ W. long.; although the Ucayale, where it unites with the Marañon at Nauta (4° S. lat., 73° W. long), is quite as important as the Marañon.

Name.	Length in statute miles.	Watershed. Square miles.	Average discharge cubic feet per second.	Length of navigable waters in miles.
Mississippi ...	2616[1]	1,285,300[6]	675,000	35,000
La Plata ...	2400	994,900[6]	700,000?	20,000
St. Lawrence	2200	565,200[6]	1,000,000[7]?	2,536
Nile	3370	1,293,050[6]	61,500	3,000[3]
Volga	2325	592,300[6]	384,000[2]	14,600
Danube ...	1735	320,300[6]	205,900	1,600[3]
Rhine	810	32,600[6]		550[3]
Thames ...	210	6,010	2,220[4]	200[3]
Amazon ...	2730[5]	2,229,900[6]	2,400,000	50,000

(1) To source of Missouri 4300 miles.
(2) At Saratoff.
(3) Exclusive of tributaries.
(4) At Teddington.
(5) To source of Apurimac 3415 miles.
(6) According to Dr. John Murray.
(7) According to Darby, the American hydrographer.
According to *Encyc. Britt.*

Area of Great Britain and Ireland	120,626
,, British India	1,560,160
,, Brazil	3,219,000
,, Europe	3,790,000

If the greatest distance from the mouth is to decide the question, then the source of the Apurimac, an affluent of the Ucayale, can lay claim to being the origin of the Amazon, rising in Peru in 16° S. lat., and 72° W. long.

Along the whole course of the Amazon, commencing at the foot of the Andes, a network of islands and canals is formed on both sides of the river, as the whole country is almost level, and is consequently inundated during the rainy season for hundreds of miles by the rivers flowing through it The most notable exception to this general state of things occurs at Obidos, where the whole volume of water is compressed into one channel a little over a mile wide, and said to be about forty fathoms in average depth A sounding taken opposite Obidos, about a third of the distance across the river, showed a depth of fifty-eight fathoms, measured by a steel wire and Lord Kelvin's sounding-machine. As the current of the river averages three knots in the main channel, it is not easy to take soundings by an ordinary lead line; and even with the steel wire an extra heavy weight (33 lb.) has to be employed, or the results are not trustworthy.

Besides the wire sounding-machine a submarine sentinel was used on the preliminary voyage, wherever serious doubts existed about a channel through which the cable was to be laid. This apparatus consists of a small winch from which a wire leads into the water and drags at a short distance behind a piece of wood, shaped like an angle-iron, in a nearly upright position. The wire is not attached directly to the piece of wood, but to a string kite-fashion, and the wood is fitted with an iron foot which, on coming in contact with the bottom of the water, releases one end of the kite-string, so that the wood remains attached to the winch wire with one end only. The consequence is that the strain on the wire is suddenly reduced to a very small amount, and the piece of wood appears on the surface of the river. It depends on the quantity of wire paid out how deep the kite or the sentinel floats, and its action is quite trustworthy, so that it is unnecessary to take soundings by the line or by wire while the sentinel is being dragged by the ship. Usually the sentinel was set at five fathoms, and when it struck a bar the ship was stopped, and a series of soundings taken to ascertain the exact depth of water, and the extent of the shallow place.

A further difficulty in sounding originated from the soft nature of the soil, which for the greater part of the Amazon valley is alluvial clay, and allows the lead to sink into it for several feet. In the narrows there appears, however, a bank of hard clay (called Tabainga) which, unfortunately, blocks nearly all the branches of the narrows, and creates bars all along the course of the Tajipuru, the main westerly waterway connecting to the Gurupá branch of the main river. Occasionally the same hard clay forms shallows in the main river, but as a rule the section of all the channels resembles the capital letter U, *i.e.* the sides are very steep and the bottom flat. In this respect, as in many others, the Amazon differs entirely from the Indian rivers, which build up their beds above the surrounding country, occasionally breaking through their natural banks and seeking a new bed. The Amazon, on the other hand, carries with it only the light clay sediment which forms the soil of the whole valley; and the inducement for the main stream to alter its course is therefore very small, and long straight reaches are the result.

Under these circumstances the largest vessels can ascend the river nearly to the foot of the Andes, but the constantly-changing sandbanks at the mouth of the Amazon proper make this approach of the river dangerous, and the State of Pará is, for obvious reasons, not over-anxious to have the deep channels properly buoyed and surveyed. This forces all the shipping to enter the Pará River, and to pass the narrows if the Amazon is the goal of the journey. In doing the latter, the choice for large ships lies between one of the channels (called Furos) with a bar, where it joins the Tajipuru, and a furo (the Macajubim) which has plenty of water, but which winds about in such a serpentine fashion that only ships with twin screws can pass it unassisted.

These difficulties are, however, much diminished during the rainy season, when the river rises to such an extent as to drive all the inhabitants of its banks into the towns, which have been built wherever a natural eminence secured the inhabitants against the flood. Near the mouth the difference is naturally not so great as higher up, where the influence of the tide is felt less; but at Manaos the difference in level between low river and high river exceeds forty feet.

With all rivers carrying sediment the Amazon shares the peculiarity that its immediate banks are higher than the country lying behind them, and thus we have in the rainy season the spectacle of the main river flowing between two banks covered with dense forest, and immense lakes stretching out on either side of these banks. These do not entirely dry up during the remainder of the year, so that the whole of the Amazon valley really forms a huge swamp covered with a most luxuriant forest, which below Manaos narrows to a broad belt close to the main river with prairies, called Campos, at the back of the forest stretching out to the hills, where the forest recommences. In such a country no land communication of any sort can be attempted, as the tropical vegetation and the annual inundations of the rivers destroy everything that man places in the way of the natural forces. By water, on the other hand, the intercourse between all habitable parts of the country is easy and expeditious since steamers were introduced in the year 1853. Belem, the capital of the State of Pará, lies on a branch of the Pará River, called Guajará, which unfortunately does not share the characteristic shape of the Amazon and the furos, but forms a rather shallow basin in front of the town.

The first station on the main cable is Breves, the centre of the rubber trade of the islands of the lower Amazon, situate in the centre of "the narrows."

In Gurupá, the second station of the main line, the inhabitants expressed their joy at being put in communication with the rest of the world by actively helping in the landing of the first shore end.

During an enforced sojourn near the mouth of the Boinasu, in the midst of the most wonderful combination of islands and rivers, the two naturalists, which the British Museum authorities had kindly sent with the expedition, took full advantage of the opportunity to explore the locality in all directions.

In the rubber-gathering industry, which is at once the wealth and bane of this part of the world, the implements in use are of the most primitive kind, but the average earnings can easily be three pounds per day during the dry season, and the facility of earning so much money with little exertion makes the inhabitants unwilling to engage in more arduous labour.

A narrow path leads from the hut on the water's edge into the forest from one rubber-tree to another, the path eventually returning to the hut. The trees are cut on the morning round, and the rubber is gathered in the afternoon. As soon as it arrives at the hut a fire of oily palm-nuts (*Attalea excelsa*) is lighted, and the thin sap thickened in the smoke For this purpose a paddle is used, on to which the sap is poured with a small earthenware or tin vessel. The smoke soon thickens it, and a new layer is poured on until the well-known flat cakes of india-rubber have been formed.

Owing to the rise of the river during the rainy season most of the huts have to be abandoned, and it can easily be imagined how comfortless they are. Nearly all of them are built on piles, and most of them are thatched with palm-leaves. There is hardly any attempt made to cultivate the soil, such as it is, but everything is imported. The s.s. *Cametense*, in which the surveying party went out, was laden with cabbages, onions, and potatoes, part of which went as far as Iquitos in Peru.

Chiefly owing to this want of provisions, and to the generally careless mode of life, the mortality among india-rubber gatherers is very great.

Everything Bates and Wallace have said of this region remains as true as it was forty years ago, and hardly anything new can be added to their description of the general features of the Amazon valley; but the town of Manaos has completely changed its character since it was made the capital of that region in 1853. A town quite European in its features has arisen in the midst of the forest, and to the benefits of rapid transport, to which it has owed so much, there is now added the characteristic lever of modern progress, the annihilator of space and time—electrical communication.

NOTES ON CLOUDS.[1]

THERE are two points connected with clouds on which I wish to make a few remarks. The first is on the classification of clouds, and the second on the manner in which certain forms of clouds are produced. It may be as well to remark at the outset that the observations are those of an "outsider," being in a department of meteorology to which I have given but little attention, and they have been written with a view of calling the attention of specialists, and getting their opinion on the subject.

It appears to me that in classifying clouds they ought first of all to be divided into two great classes. In the one class should be placed all clouds in the process of *formation*, and in the other those in the process of *decay*. The two classes might be called *Clouds in Formation* and *Clouds in Decay*. We may take Cumulus clouds as an example of the former, and Nimbus of the latter. My observations made on the clouds themselves have shown that there is a difference in the structure of these two classes of clouds. In clouds in formation the water particles are much smaller and far more numerous than in clouds in decay; and while the particles in clouds in decay are large enough to be seen with the unaided eye when they fall on a properly lighted micrometer, they are so small in clouds in formation that, if the condensation is taking place rapidly, the particles cannot be seen without the aid of a lens of considerable magnifying power. In the former case the number of particles falling per square millimetre is small, while in the latter they are so numerous that it is impossible to count them.

It appears that one good end might be served by adopting this classification. It would direct the attention of observers more to looking on the processes going on in *decay* for an explanation of many of the forms observed in clouds. In most books on clouds, when describing the different shapes of clouds, it is almost always assumed that they are in process of *formation*, and the whole explanation of the shapes taken by the clouds is founded on this supposition. Now, it is very evident that very many clouds are in the process of decay, and their forms can only be explained by the processes going on under these conditions.

This brings me to the second point in this communication, namely, the manner in which ripple-marked cirrus clouds are produced. The explanation which has generally been accepted of the formation of this form of cloud is, that the ripple markings are due to the general movements of the air giving rise to a series of eddies, the axes of the eddies being horizontal, and roughly parallel to each other. It is very evident that the air revolving round these horizontal axes, that is, in a vertical plane, will at the lower part of its path be subjected to compression, and at the upper part to expansion. The result of this will evidently be, supposing the air to be nearly saturated with moisture, a tendency for cloudy condensation to take place in the air at the upper part of its path, and it is this cloudy condensation in the upper part of the eddies that is supposed to produce the ripple-like cirrus; each ripple mark indicating the upper part of an eddy. One objection I have always felt to this explanation is, that it is difficult to imagine that the small amount of elevation and consequent expansion and cooling could give rise to so dense an amount of clouding as is generally observed. Any clouding produced in this way one would expect to be extremely thin and filmy. I have for the last few years made frequent observations of these clouds, and I have to admit I have never once seen them in the process of formation, or seen one appear in a clear sky. In all cases that have come under my observation, these ripple clouds have been clouds in decay. They are generally formed out of some strato-cirrus or similar cloud. When we observe these strato-cirrus clouds in fine weather, it will be found that they frequently change to ripple-marked cirrus clouds before vanishing. The process of their formation would seem to be: the strato-cirrus gradually thins away till it attains such a depth, that if there are any eddies at its level, the eddies break the stratus cloud up into parallel or nearly parallel masses, the clear air being drawn in between the eddies. It will be observed that this explanation requires the eddies, but not to produce the clouding, only to explain the breaking up of the uniform cirrus cloud into ripple cirrus.

One thing which supports this explanation is, that lenticular-cirrus clouds are frequently observed with ripple markings on one or more sides of them just where the cloud is thin enough to be broken through by the eddies. If we watch these lenticular-formed clouds under these conditions, we frequently see the ripple markings getting nearer and nearer the centre as the cloud decays; and at last, when nearly dissolved, the ripple markings will be seen extending quite across the cloud. It seems probable that "mackerel" and other cloud forms may be produced in the same way.

The shapes which these ripple cirrus clouds assume are much more varied than is generally supposed. I lately observed a most interesting form in the south of France while the mistral was blowing strongly. There were a few cirrus clouds in the sky at the time, and one of these was rapidly being broken up into irregular ripple forms, but at one point there was formed a most perfectly cylindrical-shaped piece, its length being about twenty times its diameter. The whirling effect of the eddy was very evident by the circular streaking of the clouding. Further, this cloud was evidently hollow, that is, the interior was filled with clear air as the cloud was thinnest along the axis, and it had all the appearance of a revolving tube of cloudy air.

It is not contended here that ripple clouds are never produced in the manner which has generally been accepted, only that so far as my observations go they have never been observed forming in the manner supposed. It is hoped that others will put the explanation here offered to the test of observation, and it is principally with a view of getting others to repeat the observations that this has been written.

[1] Paper read by John Aitken, F.R.S., to the Roy. Soc. of Edin. on May 4.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—In the Mathematical Tripos List published on June 16, Mr. W. G. Fraser, of Queens', is Senior Wrangler, Messrs. Barnes, Carson, and Wilkinson, all of Trinity, are bracketed for the second place, and four members of St. John's, Messrs. Edwardes, Houston, Cook, and Turner, follow in two brackets, fifth and seventh. Miss Longbottom, of Girton, has the twelfth place.

In Part II. seven names appear in the first division of the first class, beginning with Mr. Bromwich, of St. John's, the Senior Wrangler of last year.

Mr. A. C. Dixon, of Trinity College, has been approved for the degree of Doctor of Science, in consideration of his mathe-

matical works. Mr. Dixon was Senior Wrangler in 1886, and is Professor of Mathematics at Galway.

A lectureship in Hausa is about to be founded, in virtue of a benefaction by the Hausa Association. The language ranks with Arabic and Suaheli as one of the most important West African tongues used within the British sphere of influence.

The General Board propose that a Professorship of Mental Philosophy and Logic, with a stipend of £700 a year, should be forthwith established. Prof. Sidgwick has generously offered to accept a diminished stipend of £500 a year for the next six years in order that funds may be available for this purpose.

The Tyson Medal for Astronomy has been awarded to Mr. E. T. Whitaker, of Trinity.

Mr. W. Mather has received the thanks of the University for a valuable gift to the Engineering Laboratory of an experimental steam-engine and dynamo.

A Latin letter of congratulation to Lord Kelvin on the jubilee of his Professorship at Glasgow was approved at the Congregation on June 11, and was ordered to be sealed with the Common Seal of the University and presented to him by the University delegates to Glasgow.

The Syndicate on Women's degrees was appointed without opposition, and have already held their first meeting. Their report will not be issued until next Term.

THE following appointments have been made in the Northern Polytechnic Institute, Holloway:—Mr. Hubert A. Garratt, Senior Lecturer in Engineering, University College, Bristol, to be Head of the Engineering Department; Mr. V. A. Mundella, Assistant Lecturer in Physics and Electrical Engineering, Durham College of Science, Newcastle, to be Head of the Physics and Electrical Engineering Department; Dr. Thomas Ewan, Assistant Lecturer in Chemistry, the Yorkshire College, Leeds, to be Chief Assistant in the Chemical Department. Other recent appointments are:—Dr. G. Frege to be Professor of Mathematics at Jena; Dr. Lickfett to be Director of the Hygienic-bacteriological Institute at Danzig; Dr. Scholl to be Extraordinary Professor of Chemistry in the Technical High School at Karlsruhe. Mr. E. A. Gardner, formerly Director of the British School at Athens, to be Yates Professor of Archæology in University College, London; Dr. Paul Eisler to be Extraordinary Professor of Anatomy at Halle; Dr. L. Joubin to be Professor of Zoology, and Dr. H. Prous to be Extraordinary Professor in Lille University; Dr. Theobald Smith to be Professor of Comparative Pathology in Harvard University.

THE Technical Instruction Committee of the North Riding County Council some time ago substituted a system of individual instruction in cheese and butter making at the farm-house of any farmer who desired it, for the more commonly adopted travelling dairy school. In addition to this method of instruction they have agreed to a scheme whereby a permanent dairy school will be opened at Helmsley in the course of the present month. The school is being built by the Earl of Feversham, and is to be placed at the Committee's disposal, who are making themselves responsible for the proper fittings and apparatus. It is confidently anticipated that the school, which will be styled the "Ryedale Dairy School," will be much used and greatly appreciated.

ON Thursday evening last it was resolved by 332 votes to 83, that boroughs of not less than 20,000 population should form separate educational authorities. This will mean, as the Vice-President of the Council pointed out in his speech on this amendment, that in addition to the 128 authorities which there would have been as the Bill originally stood, we are to have 241 more authorities added, that is, provided the amendment passes the House of Lords. Further, since there is no doubt populous urban districts will claim to be treated like municipal boroughs, and it seems only reasonable to suppose that such will be granted similar powers, forty-nine more authorities will be brought in, making a total of 418 separate centres for the Education Department to deal with. In some cases the result will be extraordinary; for example, in Lancashire there will be some forty-two different educational authorities. The extent to which the work of the County Councils would suffer should this concession of the Government become law, can only be appreciated by those who know the spirit in which small local authorities approach any matters pertaining to secondary education.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, June 12.—Captain Abney, F.R.S., President, in the chair.—Mr. Campbell read a paper on the measurement of very large and of very small alternating currents. The author advocates the use of air-coil transformers for measuring voltages and currents which are either above or below the range of the instruments available. If an attempt is made to measure the current in the primary of an air-coil transformer by observing the voltage on an open circuit secondary, it is found that the readings depend on the frequency. In order to overcome this difficulty the author uses a closed secondary with a very high inductance. In this case the primary current is proportional to the secondary current, which latter may be measured by an ammeter. The author has also investigated the case of transformers with iron cores, and of which the inductance of the secondary is large. In the case of a ring transformer with a closed magnetic circuit, if the load on the secondary consisted solely of a Kelvin 100-ampere balance of very low resistance, the ratio between the primary and secondary currents is practically constant. With an open magnetic circuit transformer, however, this is not found to be so, as the ratio between the primary and secondary current varies considerably with the frequency. Mr. Blakesley said that the author's arrangement could only be used for measuring the *current* in the primary. He (Mr. Blakesley) had shown how to measure alternating currents by means of dynamometers, and without the necessity for any special apparatus. Mr. Griffiths exhibited and described his improved form of resistance box. This resistance box has many novel features: (1) It permits of all the coils being compared with one another, without the use of standard coils, and with great ease and rapidity. Hence it is sufficient at any time to compare any one of the coils with a standard to obtain the correction to be applied to all the coils. (2) The bridge wire can be calibrated by means of the box itself. (3) The temperature of the coils can be accurately determined, since they consist of bare platinum-silver wire wound on mica and immersed in an oil bath, which bath is kept stirred. (4) The resistance of the leads from the box to the object being tested is eliminated, as well as any error due to a change in this resistance with temperature. (5) The coils are arranged according to a binary scale, and the author claims that it is possible to measure resistances up to 105 ohms, to within 0·000001 ohm. (6) All the coils, after being adjusted, have been heated to redness and allowed to cool slowly, so that all strain has been removed from the wire. (7) By having a separate pair of blocks for each plug, it is impossible for the insertion of one plug to affect the fit of a neighbouring plug. The plugs themselves are so made that no part of the plug is wider than the top of the hole, and so it is impossible to wear a "shoulder" on the plug. Prof. A. Gray said that Mr. Griffiths had discovered and remedied all the weak points of the ordinary form of bridge. Lord Kelvin had ordered the paraffin to be melted off the coils of one of his resistance boxes, and it was found that the resistance of the coils altered considerably, owing, no doubt, to the strain to which the wire had been subjected, when imbedded in the solid paraffin. Lord Kelvin had made coils without paraffin, and was specially in favour of the use of the binary scale. Prof. S. P. Thompson said he considered the binary scale the weak point of the author's arrangement, since it did not permit of ratios other than 1 to 1 being employed. Mr. Campbell asked what current could safely be passed through the coils. The author in his reply said that he believed it to be a great mistake to employ any ratio for the arms other than 1 to 1.—Prof. S. P. Thompson read a communication on Röntgen rays. The author, after describing the various forms of tubes he had made with a view of discovering the best form for the production of Röntgen rays, gave an account of the experiments he had made to try and obtain some indication of polarisation. In this connection a large number of crystals have been tested, but the experiments have all given negative results. The author exhibited an electroscope with aluminium leaves and enclosed in a wire-gauze screen, to protect it from the influence of outside electric changes, by means of which he was able to show the discharge of a positively or negatively electrified body by means of the X-rays. A method of obtaining dust figures by the discharge of an electrified body by the X-rays

was shown, and some of the results which have been obtained were exhibited. All attempts to obtain true reflection have failed, although it appears as if most bodies, including air, are capable of giving diffuse reflection.—Dr. Shettle, who was announced to give a paper on Röntgen rays, explained that he had just discovered that the effects he had intended to describe were due to red light which had penetrated his dark room.—Prof. du Bois said that Galitzine had found that Röntgen rays were polarised by tourmaline, a special form of developer being employed. The behaviour of tourmaline to light waves presents some curious features, for if the wave-length is increased a point is at length reached where the ordinary and extraordinary rays are equally absorbed. For greater wave-lengths the ordinary conditions are reversed. If the Röntgen rays are not homogeneous, the contradictory results obtained by different observers might be due to the fact that they were working with rays which were differently absorbed by tourmaline.—Mr. Swinton said he had tried the effect of heating the kathode, and had obtained results which were similar to those obtained by the author. Mr. Swinton further said that he had found that the blue luminescence sometimes observed depended on the size of the kathode. With tubes in which the kathode was almost a complete hemisphere it was impossible to eliminate this blue luminescence.—Mr. Appleyard suggested the performance of the experiments under the surface of a dielectric.—Prof. Gray said he had obtained some indication of regular reflection, but nothing definite. The author in his reply said that it had been found that if the Röntgen rays are reflected from a surface of sodium in vacuo the amount reflected is a minimum for normal incidence, and increases at oblique incidence. Comparing this behaviour with that of ultra-violet light, it supports the idea that the Röntgen rays consist of transverse vibrations. The Society then adjourned till June 26.

Geological Society, May 27.—Dr. Henry Hicks, F.R.S., President, in the chair.—The President announced that a portrait in oils of the late Prof. Huxley had been presented to the Society by Sir John Evans, K.C.B., F.R.S.—On the Pliocene deposits of Holland, and their relation to the English and Belgian crags, with a suggestion for the establishment of a new zone "Amstelien," and some remarks on the geographical conditions of the Pliocene epoch in Northern Europe, by F. W. Harmer. The author drew attention to some papers by Dr. J. Lorié, of Utrecht, describing the strata met with in some deep borings in Holland, which showed that the Newer Pliocene is in that country nearly 500 feet thick, and that it had been depressed more than 1000 feet below its original position. He inquired whether this subsidence could be connected with the elevation of the Older Pliocene in Belgium and Kent, and how far these earth-movements could be traced in East Anglia and influenced the deposition of the English crag. He gave particulars of the alterations in level which have taken place during and since the Crag period in England and on the continent, showing that the two movements of upheaval and subsidence have much in common, and especially that they regularly increase in degree to the north and south respectively.—The *Lingula*-flags and igneous rocks of the neighbourhood of Dolgelly, by Philip Lake and S. H. Reynolds.—The Kildare inlier, by S. H. Reynolds and C. I. Gardiner. The area described in this paper is occupied by four prominent hills composed of lower palæozoic rocks rising as an inlier from beneath carboniferous beds. The authors gave the following succession of rocks in descending order. (6) Green and grey micaceous grits and shales of Dunmurry. (5) Red and black shales. Gap: no exposure seen. (4) Limestones of the chair of Kildare. (3) Contemporaneous igneous rocks. (2) Fossiliferous ash of Grange Hill House. (1) Green gritty shales (unfossiliferous).

CAMBRIDGE.

Philosophical Society, May 25.—(*a*) On the spectroscope used in connection with the 25-inch refractor; (*b*) on a suggestion for a form of spectroheliograph, by Mr. H. F. Newall. On the period of the earth's free Eulerian precession, by Mr. J. Larmor. The following general proposition is easily established; it has been suggested by the recent memoirs of Prof. Newcomb and Mr. Hough. Consider any solid body, for example the earth, in rotation about its axis of greatest moment of inertia: when the body is not absolutely rigid, the period of the small free precessional motions of the axis of rotation will depend in part on its elastic yielding to the centrifugal force; but in all such cases, whether the body is homogeneous or not, whether the elasticity is perfect or imperfect, this precessional motion will be the same as that of a body absolutely rigid, with its materials distributed in the configuration which the actual body would assume, on the supposition that it remains perfectly elastic, were it relieved of the centrifugal force of rotation. Taking the case of the earth, in which the equatorial moments of inertia are all equal to A, while the axial one is C, the ordinary forced astronomical precessions give the value of $(C-A)/C$; while knowledge of the variation of terrestrial gravity gives $C-A$; so that C and A are separately known. The period of the free Eulerian precession gives $(C'-A')/A'$, where C' and A' are the moments of inertia which the earth would have were the strain corresponding to centrifugal force removed. In so far then as this free period can be reliably disentangled from the actual observations of changes of latitude, which are also affected by unknown irregular variations due to meteorological causes, and so more or less of an annual character, we derive from it a knowledge of $C'-A'$; thereby obtaining an additional *datum* for discussions relating to the constitution of the earth's interior. This is on the supposition that the earth is wholly solid. The influence of the surface waters can, however, be estimated by the same principle, as they are in the main deep enough to make an equilibrium theory applicable. It appears that, if the actual earth were absolutely rigid, and wholly covered by an ocean, the mobility of this ocean would lengthen the period of free precession by about 14 per cent. But this superior limit is reduced both by the limited extent of the ocean and by the yielding of the solid earth; so that, on an outside estimate, not more than 6 or 8 of the actual 40 per cent. of lengthening of the period can be due to mobility of the surface waters. On this equilibrium theory, an amplitude of a third of a second of arc in the Eulerian precession would produce a tidal component, of the same period, whose amplitude would in middle latitudes be about half an inch; which is just the kind of result that has been derived from examination of the tidal observations in Holland and on the east and west coasts of North America. The influence of possible fluidity of a portion of the interior has been fully developed by Mr. Hough, the results agreeing with indications virtually given by Lord Kelvin so long ago as 1876, and published in the British Association Report for that year. The conclusion drawn by Mr. Hough from the Chandler period, that, for the small stresses involved, the interior of the earth is in the main perfectly elastic and about as rigid as steel, is in accord with the recent observations by seismologists of what is probably the time of propagation of earthquake disturbances from Japan to Europe in a direct line across the earth's interior.—Note on a point in theoretical dynamics, by Sir Robert Ball. Let α be a screw about which a free rigid body is made to twist in consequence of an impulsive wrench administered on some other screw η. Except in the case where α and η are reciprocal it will always be possible (in many different ways) to design and place a rigid body so that two arbitrarily chosen screws α and η will possess the required relation. Let now β and ζ be two other screws (not reciprocal); we may consider the question as to whether a rigid body can be designed and placed so that α shall be the instantaneous screw corresponding to η as an impulsive screw, while β bears the same relation to ζ. It is easy to see that it will not generally be possible for α, β, η, ζ to stand in the required relations; they must in some way be restricted. It is the object of the author's note to show that the restrictions are two in number, and to set down what they are.

EDINBURGH.

Royal Society, June 1.—Prof. Copeland in the chair.—Prof. Tait read a paper on the linear and vector function. We speak of fluid motion as being "differentially irrotational" when there is a velocity potential, and as "rotational" when there is a vortex. In the first case, the strain involved is pure, *i.e.* there are three rows of particles, at right angles to one another, whose directions are momentarily unchanged. In the second case, one such row of particles alone exists. But there is, when we look at the matter from the point of view of the roots of the strain-cubic, a third case—where there are three rows of particles, *not* generally at right angles to one another. Prof. Tait showed that such a strain is, in general, the result of the superposition of two successively applied, but different, pure strains. Thus, comparing the non-vortex states of a small element of a fluid at three successive instants, a portion, cubical at the instant A, may be found, such as to be brick-shaped, without change of direction of its edges, at B. Similarly from B to C. But to

compare A with C, we have a definite parallelepiped whose edges remain unchanged in direction.—Mr. R. C. Mossman gave the first part of a communication on the meteorology of Edinburgh, in which he dealt with the mean values of the climatic elements for each day of the year, basing his inquiry on over a million observations. The non-instrumental records extended over 125 years, and the daily sunshine means over 30, the average of the nineteen classes of observation being about 80 years. As regards pressure, the maximum was from April 7 to July 3, and the minimum on November 26. For temperature the maximum was an average of 59°·3 on August 8, while January 8 was the coldest, the mean temperature being 36°·0. The curve of rainfall showed that the seven days ending April 18 were the wettest days in the year, thus confirming the popular belief in the Lammas floods. Mr. Mossman described in detail the climatic features of each month, and showed how these reacted on each other. An interesting result was the recurrence of similar types of weather at the same time each year.—Mr. Malcolm Laurie read a paper on the nutrition of the embryo in scorpions. The variation in the modes of development in different genera of scorpions is very large. The primitive form seems to be a large egg with much food yolk, and is found in *Euscorpius* and the *Buthidæ*. This egg develops in the ovarian tube. In other *Jurudæ* the egg is yolkless, though appearing to be a considerable size owing to the surrounding embryonic membranes. In the *Scorpionidæ* the egg is entirely without yolk, and develops in a diverticulum of the ovarian tube. Various contrivances exist for the better nourishment of the embryo during the later stages of development. Nourishment, secreted by the cells of the diverticulum and by a solid cord of cells (appendix) in which it terminates, is always taken in through the mouth, which is early developed. In addition to this, in *Ischnurus*, the cheliceræ grow into long root-like processes which lie among the cells of the appendix, and seem to absorb nourishment from them. In *Hormurus* a similar function is performed by the chelæ, while in the *Scorpionini* the cheliceræ grasp a cord of cells coming from the centre of the appendix, and masticate it. In these last forms there are also present dorso-lateral out-growths of the segments of the body, which appear to act as surfaces for absorbing nourishment directly from the surrounding maternal tissues. This arrangement is carried still further in *Opisthophthalmus*, where there are two long processes, one from the prostomium, and the other from the back of the carapace, which run out among the maternal tissues.

DUBLIN.

Royal Irish Academy, June 8.—Dr. J. Kells Ingram, Vice-President, in the chair.—Mr. Charles J. Joly read a paper on quaternion invariants of linear vector functions and quaternion determinants. This was a supplement to a paper read before the Academy in December 1895, and published in their *Transactions* (vol. xxx. part 18). From given linear vector functions others are derived by repeated multiplication in any order. The Hamiltonian and other quaternion invariants of these new functions are expressed as the quotients of two determinants with vector constituents. Their scalar parts having been considered in the previous paper, their vector parts are now reduced to the results of operation on the spin-vectors of the given functions, and of one function of each of certain cyclical groups of the derived functions. Examples and interpretations are also given of determinants with quaternion constituents in the expansion of which the order of the rows is preserved.—Mr. Henry Dixon read a paper on the osmotic pressures in the cells of leaves. The method adopted for estimating the osmotic pressures existing in the cells of leaves, consisted in enclosing a branch bearing a number of leaves in a strong glass cylinder, capable of resisting high gas pressures (*e.g.* 50–100 atmospheres). The ends of this cylinder consist of stout brass castings, drawn together on the cylinder by means of bolts and nuts. The upper end is furnished with suitable couplings for connection with an air compression pump or an iron bottle containing liquid CO_2. The lower end is perforated and admits of the branch, to be experimented with, being sealed into it. The cut end of the branch dips into a vessel containing a weighed amount of water, which is placed below the glass cylinder. When the pressure in the cylinder is raised, it is found, that at a certain pressure, the leaves begin to collapse and lose their turgescence, and that water is forced down from them into the vessel beneath. By a series of experiments on each branch, a certain critical pressure is found which just balances the osmotic pressure of the cells, but which neither causes their collapse nor permits of their drawing up water from below.

PARIS.

Academy of Sciences, June 8.—M. A. Cornu in the chair.—Theory of the flow of water in conduits, by M. J. Boussinesq.—On the effect produced by the ring in iron in dynamo-electric machines. Reply to the note of M. Potier, by M. Marcel-Deprez.—Study of melted vanadium and its carbide, by M. H. Moissan. Vanadium pentoxide, reduced by carbon in the electric furnace, yields an ingot of metal which always contains an appreciable amount of carbon. If the time of heating is as short as possible, a metal containing only 5 per cent. of carbon can be obtained; by prolonging the time of heating the percentage of carbon increased to 18·5 per cent., indicating the formation of the carbide VC. The carbide is not attacked by water at the ordinary temperature. Vanadium forms alloys with iron, copper, and aluminium, but not with silver.—On a new method of preparing alloys, by M. H. Moissan. Alloys of refractory metals can be prepared by projecting a mixture of the oxide with powdered aluminium into a bath of liquid aluminium. The heat set free by the oxidation of the aluminium is sufficient to carry on the reaction. Alloys of aluminium with nickel, molybdenum, tungsten, uranium and titanium have been obtained in this way.—On the nature of the chemical processes involved in muscular action, by M. A. Chauveau. Summing up the results of a series of experimental researches on the relation between the energy given out as muscular work and the energy absorbed as food.—On the value as food of bread made from screened flours, by M. A. Girard. Analyses of flours of various qualities, from which the conclusion is drawn that the ideas generally held concerning the inferior nutritive power of fine white bread as compared with brown bread, are fallacious; both kinds of bread containing practically identical amounts of gluten and of phosphates.—On the theory of gases, a letter from M. Boltzmann to M. Bertrand, continuing the discussion concerning the validity of Maxwell's formula for the distribution of the velocities of the molecules at a given instant.—Reply to the preceding by M. Bertrand, by whom Maxwell's theorem is held to be obviously inaccurate.—The influence of the temperature of the freezing mixture upon cryoscopic measurements, by M. F. M. Raoult. Starting from simple considerations an expression is obtained giving a correction for super-cooling in cryoscopic measurements. This formula is identical with that given by MM. Nernst and Abegg, but the practical application of it given by the latter, is open to criticism. A very simple and accurate method is given by M. Raoult, who shows that the temperature of the bath is without practical effect upon the laws previously published. In the few cases where the correction is necessary, it is easily measured and applied.—On differential equations of the first order, by M. P. Painlevé.—On the regulation of motors, by M. L. Lecornu.—Observations on the errors due to variations of temperature in geodesic instruments, by H. F. A. Aimo. A discussion of the effect of temperature upon the size and shape of the air-bubble in levelling instruments.—On the spectra of metalloids in fused salts, by M. A. de Gramont. Measurements of the lines due to sulphur in metallic sulphides.—Contributions to the study of absorption by porous bodies, by M. Lachaud. An experimental study of the amounts of quinine, methyl-violet, salicylic acid, tannin, dextrine, and gelatine remaining in solution after treatment with animal black.—On the estimation of potassium, by M. Charles Fabre. The platinochloride is reduced in warm aqueous solution by magnesium powder, and the resulting chloride titrated with standard silver solution.—On the heat of vaporisation of formic acid, by Miss D. Marshall. By comparison with benzene as a standard substance, the value for the latent heat of vaporisation of formic acid was found to be 120·4, a number practically identical with that (120·9) calculated from M. Raoult's formula containing the rate of variation of vapour pressure with temperature, the absolute boiling point, and the molecular lowering of the vapour pressure as the experimental data.—Combinations of antipyrin with oxybenzoic acids and their derivatives, by MM. G. Patein and E. Dufau.—On lighting by acetylene, by M. G. Trouvé. A description of the methods used for the practical preparation of acetylene for lighting purposes from calcium carbide.—On the composition of the red pigment of *Amanita muscaria*, by M. A. B. Griffiths.—On the larval metamorphoses of the *Phoronis sabatieri*, by M. Louis Roule.—Description of a new genus of simple Ascidia, Gamaster Dakarenis, by M. A.

Pizon. This genus resembles generally the *Eugyra*, from which however it is clearly differentiated by the structure and position of the genital organs.—On the existence and development of the eggs of the sardine in the waters of Concarneau, by MM. Fabre-Domergue and Biétrix.—The latent life of grain, by M. V. Jodin.—Remarks on the preceding communication, by M. Armand Gautier.—Analysis of one of the meteoric stones that fell at Madrid, February 10, 1896, by M. S. B. Mirat. The meteorite consisted practically of the silicate of magnesium and iron, containing also estimable quantities of aluminium, nickel, and calcium.—Artificial reproduction of malachite by a new method, by M. A. de Schulten.—On the liassic domes of the Zaghouan and of Bou-Kournin, by MM. E. Ficheur and E. Hang.—The part played by the hind limbs in the motion of the horse, by M. Le Hello.—On a relation between muscular energy and sensibility, and on the laws of variation of this energy with respect to time, by M. C. Henry.—Photographs by the X-rays of a bullet in the brain, by MM. E. Brissaud and Londe.

NEW SOUTH WALES.

Linnean Society, April 29.—Mr. Henry Deane, President, in the chair.—Theoretical explanations of the distribution of southern faunas, by Captain F. W. Hutton, F.R.S. After reviewing the various theories which have been offered to explain the difficult and intricate problem of the distribution of southern faunas, the author pointed out that the supposition that the ancestors of certain groups migrated from the northern into the southern hemisphere by the present continents, and have since then become extinct in the north, explained a good deal, but failed to give a full and satisfactory explanation of the whole of the facts. Moreover the members of the fauna unaccounted for are old forms, and consequently the means of communication which served them must long ago have been destroyed. To the author a fatal objection to the theory of migration by way of an Antarctic continent is offered by the following consideration. Aplacental mammals—both Multituberculata and Polyprotodontia—existed in Europe and North America in the Triassic and Jurassic periods, and these Polyprotodontia were, no doubt, the ancestors of the living Polyprotodontia of Australia. In the Eocene strata of Patagonia remains of a large number of Polyprotodontia have been found which are far more closely related to the Polyprotodontia of Australia than to the Mesozoic forms of Europe and North America; consequently a direct land communication must have existed between these two southern countries. Now there is strong geological and palæontological evidence that no land ridge existed between North and South America during the Mesozoic and early Cainozoic eras; consequently it must be assumed that the southern forms migrated through the Malay Archipelago; and, if they went to Patagonia by means of an Antarctic continent, they must have passed through Australia. But mingled with the Eocene marsupials of Patagonia there are a number of Eutheria of typically South American character without any northern forms of *Artiodactyla*, *Carnivora*, or *Insectivora*; and it is hardly possible that these should have passed through Australia without leaving any record behind. The theory of the former existence of a South Pacific Mesozoic continent, first suggested by Huxley, seemed to be the only theory left. It not only explains the origin of the Australian and South American marsupials, but also the almost simultaneous appearance of different Eutherian mammals in North and South America. It must be supposed that this continent threw off first New Zealand, then Australia, then Chili, and finally disappeared under the waves. At a later date, New Zealand must have formed part of a large island joined to New Caledonia, but not to Australia. The objections to this theory are geological rather than biological, involving the doctrine of the persistence of continental and oceanic areas upon which geologists are not agreed; and such objections are equally applicable to the theory of an Antarctic continent.—Report on a Bone Breccia deposit near the Wombeyan Caves, New South Wales: with descriptions of some new species of marsupials, by Dr. R. Broom. A detailed examination of this deposit from which *Burramys parvus* and *Palæopetaurus elegans* have already been described by the writer, adds considerably to our knowledge of the smaller marsupial fauna of the later Tertiary period. Of existing forms there have been found *Petaurus breviceps*, *Dromicia nana*, *Phascologale flavipes*, *P. penicillata*, and some detached teeth referred to *Thylacinus cynocephalus*. Besides these are found a presumably new species of *Macropus* for which the name of *M. wombeyensis* is proposed, a new species of *Pseudochirus* (*P. antiquus*), a new species of *Perameles* (*P. wombeyensis*), and an extinct variety of the existing *Potorous tridactylus*. A few bones of a large *Echidna* are referred to *E. oweni*. There are also innumerable remains of bush rats (*Mus* sp.), together with a few bones of small birds and lizards.—The entomology of Australian grass trees (*Xanthorrhœa*), by W. W. Froggatt. The life-histories or habits of a number of insects which either breed in the stems of the grass tree or feed upon its foliage were described.—On the *Galaxias* from Mount Kosciusko, by J. D. Ogilby. After reviewing its history and describing the species (*G. findlayi*, Mcl.) from a fine series, obtained from streams on both watersheds of the Australian Alps, the author gave an account of the curious distribution of this fresh-water family of fishes, with special reference to its Antarctic origin, and concluded with a list of the known forms, holding that far too many species had been made by naturalists who relied too much on contour and coloration, both of which characters are most inconstant.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—An Elementary Treatise on the Integral Calculus: Dr. B. Williamson, 7th edition (Longmans).—Im Australischen Busch und an den Küsten des Korallenmeeres: Prof. R. Semon (Leipzig, Engelmann).—A Manual of Mending and Repairing: C. G. Leland (Chatto).—Macmillan's Geography Readers, Book VI. (Macmillan).—Arithmetic for Promotion, Scheme B.: Lock and Macdonald, 4 Parts (Macmillan).

PAMPHLETS.—A New Treatment of the so-called Incurably Deaf People: Dr. J. J. Hovent (Bruxelles, Lebègue).—Representation in Virginia (Baltimore).—St. Paul's School and the Charity Commissioners: Colonel Clementi (Bell).

SERIALS.—Science Progress, June (Scientific Press).—Geographical Journal, June (Stanford).—Botanische Jahrbücher, &c., Zweiundzwanzigster Band, 2 Heft (Leipzig, Engelmann).—Proceedings of the American Philosophical Society, December (Philadelphia).—Physical Review, Vol. 3, No. 6 (Macmillan).—Proceedings of the Royal Society of Victoria, Vol. 8, new series (Williams).—American Journal of Science, June (New Haven).—Engineering Magazine, June (Tucker).—Bulletin of the American Mathematical Society, May (New York, Macmillan).—Westminster Review, June (Warne).—Leisure Hour, June (56 Paternoster Row).—Proceedings of the Physical Society of London, Vol. xiv. Part 6 (Taylor).—Rapport Annuel sur l'Etat de l'Observatoire de Paris, 1895: M. F. Tisserand (Paris).—American Naturalist, June (Philadelphia).—Journal of the Franklin Institute, June (Philadelphia).

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