THURSDAY, OCTOBER 11, 1900.

A NEW GEOGRAPHY OF PLANTS.

Pflanzen- und Tierverbreitung. Von Alfred Kirchhoff. Hann, Hochstetter, Pokorny, Allgemeine Erdkunde. Fünfte Auflage, von J. Hann, Ed. Brückner und A. Kirchhoff. iii. Abteil. Mit 157 Abbild. im Texte, u. 3 Karten in Farbendruck. Pp. 327. (Prag u. Wien: F. Tempsky. Leipzig: G. Freytag, 1899.)

TO see a portion of my special domain surveyed by an authority in another branch of science appeals to me in a particularly interesting and instructive light, especially if it comes from a man of judgment and broad views. Such a survey may expose any bias, and is likely to open up new vistas. Dr. Kirchhoff, professor in the University of Halle, is a geographer of repute, and naturally approaches the facts of distribution of plants and animals from a point of view different to that of a botanist or zoologist. It is true his book is intended as an introduction to phytogeography and zoogeography for the student of physical geography, and not as a critical essay on these branches; yet its merits seem to demand that we should rank it higher and judge it accordingly. It is not a mere abstract of one of the few well-known treatises on the distribution of plants and animals, made to serve as a text-book for the beginner, but the product of a mind evincing a considerable power of assimilation of matter, necessarily foreign to it in many of its details, and with an admirable grasp of that which is essential. With these accomplishments are combined the gift of a lucid exposition and of a language which is, apart from certain idiosyncrasies of expression, clear and pleasant.

The author reminds the reader in the preface that in the earlier editions of Hann, Hochstetter and Pokorny's "Allgemeine Erdkunde," the corresponding part was written by Dr. A. Pokorny; that the progress of phyto- and zoo-geography has rendered it necessary to recast the whole; and that it is written more especially for the students of geography, and excursions into the domain of the naturalist had therefore to be avoided. Yet geography on the one side, and botany and zoology on the other, overlap to such an extent within the compass of phyto- and zoo-geography, that the author was naturally obliged to fall back over and over again on the botanist or zoologist, who supplied him, if I may say so, with the woof to his warp. It is here where, as one might expect, the weak points of the book become evident; and it is a pity that the author did not avail himself of the aid of a competent botanist for final revision. I suppose the same applies to the zoological details. Reckless statements, as, for instance, that a single individual of *Sisymbrium sophia* produces 720,000 seeds, or that most of the 854 species of the Egyptian flora are introduced, or that Southern Italy (exclusive of Sicily) possesses 3132 species against 9000 for the whole of British India, &c., can hardly be excused by the desire of putting the case as emphatically as possible. Instances of a decided looseness of expression in describing certain facts would have been discovered at once by a botanical critic, *e.g.* when the author says, on p. 18, that the plants derive their "principal food" from the soil, while he applies the same term, on p. 24, to the carbon dioxide of the atmosphere; when he quotes the orchids and aroids of the equatorial zone as examples of parasites (p. 19), although he describes them quite correctly as epiphytes in another place; and again, when he attributes "genuine grass leaves" to the Australian *Xanthorrhoea* (p. 112). Slips, also, like that on p. 162, where the "Rose of Jericho" is figured as *Asteriscus pygmaeus*, a member of the order of Compositæ, but described in the text as a "little Cruciferous plant (*Anastatica hierochuntica*)," or on p. 198, where the author speaks of the "Kompositengeschlecht der . . . Cæsalpinien," call for the helping hand of the botanist. Willows are not wind-fertilised (p. 51); *Rhododendron ponticum* is by no means killed by $-2°$ C. (p. 86); the peach has not originated in Southern Asia (p. 135); there is no transformation of our ordinary grape-vine into an evergreen plant in the tropics; these are statements which should be repeated no longer in text-books. It would be easy to quote a good many more mistakes of this order, but I do not wish to dwell on them more than is necessary to show where, in a future edition, careful revision must be undertaken.

The book is divided into three parts. The first part occupies 139 pages, and deals with general telluric conditions in relation to the organised world, the second (88 pages) with the phytogeographical divisions (Florareiche), the third (100 pages) with the zoogeographical divisions (Faunareiche). The first part is subdivided into five sections, dealing with (1) the reproductive and migratory capacities of the organisms, (2) the natural conditions of vegetable and animal life, (3) the variability of organisms, (4) the Theory of Descent and its geographical proofs, and (5) the general principles of the distribution of plants and animals. To condense this abundance of matter into 139 pages is a very difficult task, and that it has been done on the whole so satisfactorily says much for the judgment of the author.

In the following two parts, Prof. Kirchhoff has set himself the task of characterising the principal geographical divisions of the organic world, relying, of course, on the researches of the recognised authorities in phyto- and zoo-geography, but viewing them from the more comprehensive standpoint of the geographer, as it appeared to him "desirable for a more vivid comprehension of the nature of the countries of the globe." The separation of the vegetable and the animal kingdom into floras and faunas, their distribution in the present, their harmony with the physical character of their respective areas, and their mutual adaptation within each area, are the result of a process of evolution in which the shaping, selecting, separating and shifting forces have been, for both kingdoms, the same to such an extent that a far-reaching parallelism in their geographical differentiation is to be expected *a priori*. This has been, perhaps, too often lost sight of by specialists.

On the other hand, the modern geographer, from the very fact that he starts with conditions bringing about that parallelism, would be naturally led to a more uniform conception of the differentiation of the organic world into floras and faunas. The result of this has been, in Prof. Kirchhoff's case, the almost complete congruence of the

two maps representing the "Florareiche" and the "Faunareiche" respectively. Much might be said with respect to the divisions adopted by the author, but space forbids.

The book is abundantly illustrated, and most of the illustrations are well selected and quite to the point; but exception might perhaps be taken to some of the pictures in which the author attempts to represent as many types as possible in one plate, with the usual consequence that the *ensemble* looks unnatural and untrue. The map showing the distribution of the European species of *Asplenium* (p. 89) is not very illustrative and scarcely in place; whilst Kerner's maps dealing with *Tubocytisus* (pp. 90, 91) require thorough revision, although they are excellent so far as method is concerned.

OTTO STAPF.

FOUNDATIONS OF AGRICULTURE.

Agricultural Botany—Theoretical and Practical. By John Percival, M.A.(Cantab.), F.L.S. Pp. xii + 798. (London: Duckworth and Co., 1900.)

THE professor of botany at the South-Eastern Agricultural College at Wye has done well to depart from the utterly inefficient standard of text-books in this subject hitherto set and followed in this country; and, although we do not think the best possible has yet been produced, the present work is so distinctly an improvement, and so clearly sounds the right note, that we have no hesitation in recommending it as *the* elementary handbook for the agricultural student. What it lacks most conspicuously is a clear enunciation of the principle underlying the teaching of botany to students of agriculture, and it will be just as necessary for the teacher using this book, as it is for him who uses others, to emphasise the point of view (lost sight of in nearly all our text-books) that the plant is a focussing centre in which are concentrated the materials gathered by roots and leaves and the solar energy fixed by the chlorophyll-action, so that plant substance—be it in a cabbage, a potato, a crop of wheat or an oak forest—represents a real gain of energy from the surrounding universe, stored up with an equally real recovery of material which would otherwise have been lost to us because dissipated into the atmosphere in an unavailable form. It is this which makes farming, planting, forestry and other branches of agriculture so fundamentally different from the mining industries, where the coal, iron, &c., brought from their storehouse in mother earth are merely temporary sources of wealth representing expenditure of capital.

As regards features of technical detail, there are several interesting departures from the repetitions of previous text-books, and our chief regret is that these are not more original in conception and treatment. For instance, the section on recognition of trees and shrubs by means of twigs in winter is a very welcome one, but it might have been made far better. Again, the part dealing with our common grasses could have been improved by bolder departures from, and less reliance on, Continental and other authorities in common use, though it should be pointed out that the author has, at any rate, provided new drawings of the "seeds" of most of the grasses. This, however, not always with advantage—*e.g.* the very bad figure (210) of Yorkshire fog. Nor do we regard the summary of characters leading to the recognition of grasses by their leaves as either adequate or worthy of the scope of the book; it might have been made much better with a little attention to points not included in ordinary pamphlets on the subject.

These are faults to be remedied in later editions, and must not be allowed to outweigh the really excellent portions of the book dealing with the various large groups of cultivated farm-plants—*e.g.* Chapter xxv., dealing with the hop, is well done, as are Chapters xxxiv.–xxxviii., dealing with those very difficult subjects, the varieties of our cereals. Indeed, we may commend the whole of this part of the work which treats of the classification and special botany of farm crops, with few reservations, such as those hinted at above, as an admirable summary of what the student should direct his attention to in this department of his studies. The general botany is also fairly well done; and although we do not consider the section on "Internal Morphology" quite happy either as regards selection of subjects or treatment of details, we have little but praise for the part dealing with physiology, which is so markedly in advance of the stuff we are too apt to meet with in existing agricultural text-books in this country, that we prefer to dwell only on its merits. The chapters on weeds and on diseases of farm-plants are also distinctly better than those in any previous English works dealing with agricultural botany, and we heartily congratulate the author on his exhibition of capacity in the *rôle* of a teacher of elementary students of agriculture. At the same time, we would point out that much may be done in future editions to improve this subject, and still more in improving and extending the account of the doings of bacteria in the soil. The agricultural student ought to be made to realise that the soil is a matrix, in which the rocks and salts, water and other lifeless constituents, play little more than the subordinate parts of a skeleton or scaffolding, on and between which the real work of conversions, transferences, destructions and constructions of materials necessary for the life of higher plants are being carried out by lower organisms of many different kinds. A vivid picture of the struggles of root-hairs for salts and oxygen, of the relations between anaërobic and aërobic organisms, of the dangers of attack from parasites here, and of the missing of advantageous connections with symbiotic helpmeets there, and of the mutual interactions of the living and non-living factors in keeping up the "fertility," moisture, heat, &c., of the complex soil, would be a fitting subject for a chapter designed to knit together the enormous number of facts here thrown down before the unwary student, and among which he is sure to stumble and flounder.

The ideal here sketched is not an easy one to attain, and we are aware that facts are coming in every day, and that our knowledge of the factors concerned is still in its infancy. Nevertheless, it is no empty compliment to the author to point out that there are indications in the present book that he would be quite capable of putting the crown to his really excellent attempt at an elementary text-book for agricultural students,

by adding a chapter which should drive home to this somewhat apathetic class of learners that botany is no longer to be looked upon by them as a luxury or hobby, or as an interesting adjunct to the study of agriculture, but it must be regarded as *the* fundamental science on which all agricultural operations must be based; and such a chapter should make it perfectly clear that the neglect of the principles and facts it embraces is going to spell ruin in the future, just as the intelligent appreciation of its teachings is going to render the properly trained and equipped planter, forester or farmer, master of the situation his forefathers misunderstood.

OUR BOOK SHELF.

Surveying and Exploring in Siam. By James McCarthy, F.R.G.S., Director-General of the Siamese Government Surveys. Pp. xii + 215. (London: John Murray, 1900.)

ABOUT the year 1880 the Siamese Government became convinced of the necessity of accurate surveys for frontier delimitation, and then it was that Mr. McCarthy commenced the long series of explorations which are recorded in the present work, and which have won for him the gold medal of the Royal Geographical Society. To the student of Indo-China, Mr. McCarthy's book is full of extremely valuable information regarding the aboriginal and mountain races of the highlands of the interior, with whom the nature of the author's work brought him into constant contact. Mr. McCarthy has a sympathetic eye for his fellow travellers, and a kindly word for all but the most obstructive of the native officials. From obstruction by this class, the officers of the Siamese Survey have indeed suffered probably more than any other European officials of the Government; inasmuch as the Survey was practically the pioneer department of the modern régime, and it had to contend against the whole of the forces of conservatism, superstition and suspicion which were at the outset arrayed against all innovation of the kind. Against these, for many years, Mr. McCarthy battled almost single-handed, carrying out meantime slowly and laboriously the triangulation of the frontier districts, and himself training his own assistants. The physical difficulties of the country, which can only be thoroughly appreciated by those who have experienced them, and the inevitable sickness which attacks all who spend the wet season in the jungle, further delayed and hampered the work. The author makes light of the difficulties which had to be overcome, but those who read between the lines will see how formidable they were.

As may be supposed, the book is in no way popular or sensational, and the author's dry, matter-of-fact style does not lend itself to picturesque narrative. Yet politics on the north-eastern frontier of Siam during the incursions of the Haw bandits, in the 'eighties, were exciting enough. If one desired to be critical, one might say that the book is composed of short sentences and scrappy and incomplete descriptions. Yet these faults will be condoned by all who take an interest in scientific geography for the sake of the admirable scientific results of Mr. McCarthy's work. And those who seek to know more of the magnificent plateau of Teng, the highest peaks of Indo-China, or the very interesting hill tribes, such as the Ka, Lamet, Meo and Yao, and the Southern Shân races generally, will find more accurate information in the present work than in any other we are acquainted with.

An excellent index, triangulation charts, and a map of Siam in two sheets, with a number of illustrations, complete a work which forms an important addition to the bibliography of Eastern Asia.

Church Stretton. Vol. i. *Geology*, by E. S. Cobbold; *Macro-Lepidoptera*, by F. B. Newnham; *Molluscs*, by Robert A. Buddicom. Edited by C. W. Campbell-Hyslop. Pp. 196. (Shrewsbury: L. Wilding.)

THIS is an excellent piece of work, and reflects much credit upon those who originated the idea of preparing an account of the scientific features of the Church Stretton district, and also upon the contributors, editor and publisher of the present volume. Church Stretton is a market-town about twelve miles south by west of Shrewsbury, Shropshire, and has a population of about 2000. The district is interesting from a geological point of view, and Mr. Cobbold's notes (which occupy the greater part of the book) will be valuable to geologists visiting it for the first time, and will also give residents a new interest in their rambles. Most of the fossiliferous localities and the main rock exposures are mentioned or described, so that any one interested in the geological and topographical characteristics can readily find them.

Mr. Newnham gives a descriptive catalogue of the macro-lepidoptera found in the neighbourhood of Church Stretton. The district is a fair field and good hunting-ground for the entomologist, many insects being found in it which do not occur in the lower-lying parts of Shropshire. Future collectors will find the catalogue exceptionally valuable, and will doubtless be able to supplement it.

A list of the land and fresh-water molluscs, with notes on the habits of each species and its comparative local scarcity and abundance, is given by Mr. R. A. Buddicom. The total number of species of British land and fresh-water molluscs is reckoned at 138 (not counting slugs) of which 42 have been found in or near Stretton. A plate containing illustrations of 37 species, natural size, photographed from actual specimens, accompanies Mr. Buddicom's paper.

Other monographs, on the botany, archæology, climatology and ornithology of the district, are in preparation, and if they are of the character of this one they will afford pleasure to every resident or visitor in Church Stretton who has an interest in the study of outdoor nature. The district is fortunate in possessing such a useful guide to its natural characteristics.

Surveying with the Tacheometer. By N. Kennedy. Pp. vi + 104. (London: Crosby Lockwood and Son, 1900.)

THIS handy little volume is put forward in the hope of bringing the tacheometer into more general use among land surveyors, its present position in the background being due chiefly, the author thinks, to the fact of the Continental instruments having hitherto been provided with circles divided with 100° to a right angle, instead of 90°, thus necessitating special reduction tables. The publication of a universal method of reduction, no matter what the division value, by Mr. G. Gilman removes the greater part of these objections.

The tacheometer is first minutely described, excellent illustrations being provided for reference, the only essential difference from a good transit theodolite being the insertion of a subsidiary lens between the objective and eye-piece, which, by special adjustment, enables the angular distance between two wires in the eye-piece to be made equal to any desired quantity, decided by calibration on a previously measured base. Subsequent sections deal with the variations introduced by working on inclined ground, details of actual field and office work, concluding with some suggestions on possible methods of utilising existing transit theodolites for tacheometric work. Examples of entries in field-book, plans of surveys, &c., are given at the end of the book. The work is very clearly written, and should remove all difficulties in the way of any surveyor desirous of making use of this useful and rapid instrument.

LETTERS TO THE EDITOR.

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

Ascent of Sap.

PROF. VINES, in his interesting address to the Botanical Section of the British Association, has referred to the problem of the ascent of sap.

We believe Prof. Vines is under a mistake when he states: "Now as to the force by which the transpiration-current is raised from the roots to the topmost leaf of a lofty tree. From the point of view that the water travels in the substance of the walls the necessary force need not be great, and would be amply provided by the transpiration of the leaves, inasmuch as the weight of the water raised would be supported by the force of imbibition of the walls. From the point of view that the water travels in the lumina, the force required to raise and support such long columns of water must be considerable." If we gather the sense aright, this statement involves perpetual motion, as may be seen by imagining both cell-walls and lumina filled with water. According to Prof. Vines, water may be obtained from the cell-walls in the higher parts of the plant with the exertion of a less force than from the lumina. If now we establish a connection, the lumina will draw from the cell-walls, and with a second connection below, an endless circulation will arise. The error arises from supposing that water can be withdrawn from the cell-walls and maintained in upward motion without opposition from the entire gravitational pull. Or, stating the matter in another way, the force which is assumed to uphold the water will also act to resist its withdrawal from the walls. Indeed the withdrawal of water from the cell-walls must be necessarily attended by much higher frictional resistance than would obtain if the supply were received from the lumina. The same objection may, in our opinion, be urged against any exposition of the "imbibition" theory. The underlying fallacy is, in fact, essentially the same as that on which the theory of capillarity and gas-pressure is founded, and which Prof. Vines rejects as "quite inadequate."

Prof. Vines, in further discussing the question, speaks of a tensile force of 360 lbs. to the square inch as being required to bring the sap to the summit of a tree 120 feet high, and states that, not only is there no evidence for the existence of such a force, but that it is even negatived by the indications of the experiments of Hales and Boehm. Without discussing the validity of the supposition that such a force is anywhere required (beyond stating, as our opinion, that the grounds upon which this estimate has been obtained are very doubtful), we would certainly like to know to which of the experiments of Hales and Boehm Prof. Vines refers. So far as we are aware, the indications of Hales' and Boehm's experiments were of necessity limited by the difficulty of putting the water (external to the branches experimented upon) into a condition capable of bearing tension. These investigators, however, did not clearly understand this point. The experiments made by us in the same direction certainly all failed from this cause. The most, then, that can be admitted is that direct observation has never revealed the full state of tension of the sap of a transpiring tree, although, as in the case of some of Boehm's experiments, indications of the existence of tension were conclusively obtained. This is a very different thing from assuming that negative indications have been experimentally obtained. It is hard to see why Prof. Vines should consider the existence of a transpiration force of 20 atmospheres as improbable. It has, indeed, been shown by experiment that the turgescence of the cells of the leaves of many trees is capable of exerting a tractional force of over 20 atmospheres on the water in the conduits.

Prof. Vines dismisses the tension theory as offering no solution to the problem. But how does the matter stand? The more important points may be stated in a very few words.

In the theory of the tensile sap we find full reason for the subdivided structure of the water-conduits and for the structure of their lignified cell-walls (especially as seen in the ingenious mechanism of the bordered pit); stability is conferred on a liquid in tension and liable to the evolution of gas-bubbles by the first, and a minimum of resistance with safety against rupture is secured to the wall by the second. To raise the water through this system the turgescence of the leaf-cells is fully adequate, even were the tension greater than what Prof. Vines demands. Again, in the light of this theory, the advantage of the periodic recurrence of root pressure becomes apparent, as a safeguard against the multiplication of functionless lumina destroying the continuity of the system. On the other hand, those who have discussed this theory have as yet brought to light no fact in vegetable physiology or anatomy opposed to its validity; while many points, *e.g.* the collapse of protoxylem elements, and the occurrence of year-rings, have received in it an explanation.

From the physical point of view, the theory is not only adequate to meet all the requirements of the plant, but the existence of tension in a system of minute chambers having walls at once permeable to water and impermeable to free gas, whether altogether or partially filled with dust-free water, is inevitable. The *onus* of proof does not here lie with the upholders of the tension theory merely because it has come late upon the scene, but its opponents must show how the tensile state is evaded before they can dismiss the existence of the tensile stress in the sap at such times as root-pressure is not the uplifting force.

If, then, the sap is in tension from the nature of the conditions and the leaves active in withdrawing water from above, why deny the adequacy of the explanation?

With regard to the date of publication of our theory, Prof. Vines is slightly in error. Our paper was communicated to the Royal Society in Nov. 1894, and an abstract of it appeared in NATURE in the same month.

HENRY H. DIXON.
Trinity College, Dublin. J. JOLY.

Homochronous Heredity and the Acquisition of Language.

THE question raised by Mr. Stuart-Menteath in NATURE of September 27 (page 524) is one of such general interest to all students of heredity that it is to be hoped that some authoritative expression of opinion will be forthcoming. Even in its present form the query involves the subject of the heredity of acquired characters, and it would be of the greatest importance to have experimental systematic observations carried out if such observations have not already been recorded. So far as my very limited acquaintance with the subject extends, I know of no such experiments. It would be desirable perhaps to widen the scope of the question, and to put it in this form: Take children of different nationalities, say German, French and English; allow them from infancy to hear all three languages indiscriminately. Is there any reason for believing that each child would show a predilection or greater facility for acquiring the language of its country?

R. MELDOLA.
October 8.

Autotomic Curves.

BRITISH mathematicians have usually employed the phrase "non-singular curve" to designate a curve which has no double points. This phrase is an exceedingly infelicitous and misleading one, since a *point of inflexion* is just as much a singularity as a *double point*.

The word *autotomic* (self-cutting) has occurred to me as a suitable one to designate a curve which has double points; but the objection to this word is that the phrase "an anautotomic curve" is somewhat offensive to the ear. In the case of media which are not isotropic, mathematicians have evaded a similar difficulty, which would be caused by the use of the word *anisotropic*, by employing the term *aeolotropic*.

Perhaps some of your readers, who have kept up their classics, may be able to suggest a suitable word to convey the idea of a "not-self-intersecting-curve."

A. B. BASSET.
Fledborough Hall, Holyport, October 5.

THE OPENING OF THE MEDICAL SCHOOLS.

THE subject-matter of the studies comprising the medical curriculum lends itself exceptionally well to the delivering of inaugural addresses. Every October produces its crop of young men and women beginning the study of medicine, and to these are addressed with never-failing regularity an almost constant number of introductory lectures. To those who watch from a distance the perhaps somewhat monotonous rhythm of

medical academics, it would appear at least probable that these opening addresses, actuated, as they certainly are, by a perpetually similar motive, would be in imminent danger of suffering from a monotony almost approaching boredom. Medicine, however, and its allied sciences are never at rest, and the constant change in them from year to year forms an almost inexhaustible subject-matter at once interesting to the initiated, and stimulating to the novice. The latter learns, as a rule even in his first lecture, that in embracing medicine as his profession he has not to tread a rigid scholastic entity, but to pick a somewhat circuitous way over a plastic science, which is capable and willing to receive the intellectual footprints of all who are strong enough to impress them.

The third Huxley lecture was delivered this year by Lord Lister, and the authorities of Charing Cross Hospital are to congratulated upon having heard one of the most interesting discourses which it will probably ever be their lot to listen to. Although none of us can for any length of time forget the scientific work for which Lord Lister is celebrated, perhaps few of us are cognisant of his early researches, which, indeed, although perhaps to the superficial observer remote from his later work, according to him—and what better authority can we want—led up to it. All those who have the opportunity of reading this address *in extenso* should do so; it forms another of the many instances of how work of a more or less erudite character led up to results most emphatically utilitarian. This should be remembered and taken to heart by those in authority who are apt to look askance at work, whatever it may cost in the way of perseverance or intellectual effort, which is not immediately productive of utilitarian result.

At the relatively new School of Tropical Medicine, Sir W. MacGregor delivered an inaugural address, taking for his subject some problems of tropical medicine. An interesting point in his discourse was the importance he attached to the study of dysentery. According to him, epidemic dysentery is a scourge of tremendous magnitude, carrying off in some cases 50 to 75 per cent. of the labourers upon certain plantations in Polynesia. His concluding remarks were directed to malaria, and he emphasised in this connection the importance of investigating certain equine maladies on the West Coast of Africa, apparently of a malarial type.

At University College an inaugural lecture was delivered by Dr. Vivian Poore upon science and practice. The lecturer addressed himself mainly to those students who were actually beginning the study of medicine as distinct from the so-called elementary medical sciences. He warned his hearers against adopting the view that all that could not be submitted to laboratory methods was *ipso facto* not scientific, and in this connection drew attention to certain discoveries made by physicians by mere observation, which were from the highest standpoint scientific. Many facts, although explained by bacteriological research, had been discovered by physicians by methods which were purely clinical. Dr. Poore finally pointed out the advantages that should accrue to the students at University College Hospital from the reconstruction it was undergoing, and also how the reconstitution of the University of London might be expected to affect the medical lectureships in the metropolis.

King's College Hospital began the medical session by an old students' dinner, at which Sir John Cockburn presided. The speeches which ensued, although limited, were mainly directed to two subjects, the share which has been taken by the staff in the surgical work in South Africa, and the manner in which the school had been improved during the past year by the establishment of largely increased laboratory accommodation and new lectureships, special reference being made to the subject of pharmacology.

At the inaugural dinner at Guy's considerable interest was attached to Mr. Fripp's speech, which dealt with the work done by the Imperial Yeomanry Hospital in South Africa. This hospital had broken a deal of new ground, and many in a position to judge of the organisation and management of hospitals had expressed the hope that from the demonstration which it had been enabled to give of the way that modern scientific methods could be introduced into the service of the sick and wounded in the time of war, reorganisation of military hospitals upon the lines of the large civil institutions might be effected.

The medical session at St. Thomas's was opened by Sir William MacCormac. In the course of his remarks Sir William pointed out that the present time was a favourable one for entering the medical profession, as London was about to have a great university in reality, and not one in name only, and also that the supply of medical men was not keeping pace with the increase in the population, as shown by the list of medical students entered on the rolls of the General Medical Council.

At St. Mary's Hospital the introductory lecture was delivered by Mr. Stansfield Collier upon the future of the medical student. At the London School of Medicine for Women Mr. Aldrich Blake addressed the students. The subject-matter of both these lectures consisted mainly of advice to the student with regard to the mental habits he should cultivate in approaching his work. An interesting lecture was delivered at the Royal Veterinary College by Prof. MacFadyean. According to the lecturer, the century approaching its conclusion embraces practically the whole history of the veterinary profession in Great Britain. One hundred years ago the Royal Veterinary College was only in the tenth year of its existence, and since then great changes had come over veterinary opinions and practice. With regard to the progress that had been made concerning the causes of disease, glanders and tuberculosis were taken as types. As recently as twenty years ago the opinion that tuberculosis was an extremely hereditary disease was universal among veterinary surgeons, and it was only within the last decade that the erroneousness of this view had been generally recognised. Discoveries which threw light on the cause and nature of maladies necessarily influenced methods of treatment and prevention, and the past century had witnessed great changes in the means adopted to counteract disease. As an instance of this, the almost complete extent to which bleeding has become obsolete may be given. Firing and blistering, although still extensively used, were employed now with more discrimination than formerly, and it seemed upon insufficient evidence.

The inaugural address in the medical faculty of the University of Birmingham was delivered by Prof. Windle, who chose for his theme the very appropriate one of the needs, aspirations and ideals of the Birmingham Medical School. Those who have carefully followed the stages in the development of the great Midland University will not have failed to observe that the main spirit which actuated it when it was, so to speak, on paper, and will continue to guide and distinguish it when architects' plans have been replaced by well-equipped laboratories, is the spirit of scientific research. It will be a great centre for teaching students how to prosecute research in all branches of technical industry. The generous manner in which land has been given by Lord Calthorpe and funds have been supplied by the wealthy citizens of Birmingham has secured opportunities for this purpose, which, when the whole is complete, will probably be unrivalled. Such opportunities are certain to attract students, and especially medical students. It is to be hoped that what is being done at Birmingham will stimulate the formation and endowment of laboratories at the London schools, which, if they wish to attract the mass of students they have done in the past,

will be compelled to offer them advantages at any rate not inferior to those that they can find much nearer home.

The students of the Middlesex Hospital were addressed by Prof. Clifford Allbutt upon abstractions and facts in medicine. His concluding remarks with regard to the value of research laboratories are significant, the lecturer confessing that mere observation of disease and morbid anatomy have taken us almost as far as these means can do. Morbid processes should be tracked in their earliest dynamic initiation in order that they can be arrested in these stages. The clinical laboratory of a county hospital should be the centre of enlightenment to all the private practitioners of the district.

The space at our command has only permitted us to reproduce a relatively small fraction of the many interesting and instructive addresses that were delivered during the course of last week. It is sincerely to be hoped that teachers and students alike have profited by them, and that their united efforts will result in the addition to the profession of a body of workers who will be in the truest sense medical imperialists, and who, while working to the fullest advantage the store of learning they have inherited, will not rest content with it, but extend in all directions the empire of medical knowledge, even up to the threshold of the temple of truth.

F. W. TUNNICLIFFE.

A NIGHT WITH THE GREAT PARIS TELESCOPE.

SINCE the final decision was made some years ago to commemorate the Paris Exhibition of 1900 by the installation of a giant telescope which should surpass in size and power any other then in existence, so many varied and contradictory statements have been quoted in the Press, and even in many scientific journals, that a considerable amount of scepticism has been inherent in the minds of most persons interested in the matter. Much of the inaccuracy is traceable to a rather loose estimate being given of the magnification which it was hoped to employ, it being stated that the moon would be apparently brought so close that any object of 1 square metre area could be distinguished. By the extreme kindness and courtesy of M. François Deloncle, to whose initiative the entire instrument is due, the writer was enabled, not only to thoroughly examine all parts of it during the day, but also to take part in the practical astronomical use to which it is already being put during every clear night. A general view of the siderostat is shown in Fig. 1, and the inclusion of the attendant's figure in the upper balcony will give some idea of its relative size. The masonry foundation is about 5 feet 6 inches high, the extreme height of the curved casting carrying the mechanism at the back being about 34 feet. The circular glass mirror seen between the upright fork in front is 6·5 feet (2 metres) in diameter, and about 11·8 inches (30 centimetres) thick, being silvered on the upper exposed side. When not in use a large glass plate is lowered over the silvered surface by a windlass worked from the gallery. As the glass mirror weighs some 3600 kilogrammes, and the iron cell and forked support about 3100 kilogrammes, the friction on the pivot allowing rotation would have been too great for accurate driving if some provision had not been made for eliminating it. This has been successfully done by immersing the base of the fork casting in a bath of mercury, contained in the circular part of the front half of the main base plate, thereby relieving the pivots of about 9/10ths of the total weight. The rotation of the mirror in a vertical plane is also facilitated by the counterpoise weights shown at the ends of the levers acting on each extremity of the horizontal axis passing through the centre of the mirror.

At the western side of the siderostat, above the handles moving the instrument in right ascension and declination, are two telescopes, which by a system of lenses and mirrors enable the observer to read the divisions on two graduated circles without leaving his position. By his side there is also a standard sidereal clock and a telephone.

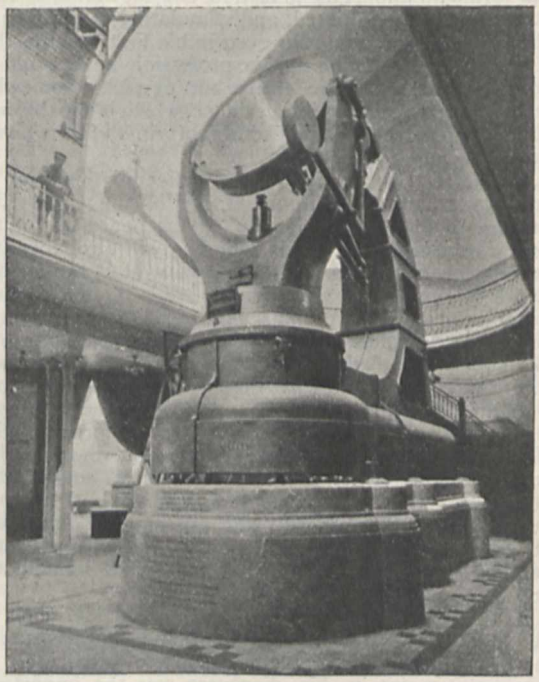

FIG. 1.—The great siderostat, Paris, 1900.

Leaving now the siderostat, and mounting the staircase seen behind it, access is gained to the upper balcony which runs round both sides of the whole length of the building. Fig. 2 is a view taken from the eye-end of the telescope, 200 feet away to the south, and the siderostat

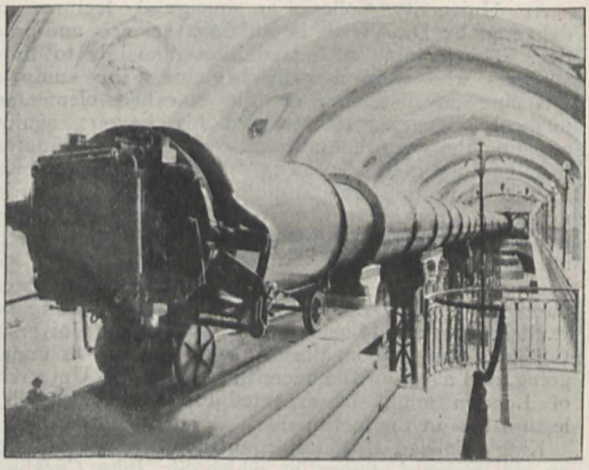

FIG. 2.—Eye-end of the refractor, Paris, 1900.

can just be seen under the arch at the north end. Above, on the gallery, the circular object-glass is clearly shown in its case. Two of these lenses are to be provided, one specially corrected for visual work, the other for photographic purposes. The lens completed and in position is the latter. The carriages for holding these lenses in

their massive cells are enclosed in the large rectangular glass case shown in the figure, and being mounted on rails, it is a matter of but a few moments to interchange the position of the lenses with respect to the long tube seen extending from end to end of the gallery. This enormous (and, from an astronomical point of view, probably superfluous) tube is composed of twenty-four sections of sheet steel, each about 8 feet 3 inches (2·50 metres) long, and 59 inches (1·50 metres) in diameter, which are supported on six braced columns rising from the floor below.

At the near end of the tube is shown the massive tail-piece, with the various arrangements for focussing, clamping and rotation of the photographic plate. The focussing is done by traversing the whole of the tail-piece on the two short rails, a motion of about 5 feet (1·50 metres) being allowed, as it is unlikely that the focal lengths of the two lenses will turn out identical.

The lens in position, corrected for the photographic rays, is 49·2 inches (1·25 metres) aperture, and 187 feet (57 metres) focal length. The diameter of the image of the sun or moon at the principal focus will therefore be about 21 inches in diameter.

Rotation of the photographic plate, about 30 inches square, during exposure is necessary on account of the fact that when a siderostat is used, only the central point of the field of view remains stationary, all the surrounding parts having a motion round this as centre. To eliminate this M. Gautier has provided a subsidiary clock, placed to the rear of the eye-end, which, by means of connecting gear to the milled wheel seen on the circumference of the end of the tube, turns the whole tail-piece of the telescope at any desired rate. For visual observations the plate-holder is removed, and an adapter carrying an eye-piece is inserted. The whole of this eye-end section is now covered in by a temporary dark-room.

To admit the light from celestial objects to the mirror of the siderostat, the roof and walls of the building for some 70 or 80 feet are made in two sections, one of which slides to the north, the other to the south, allowing of a clear view from the zenith southwards to within some few degrees of the horizon. This done (requiring some six or eight attendants to work the pulley blocks), all the subsequent movements and adjustments are easily made by two observers. One is stationed at the base of the siderostat, with the handles for working the instrument, telescopes for reading the circles, sidereal clock and telephone all within his reach. Whatever object is selected from the previously prepared working list for the evening, the declination handle is turned until the scale reading seen through the telescope gives the correct declination of the object. Then the hour-angle, or difference between the sidereal time indicated by the clock and the right ascension of the star, is set by means of another handle and the second small telescope. This done, the required object will be near the centre of the field of the large telescope, and the clock being set running to keep it there, the astronomer takes his place at the eye-end to bring it exactly to the centre of the eye-piece. He also has a telephone by his side, and for a space of some two or three minutes there is a continual cross-fire of such terms as "Déclinaison," "Ascension droit," "Doucement," "Au sens contraire," with various endearing terms of admonition in cases of over-doing the movements. Considering, however, the comparatively high power (500) which is the lowest used, it is astonishing how quickly an object is obtained after the setting of the circles. This in itself furnishes an incontestable proof of the extremely accurate adjustment of the siderostat and telescope, both as regards the angle of its polar axis and its position in the meridian. The object being found, all lights are extinguished and a drawing or photograph made as carefully as possible. On the evening it was my privilege to be present, our first object was the Ring Nebula in Lyra (Messier 57). The astronomer in charge was M. Eugène Antoniadi, of the Juvisy Observatory, near Paris, who has started a systematic study of nebulæ with the telescope. This view of the nebula surpassed anything seen before, although frequent observations of it have been made by the writer with a telescope of 36 inches aperture. The great increase of light given by the great glass made it possible to use a highly magnified image, which was at the same time bright enough for the eye to detect detail without any strain.

We next turned to the coloured double star β Cygni, after that α Lyræ (Vega), the companion of which was a very conspicuous object. During all this time the instrument was being used in a building containing several hundred people, electric lights all over heating the air, and the huge searchlights and illuminations from the surrounding buildings causing considerable atmospheric glare—conditions under which none but first-class apparatus would be workable. However, owing probably in a great measure to the large proportion of the roof which is opened, the star images were not inconveniently unsteady.

M. Deloncle appears indefatigable in doing his utmost to entertain any one having special interest in his *protégé*. Parties of guests are often there to listen to a short address from him on its construction and installation, after which they go to the eye-piece, and in turn see whatever may be on view. This goes on till after midnight, and then, the last visitor away, all lights are turned out, the lens case opened to permit of air circulation, and about half an hour or more allowed to elapse for the general temperature to be equalised throughout the various parts. We turned next to an object which M. Antoniadi had not previously observed (a small planetary nebula in Sagitta), found it quite easily by the circles and slight subsequent sweeping, and then occupied about an hour and a half in careful drawing. This nebula is G.C. 4572, and M. Antoniadi's drawing appears in the *Bulletin de la Société Astronomique de France*, September 1900.

In sweeping from one object to another, thousands of stars cross the field of view, and it was specially noticeable that no distortion of the star images was to be detected as the mirror was moved to different angles of incidence. With such a high power this is in itself a severe test of the planeness of the silvered surface, and it is worth drawing attention to the fact that the figuring of this mirror by M. Gautier has been done entirely by mechanical means, controlled at every step by the most delicate optical tests.

In connection with the actual work of observing, nothing is so important as accurate clock driving, in order that the astronomer may not be troubled by constantly having to bring the object into the centre of the field. How efficient this instrument is in this respect will be understood when it is stated that during the period for which the clock runs at one winding, about forty-five minutes, the star images do not move sufficiently in the field of a power of 500 to necessitate any adjustment. The angular diameter of the field of view is about 3′ of arc.

By the time M. Antoniadi had finished his drawing of this planetary nebula it was about 3.0 a.m., and approaching daylight. The mirror cover was lowered into its place, the two sliding sections of the roof pulled together over the mirror, and the clock stopped. In a few minutes M. Antoniadi and myself were the only occupants of the gallery, and the institution being already in such regular use that a couple of beds are provided for observers staying all night, we decided that, as it was so terribly hot indoors, we would take up our beds and camp out in the courtyard. We did this, and sleep being somewhat out of the question, spent some time gazing upward in the hope of seeing some forerunners of the August

Perseids, with the usual result of latter-day meteor watching—we saw none. However, it was a novel and exceedingly pleasant experience to be there lying under the stars, the greatest telescope on earth immediately to one's side, the highest building in the world towering over our heads.

It is to be hoped that after the Exhibition is over the telescope will find a resting-place under the Home Government at some station out of the city, where the purity of the atmosphere will allow of its power being efficiently used. C. P. BUTLER.

TOBACCO.

WHEN Columbus landed in 1492 in the West Indies he found the natives smoking a herb wrapped in a maize leaf, and the name of the herb was Tobago. In 1560 Jean Nicot distributed plants raised from seed to various parts of Europe. These two events give us the clue to the popular and scientific names of a drug the cultivation and preparation of which have now attained such enormous importance that Governments are supported by the revenue derived from its taxation, and colossal fortunes are made by its sale. Some idea of the scale on which the industry is carried on may be gathered from the statistics recently published in the "Year-book of the United States Department of Agriculture for 1899," where we read that during that year 266,661,752 pounds of tobacco, 4,542,016,570 cigars and 4,590,388,430 cigarettes were prepared in the United States alone, yielding a revenue to the Government of 52,043,859·05 dollars.

Small wonder then that the cultivators of so valuable a plant have shown great interest in all the processes of raising, planting, manuring and gathering the crop, and of drying, curing and preparing it for market; or that consternation has arisen in their midst at the origin and spread of a disease which attacks the golden leaf, and bids fair to ruin the crop in some districts. It happens, moreover, that biological problems of wide significance are arising in connection with the complex art of fermenting the leaf so as to obtain the best flavour and strength, as well as in regard to the "Mosaic disease" above referred to, and the experience of Dutch growers, of which an excellent account is now to hand in Koning's "Der Tabak, Studien ueber seine Kultur und Biologie" (Amsterdam and Leipzig: W. Engelmann, 1900), shows that the employment of scientifically trained botanists in the technical laboratories of tobacco plantations is likely to be as usual an event in the future as in breweries and bacteriological laboratories.

The tobacco plant is exceedingly small in the seedling stage—eighteen thimblefuls of seed suffice for a hectare, *i.e.* two and a half acres of land—and is very carefully raised in pots and manured with pigeon's dung, planted out and weeded with extraordinary precautions against numerous enemies, and the leaves eventually picked by hand, sorted, tied into bundles and hung to dry. It is a very exhausting crop, and requires much potash; and an astonishing amount of information has accumulated concerning the effects of different soils, manures, climate and other factors of the environment on the properties of the leaves. Moreover, there are numerous cultivated races in existence in the various tobacco-growing countries, as always occurs with planted crops.

During the process of slow drying the leaf may remain alive for two to three weeks, and the contained starch is converted into sugar, and further alterations result in an increase of acids. Proteids diminish and amines increase, but the nitrates and alkaloids (nicotin) should undergo no change. The slow alterations referred to are essential, and due to enzyme and other actions in the still living leaf; in artificially or rapidly dried leaves the arrest of such changes materially affect the flavour and burning of the tobacco, and naturally much turns on the age and quality of the leaf itself, the soil and season and other conditions of growth, &c.

The dried or "cured" leaves are next submitted to fermentation, a process of vital importance in the opinion of the tobacco expert, since it is this which determines the finer flavours and odours of the manufactured product. Fermentation is started by damping heaps of 15,000 to 30,000 lbs. of the dried leaves, packed in a special manner, and carefully watched by experienced workmen as the temperature rises. The process occupies three to four months, and the leaves are turned about once a month. The temperature rises to about 50–56° C., and a loss of vapour, accompanied by a sweet and sharp odour, is noticed. The reaction may be neutral, though in some cases ammonia is given off, due to the action of undesired bacteria.

As would be expected, the fermentation is always accompanied by bacteria; but it has long been in dispute whether the essentials of the process are due to bacteria or to the action of special enzymes in the cells of the leaves.

Suchsland's researches had convinced him, not only that the fermentation is due to bacteria, but that a peculiar species of bacteria was specially concerned in the production of the approved flavour, and that the desirable properties of Cuban tobaccos could be imparted to inferior growths by introducing this species into the fermentation. Loew, on the other hand, maintained that the aroma and flavour depend simply on the action of enzymes or other cell-contents in the leaf itself.

Koning has investigated the various bacteria found in the fermenting heaps, and followed the changes induced in the tobacco.

Put generally, the fermented tobacco undergoes little or no change as regards the total nitrogen or the nicotin, but organic acids diminish, and the sugars and nitrates are destroyed, and various aromatic substances are formed which affect the quality of the product.

Among the bacteria isolated Koning claims to have found the species concerned in this remarkable neutral fermentation, and which imparts the aroma and flavour desired, and thus confirms Suchsland's results. He states that tobacco infected with the specific bacteria, fermented and made up, and then handed to experts, was selected by the latter as the superior from specimens containing other kinds. There is more than a touch of the dramatic in this scene of the experts sitting down to smoke a pair of cigars each, in packets of two, and labelled *a* and *b*, *c* and *d*, &c., only; but the evidence appears conclusive.

During the last ten years increased attention has been drawn to a disease of tobacco leaves, which causes irregularly alternating light and dark patches, and is known as the "Mosaic disease." Koning has established that this is infectious, and is carried through the fields by the fingers of the workmen who "top" the growing plants by pinching off the buds. He has examined the various fungi known to cause leaf-diseases in tobacco, and cannot refer it to these, and the presumption that it is a bacterial disease was strengthened by finding that certain manured soils were almost sure to have badly diseased plants on them; and that experiments showed that if a bit of diseased leaf, or a little of the sap from such is rubbed into a wound, the young leaves formed above the wound contract the disease. The same result follows if such sap is placed at the roots of healthy plants. But infection fails in all these cases if the sap is previously boiled.

Here may be mentioned that Adolf Mayer had proved the infectious nature of the filtered sap in 1885, and Beijerinck, working at this disease a short time ago (1898), had come to the conclusion that since no

organisms could be isolated from the sap—the infectious nature of which he also proved—which will reproduce the disease, and since the same sap *filtered through porcelain* still infects the plants, unless it was previously sterilised by heating, the causal agent must be a *contagium vivum fluidum*—a something of the nature of a poisonous enzyme, which not only diffuses through the plant-membranes—*e.g.* the cell-walls of root-hairs—but increases as it passes from cell to cell.

Koning confirms Beijerinck's principal results, but concludes that since the infecting fluid may be heated to 100° C. for a few minutes without losing its powers, whereas alcohol and glycerine destroy the virulence, as also does *repeated* filtration through porcelain, the active agent is *an extremely minute organism*, which can traverse the pores of a filter. He compares the results with those obtained with the virus of various animal diseases from which no organism has as yet been isolated.

It should be borne in mind that the existence of organisms small enough to pass through a porcelain filter has been accepted by several authorities.

When we reflect that well-studied micrococci are only 0·5–0·8 μ in diameter, and that the wave-length of those light rays corresponding to the sodium-line D is about 0·6 μ, some of these matters become less astounding: organisms 1/5th to 1/10th this size would probably be well beyond the powers of our best lenses, and would roll through the pores of a filter as shot through the meshes of a sieve.

It thus appears that—without regarding the work as quite conclusive, which it is not—we have here important contributions to several most weighty biological questions centred about the culture of an economic plant.

NOTES.

THE International Congress of Botany was opened in Paris on the 1st inst., and was in session until Tuesday last. M. Prillieux was the president.

THE new science laboratories at King's College, London, are to be opened on the 30th inst. by Lord Lister.

ANOTHER death from plague has occurred in Glasgow, bringing the number of fatal cases in hospital since the outbreak up to six. A fatal case of plague is also reported from Llandaff.

A REUTER telegram announces the arrival at Copenhagen, on October 4, of Lieut. Amdrup and all the members of his expedition. From July 18 to September 2 the expedition, while engaged on the coast of Greenland, explored and mapped out a stretch of land hitherto entirely unknown and extending from Cape Dalton, 69°28′, to Aggas Island, 67°22′. Lieut. Amdrup is reported to have brought with him important collections, the results of his researches. The *Antarctic* reached Tasiusak on September 11, and sailed thence on her return journey on September 18.

THE *Athenaeum* states that the Kolthoff Arctic Expedition has succeeded in bringing to Sweden a male and a female calf of the musk ox (*Ovibos moschatus*, Gmelin). As soon as the animals appear to be acclimatised they are to be set free in the northern mountain regions, where it is thought they will speedily increase in number, as they are very prolific. Herr Kolthoff has great faith in the future importance of the musk ox, not so much as an article of food as on account of its thick brown wool, which is said to be remarkably strong.

THE petrified remains of the extinct rhamphorhynchus have been discovered in the stone quarries of Eichstätt, Bavaria. It is stated that the teeth and fingers are very distinct, and that the membrane between the fingers is visible in places.

ACCORDING to the *Exchange Gazette* of St. Petersburg, the question of the official introduction of the metric system of weights and measures into Russia has been decided in principle in an affirmative sense. The Ministry of Finance is now considering in what manner, and when, the projected reform shall be carried out.

THE trustees of the American Medical Association have established a fund of 500 dollars, to be expended annually for the encouragement of scientific research; but no individual is to receive more than 100 dollars at one time.

THE lecture arrangements of the London Institution for the session terminating on February 28 next have now been completed. The science lectures are as follows:—"The Rise of Egyptian Civilisation," by Prof. Flinders Petrie; "The Earth's Beginning," by Sir Robert Ball; "The Earth's Earliest Inhabitants," by Prof. Grenville Cole; "The Caves of Jenolan," by Mr. F. Lambert; "The Tercentenary of the Science of Electricity," by Prof. Silvanus Thompson; "The Evolution of the Brain," by Dr. Alex. Hill; "Modern Aeronautics," by Mr. Eric S. Bruce; "The First Ascent of Mount Kenya," by Mr. H. J. MacKinder; The Effect of Alcohol on the Nervous System," by Prof. Victor Horsley; "The Decorative Art of Primitive Peoples," by Prof. A. C. Haddon; and "Aquatic Autocrats and Fairies," by Mr. F. Enock. The Christmas course, intended for juveniles, is to be delivered by Prof. W. B. Bottomley, and will be devoted to "Structure and Colour," "Insect Visitors," "Unbidden Guests," and "Place in Nature."

THE next meeting of the Royal Microscopical Society will be held on Wednesday, the 17th inst., when Part ix. of a report on the recent Foraminifera of the Malay Archipelago will be presented. Preceding the meeting there will be an exhibition of slides and models of skin structure, by Mr. F. W. Watson Baker.

THE first monthly general meeting of the new session of the Institution of Mechanical Engineers will take place on Friday, October 19, when a paper, entitled "Observations on an Improved Glass Revealer for Studying Condensation in Steam Engine Cylinders and rendering the Effects Visible," will be read by Mr. Bryan Donkin, and discussed.

A new monthly meteorological journal has recently made its appearance in Holland, and bears the name of *Nederlandsch Tijdschrift voor Meteorologie*. The style of the journal is popular in character.

THE current *Geographical Journal* publishes further details as to the programme of Dr. Sven Hedin's journeys in Northern Tibet and neighbouring regions for the present year. At the time of sending his last letter, on June 27 last, the explorer was about to start for the Chamen Tagh, whither his caravan had already preceded him, his intention being to cross the Astyn Tagh and Koto-Shili ranges, so as to obtain a geological section of the country, and correct his route with that of his former Tibetan journey. After returning to his headquarters in the Chamen Tagh, he hoped to make his way across Northern Tsaidam to Sachu, and thence west to the old bed of Lob Nor, continuing his investigations of the latter end of the ruins in its vicinity. Thence he proposed to carry a chain of altimetric observations to Kara-koshun and Chaklik. He hoped to arrive at the last named point by about January 1, 1901.

A SLIGHT earthquake disturbance in Bombay, on Monday, September 17, is noted in the *Pioneer Mail*, Allahabad. Only one of the instruments at the Colaba Observatory recorded it. The disturbance began at about 3h. 48m. a.m., Bombay time, and reached its maximum at about 3h. 54m. The larger movements ceased at 4h. 2m., and the after-tremors at 4h. 16m. Thus the whole disturbance lasted fully 28 minutes. It was not a distant earthquake, nor was the movement large. The apparent distance of the origin from Bombay may have been about 500 miles. The same journal also records the occurrence, on September 10, of a slight earthquake shock in Madras.

THE New York correspondent of the *Lancet* states that the Chicago Board of Education has established a department called "Child-study and Pedagogic Investigation." The examination is undertaken for the purpose of determining the mental and physical status of the school-children. Examinations were at first limited to the determination in each pupil of the following points: Height, height sitting, weight, ergograph work, strength of grip right and left, hearing right and left, and acuity of vision. In addition to this, obvious developmental defects have been noted. The number of children examined down to the present time is 5636. The conclusions thus far reached are that there is a physical basis of precocity, that dull children are lighter and precocious children heavier than the average child, and that mediocrity of mind is associated with mediocrity of physique. A similar result was obtained in the examination of 33,500 school-children in St. Louis in 1892 by Dr. W. T. Porter. This is the first instance of a municipal board in America appropriating money for research work, and its effect may be far-reaching.

THE German Consul in Payta-Piara (Peru) reports the discovery of large rubber forests on the Niera River, a branch of the Amazon. An expedition has been organised to start for the interior to secure the right to collect the rubber. The increasing demand for rubber has drawn attention to the advantages of cultivating gutta—a leading product of Java and several of the neighbouring islands. A recent number of the *Straits Budget* points out that gutta trees growing wild cannot meet the growing demand which must soon outrun the supply unless gutta plantations extensive enough to meet future needs are laid out. Gutta leaves have been freely resorted to in order to eke out the supply. A company has recently been formed at Batavia to develop this branch of industry.

A LENGTHY account (based on the preliminary report presented to the R. Accademia dei Lincei) of Prof. Grassi's malaria experiment appears in the last number of the *British Medical Journal*, from which we glean the following particulars. In making the experiment, which took place in the plain of Capaccio, near Salerno, two objects were kept in view, viz., (1) To afford an absolute proof of the fact that malaria is transmitted exclusively by the bite of *Anopheles* mosquitoes; (2) to found on the results of recent research a code of rules to be adopted for freeing Italy from malaria in a few years. The experiment consisted in protecting from malaria railway employés and their families living in ten railway cottages and at the stations of S. Nicolò, Varco and Albanella, situated along the Battipaglia-Reggio Railway. They numbered 104 persons, including thirty-three children under ten years of age, Of these 104 individuals, at least eleven, including four children, had never suffered from the disease, not having previously lived in a malarious district; a certain number, it appeared, had not suffered from it for two or three years, and all the others, that is to say, the large majority, had suffered from it during the last malarial season, some of them even in the winter. During the malarial season, the health of the protected individuals was good, with the exception of a few cases of bronchitis and a case of acute gastro-enteritis. None of these cases were treated with quinine. The 104 persons, with three exceptions, had remained free from malaria up to September 16th, the date of the report. From the report it is evident that the twofold object of the experiment has met with every success, and it certainly looks as if it will be possible to free Italy in a short time from malaria, and that the much dreaded plain of Capaccio (excepting for the *Anopheles* infected by malaria germs, from which one can easily protect himself) is one of the healthiest places in Italy.

THE current issue of the *British Medical Journal* gives particulars of the new bacteriological laboratory of the Melbourne University, at present in course of erection. The large hall of the laboratory will afford accommodation for eighty students. Situated on the ground floor there are four research laboratories and one preparation room specially fitted for the professor of pathology, who has, in addition, one room set apart for pathological-histological work and one for chemical pathology. Steam is laid on all over the building for both heating and sterilising purposes. One room has been set apart as a plague laboratory, having germ-proof windows and doors. The walls are covered with tiles made of opaque glass and the floor with lead, so that it can be flooded with antiseptics in case of accidents. In the building there are rooms devoted to micro-photography, the preparation of media of all kinds for the sterilising and disinfecting of all utensils, and departments for numerous other purposes. The department is subsidised by the Board of Public Health, by the Ministry of Agriculture, by the Metropolitan Board of Works, by the City Council, and by other municipalities, who contribute between them about 800*l.* per annum. The duties of this bacteriological department consist in the examination of water and milk supply, of investigating diseases which are discovered at the abattoirs and amongst stock, and analysing the effluence from the sewage farm. It is also prepared to assist the Board of Public Health, on behalf of the medical profession, in diagnosing diphtheria, typhoid, tubercle and cases of plague. It is expected that the building will be opened in March next.

A NEW use for kites is brought under notice in the latest issue of the United States *Monthly Weather Review*. An exhibition has recently been given in Chicago showing how those within a besieged town or other inaccessible place can use the kite line to carry a telephone, with its separate telephone wire, through the air, and let it drop from the kite upon a distant place while the kite still remains in the air. By using a very large box kite and attaching to the kite line a little way below the kite a pulley through which runs the telephone wire, the telephone may be dropped from the pulley while the insulated wire keeps up the connection with the man at the kite reel. Of course, at the present time (as is pointed out in the *Review*), when kites have rarely been sent out with more than two miles of wire, which corresponds to a horizontal distance of much less than two miles, this method does not promise to put into communication persons separated by a great distance, but it may be very useful for short distances.

IN order to enable Essex dairy farmers and ladies engaged in dairying to gain an insight into agricultural education and the organisation and practice of the agricultural industries of Denmark, the Essex Technical Instruction Committee arranged a visit to that country in May last, when thirty-one persons spent a week there in visiting the agricultural schools, dairy farms, butter factories, &c. The excursion (judging from the careful report just issued from the County Technical Laboratories, Chelmsford) seems to have been in every way a great success. The members of the party were impressed with the thriving

condition of agriculture in Denmark, the happy position of which is attributed in the report to legislation, education and co-operation. Visits such as that under consideration cannot, if properly organised, fail to bring about useful results.

THOSE interested in the phylogeny of the Vertebrata will be pleased to hear of the discovery in the seas of Alaska of a new representative of the Enteropneusta, in the form of a species allied to the typical group of Balanoglossus. This new form, which it is proposed to call *Harrimania maculosa*, is described by Mr. W. E. Ritter in Part 2 of "Papers from the Harriman Alaska Expedition," now in course of publication in the serial last quoted. The new form leads its describer to conclude that the notochord of the Enteropneusta is undoubtedly homologous with that of the Vertebrata. It is specially noticeable in that it consists of two parts; the anterior corresponding with the same structure in the other members of the group, while the additional posterior moiety is connected with the œsophagus. This latter portion is peculiar in that it persists throughout life. Harrimania, which is considered to be the most primitive member of the group, instead of burrowing like Balanoglossus, lives under stones, where it often makes its way through the mud at the plane of contact between the latter and the stone beneath which it is concealed. While some examples were only found at extreme low tide, others occurred much nearer high-water mark than is the case with any other Enteropneusta.

THE last published number of the U.S. *Monthly Weather Review* (June) contains a note by Prof. E. B. Garriott on the extension of the Weather Bureau work, which constitutes one of the most substantial advances in the history of that institution. The West Indian branch was established in 1898, and at the present time practically all the cable islands and ports of the West Indies and the Carribean coast of South America receive advices regarding tropical storms. The West Indian observing stations number thirteen, and hurricane warnings are displayed at more than a hundred points. Telegraphic reports are now also received from well-distributed Mexican stations. It is believed that the reports received from the northern and western parts of Mexico will lead to a better understanding of the important storms which sweep north-eastward from the tropical Pacific and cross the United States to the Atlantic. Reports from the extreme north-west of Canada have been added within the last two years and have furnished valuable data regarding the movements of North Pacific storms. The Weather Bureau has consequently reports from an area extending over more than 42° of latitude and 65° of longitude. The advantage afforded by these widespread telegraphic stations can hardly be over-estimated.

THE *Philosophical Magazine* for October contains an interesting paper by Mr. R. J. A. Barnard, of Melbourne, on the annual march of temperature. The author has examined the observations for forty years at Melbourne and has divided them into two groups, 1859–78 and 1879–98. In each group the average for every day is obtained and smoothed twice by replacing the temperature of each day by the mean of the five consecutive days of which the particular day is the middle. The results of the second smoothing show that in the second week of March the temperature begins to drop rapidly, reaching a secondary minimum for each curve on the 19th. It then rises again to the extent of 2°·5 during the next week, reaching a maximum on the 25th and 26th, the data being the same again for both groups. The spells are not so marked as those found by Dr. Rijkevorsel for Europe, owing probably to the more uniform conditions of the southern hemisphere. The results show that a period of less than forty years is not likely to give any trustworthy information about spells, and that the division of the observations for any particular place into groups of twenty years and the comparison of them in the way specified appear to be satisfactory methods of finding out whether such spells really exist.

THE rise and fall in the level of a lake, produced by the mechanical action of wind, is strikingly shown in a short paper contributed by Prof. A. J. Henry to the U.S. *Monthly Weather Review* for May. Continuous records of lake level at four points, viz. Amherstburg, Ontario, mouth of the Detroit River, and Buffalo Harbour, Lake Erie, were considered in conjunction with continuous records of wind direction and velocity and atmospheric pressure made at the Weather Bureau offices in Detroit and Buffalo; and a relation between the wind and water is clearly shown when the two sets of records are plotted under one another. It has been known for some years that general winds, as distinguished from local winds, blowing parallel to the longer axis of the main body of the lake, have a tendency to heap up the water at the end of the lake toward which they blow, and to depress it at the opposite end. Owing to the convergence of the shore lines at Buffalo, the heaping up of the waters in that harbour, under the influence of a south-westerly wind, becomes a serious menace to the safety of wharf and dock property. Likewise, owing to the shoal water at either end of the lake, a decrease in the available depth in the harbours and channels produces vexatious delays and frequent groundings.

PROF. HENRY'S examination of the facts referred to in the foregoing note shows that when high water exists at Amherstburg it is always low water at Buffalo. The synchronism of the times of high water and low water at the two places is almost perfect. The period of oscillation is likewise fairly constant, ranging from six to eight hours for a half oscillation, and from twelve to sixteen hours for a whole oscillation. The computed time of a whole oscillation, assuming the lake to have a mean depth of 50 feet, is, roughly speaking, seventeen hours. While the information on the subject is as yet too fragmentary to admit of drawing trustworthy conclusions, this much seems to be apparent: the oscillations are stationary rather than progressive. A wave of water is not propagated, in the ordinary sense of that word, from one end of the lake to the other, but the whole lake oscillates about a pivotal or nodal line, which, in the case of longitudinal oscillations, may be said to cross the lake about the longitude of Fairport, Ohio. Although there is no instrumental evidence of the fact, it may be assumed that, as in the case of similar oscillations in other land-locked bodies of water, the oscillations at the nodal line are zero, increasing to a maximum at the respective ends of the lake. Prof. Henry concludes by saying that it is within the range of probability that the occurrence of the more pronounced oscillations can be forecast by the Weather Bureau at no distant period.

TO the *Entomologists' Monthly Magazine* for October, Mr. R. McLachlan contributes an abbreviated translation of an article, by M. A. Lancaster, on the swarms of a species of dragon-fly (*Libellula quadrimaculata*) which were observed in Belgium on June 5 and 10 last. On both occasions the temperature was very high, and the insects flew against the wind. The translator is of opinion that nothing certain in regard to the causes of these remarkable migrations has hitherto been ascertained. "As a rule," he writes, "the multitudes are so vast as to make it difficult to believe that all can have been bred within a very limited area. On the contrary, it rather looks as if the individuals in a certain initial locality, being seized with an uncontrollable migratory impulse, were progressively joined by others till the accumulations formed the ultimate swarm. A part of the second swarm seems to have reached England.

IN an exhaustive paper read before the Manchester Literary and Philosophical Society (*Memoirs*, vol. xliv. Pt. 4, pp. 1–8), Mr. Thomas Thorp describes his modification of the diffraction process of colour photography, first put forward by Prof. Wood. The difficulty of determining the correct degrees of rulings necessary for giving certain colours by Prof. Wood's arrangement is obviated by adjusting several copies of a grating having the same spacing at angles to each other, the angles giving the best colour combinations being found by experiment. Full details are given of the method of obtaining the celluloid copies from an original metal reflection grating. A diagram is included to illustrate the procedure for obtaining stereoscopic views with the apparatus.

IN the *Astrophysical Journal* (vol. xii. pp. 30–48), Herr J. Hartmann, of the Astrophysical Observatory at Potsdam, gives a useful and interesting series of suggestions on the design and critical adjustments of photographic spectrographs intended for observational work of a high degree of accuracy.

IN *Science* for September 28 is to be found an article on the "International Catalogue of Scientific Literature" from the pen of Sir Michael Foster, in which it is stated that more than forty-five complete sets of the work have already been subscribed for in the United States, and that, therefore, the catalogue will be begun at once.

MANY of our readers will be pleased to know that the recently delivered Huxley lecture of Lord Lister is to be had *in extenso* in both the *Lancet* and the *British Medical Journal* for Saturday last.

THE last part published (vol. xii. Part 4) of the *Journal* of the College of Science, Tokyo, gives evidence of the continued activity of the Japanese University in zoological research, in two valuable papers:—Further observations on the nuclear division of Noctiluca, by C. Ishikawa; and Notes on some exotic species of Ectoparasitic Trematodes, by Prof. S. Goto, both well illustrated. This number also contains the commencement of an enumeration, by T. Ito and Prof. J. Matsumura, of the flowering plants of the Lûchû Islands, the rich and interesting flora of which is at present but imperfectly known.

THE second volume of the elaborate "Cyclopedia of American Horticulture," by Prof. L. H. Bailey, Dr. W. Miller and others, has been published by Messrs. Macmillan and Co., Ltd. The volume extends from E to M, and is to be followed by two others. There will be more than two thousand original illustrations in the complete work, and the text will be on a proportionally large scale. The scope of this remarkable undertaking may be judged from the sub-title, which certifies that the complete work will comprise "suggestions for cultivation of horticultural plants, descriptions of the species of fruits, vegetables, flowers and ornamental plants sold in the United States and Canada, together with geographical and biographical sketches." Our review of the work will be deferred until the appearance of the final volume.

NEW editions of several established works have been recently received. The fifth edition of "Quantitative Chemical Analysis," by Dr. Frank Clowes and Prof. J. B. Coleman, has been issued by Messrs. J. and A. Churchill. The book provides a sound course of work both in manipulation and analysis, and is well in touch with modern methods. Among the additional matter we notice a description of a new and ingenious method of determining melting-points, a special apparatus for the rapid filtration and ignition of precipitates, and an improved form of condenser for use in the distillation of liquids.—The principles and practice of paper manufacture are presented in a form suitable for students in "A Text-book of Paper-Making," by C. F. Cross and E. J. Bevan (E. and F. N. Spon). The second edition of the book has just appeared.—Another second edition is "Agricultural Zoology," by Prof. J. R. Bos, translated by Prof. J. R. Ainsworth Davis. An appendix has been added, containing an instructive statement of conditions which determine the appearance of harmful animals; also the general principles as to the means to be employed against them, and lists of pests classified according to their habitat. A full index has also been added.—Now that attention is being given to nature study in rural schools, Mrs. Brightwen's writings upon animal and plant life should receive additional admirers. Her books are of a kind that cannot be too widely known, so we are glad to see that Mr. Fisher Unwin has just issued new editions of "Wild Nature Won by Kindness" and "Glimpses into Plant Life."

THE "Memoirs and Correspondence of Lyon Playfair" was fully noticed in our issue for December 7 last, so that it is now unnecessary for us to do more than to state that a "popular" edition of the book has just been issued by Messrs. Cassell and Co., Ltd.

THE new issue of the *Journal* of the Royal Agricultural Society of England, contains, as usual, a number of interesting and valuable articles, among which may be mentioned an account, by Dr. Fream, of the York meeting of the society, "The Trials of Steam Diggers at York," and an obituary notice (with a page portrait after Herkomer) of Sir John Bennet Lawes.

Nature Notes for October mentions that an avocet was shot near Penzance in the spring.

IN the October number of the *Journal of Conchology*, Mr. A. G. Stubbs concludes his synopsis of the freshwater and land molluscs of the Tenby district.

IN the last annual "General Report of the Geological Survey of India," a voluminous book of 258 pages, the results of much industrious labour by the officers of the Survey are summarised. Considerable activity is being displayed in the prosecution of chemical and palæontological research, and the field-work has been directed towards elucidating economic questions as well as others purely geological. Part iii. of this work contains individual "progress reports" by various officers of the Survey, which consist of papers dealing, not only with economic matters such as auriferous reefs and coal-fields, but also with various questions of considerable geological interest.

UNDER the title of "A List of Works on North American Entomology," the U.S. Department of Agriculture, Division of Entomology, have issued, as No. 24 of the new series of their *Bulletin*, an extremely useful classified index to the most important publications relating to the various orders and families of North-American insects. It has been compiled under the direction of the entomologist, Dr. L. O. Howard, by his assistant, Mr. Nathan Banks. The idea is excellent and might well be adopted for other publications of a similar character respecting the insects of other countries. Such an index cannot be complete, but so many of the most important works on the subject are included that it will be easy for a student taking up the study of any special branch of North American insects to feel his way by this bibliography at the commencement and to enlarge his knowledge on a good foundation as he progresses.

THE latest part of the *Journal* of the Asiatic Society of Bengal (that issued on July 9) is wholly taken up with Sir George King's "Materials for a Flora of the Malayan Peninsula," a portion of which has been written by Dr. O. Stapf, of Kew.

IN addition to the usual "notes" and proceedings of Irish Societies, the October issue of the *Irish Naturalist* contains an interesting communication by Mr. C. B. Moffat, entitled "The Habits of the Hairy-armed Bat."

WE have received a copy of the *Papers* and *Proceedings* of the Royal Society of Tasmania for 1898-1899 (issued June 1900). It contains a useful list of Tasmanian mollusca, by Miss Lodder; several petrological papers, by Mr. W. H. Twelvetrees and Mr. W. F. Petterd, in which limurite, haüyne-trachyte, felsites, nephelinite and other rocks are described; also a note by the same authors on bones of Tasmanian labyrinthodonts. Numerous other natural history subjects are dealt with.

AMONG recent American and Colonial reprints we have to note the following:—Contributions to the U.S. National Herbarium, the plant covering of Ocracoke Island, by Thomas H. Kearney, jun.; and Stigmonose, a disease of carnations and other pinks, by Albert F. Woods; both issued by different divisions of the U.S. Department of Agriculture; Progress of plant breeding in the United States, by Herbert J. Webber and E. A. Bessey, reprinted from the year book of the U.S. Department of Agriculture for 1899; and Observations on the eucalypts of New South Wales, parts 5 and 6, by H. Deane and J. H. Maiden, from the *Proceedings* of the Linnean Society of New South Wales.

A SMALL pamphlet, issued by the Joint Agricultural Council of the East and West Ridings and of the Yorkshire College, containing a list of one hundred Yorkshire weeds, should be useful to farmers. It will be supplemented by a herbarium containing entire plants of the hundred weeds, and a cabinet containing their seeds or fruits, and will be followed by others.

IN the *Bulletin*, No. 3 (Petroleum Series), issued by the School of Mines, University of Wyoming, Mr. W. C. Knight gives an account of the oil-fields of Crook and Uinta counties. The geological features of the oil-yielding districts are briefly sketched and illustrated by maps and sections in the text. Tables showing the results of testing in various samples of oil are contributed by Mr. E. E. Slosson.

"NOTES on some Jurassic Plants in the Manchester Museum," by Mr. A. C. Seward, are published in the *Memoirs* of the Manchester Literary and Philosophical Society, vol. xliv. 1900, and reprinted in "Notes from the Manchester Museum," No. 6. The collection dealt with includes the plants figured by Lindley and Hutton, in addition to other specimens in the museum. The synonymy of numerous species is given, and a list of Inferior Oolite plants contained in the museum collections is also added. These notes are accompanied by four well-executed plates and a useful bibliography.

IN the *Mémoires du Musée Roy. d'Hist. Nat. de Belgique*, t. i. 1900, Mr. Seward describes the Wealden flora of Bernissart (Belgium). The plants described are obtained from a fresh-water deposit and are of a fragmentary nature; the flora is remarkable for the relatively large number of ferns included, while the cycads are absent and the conifers rare. Twenty species of plants are recognised, more than half of which are known also from England and Germany. The memoir is well illustrated by four plates and several text-figures.

SINCE the publication in our last number of a list of forthcoming science books, we have received the list of announcements of Mr. Gustav Fischer, of Jena. It is as follows:—"Atlas der topographischen Anatomie des Menschen," by Profs. Bardeleben and Haeckel, Zweite völlig umgearbeitete und vermehrte Auflage; "Organographie der Pflanzen, insbesondere der Archegoniaten und Samenpflanzen," by Prof. Goebel, Zweiter Teil, 2 Heft, Erster Teil; "Klinisches Jahrbuch," Siebenter Band, Funftes Heft; "Lehrbuch der vergleichenden Anatomie der wirbellosen Tiere," by Prof. A. Lang, Zweite umgearbeitete Auflage, Erste Lieferung, Mollusca; "Die Grundlagen und die Methoden für die mikroskopische Untersuchung von Pflanzenpulvern," by Prof. A. Meyer; "Aetiologie und Prophylaxe der Lungentuberkulose," by Dr. J. Ruhemann; "Anatomisch-klinische Vorträge aus dem Gebiete der Nervenpathologie," by Prof. K. Schaffer; "Praktikum der physiologischen Chemie," by Prof. Fr. N. Schulz; "Lehrbuch der Histologie und der mikroskopischen Anatomie des Menschen mit Einschluss der mikroskopischen Technik," by Prof. P. Stoehr, Neunte verbesserte Auflage; "Das Neuron in Anatomie und Physiologie," by Prof. Max Verworn.

Mr. H. K. Lewis promises the following new books:—"Blood and Blood Pressure," by Dr. G. Oliver; and new editions of "Hygiene and Public Health," by Dr. Louis Parkes: "Medical Electricity," by Dr. Lewis Jones; "The Student's Medical Dictionary" and "A Pocket Medical Dictionary," by Dr. G. M. Gould.

Messrs. Lovell Reeve and Co., Ltd., have in preparation a "Monograph of the Membracidæ," by G. B. Buckton, F.R.S., who will be glad to hear, through the publishers, from entomologists and others as to specimens which they have reason to believe are as yet unknown to science.

Messrs. Williams and Norgate announce:—"The Opus Majus of Roger Bacon," edited with introduction and analytical table by J. H. Bridges.

MR. MARTINUS NIJHOFF, bookseller, of the Hague, has just issued the first part of his classified natural science catalogue containing nearly 2500 entries.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Lieut. Sullivan; a Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Mr. J. E. Matcham; a Two-spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Mr. R. G. Pointer; a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Miss Bartlett; a Blue-faced Amazon (*Chrysotis versicolor*) from St. Lucia, West Indies, presented by Miss M. Moon; two Greek Tortoises (*Testudo graeca*), European, presented by Sister Heather Grey; a Chameleon (*Chamaeleon vulgaris*) from North Africa, presented by Mrs. E. Putz; a Bonnet Monkey (*Macacus sinicus*) from India, two Pucheran's Guinea Fowls (*Guttera pucherani*) from Somaliland; a Large Grieved Tortoise (*Podocnemis expansa*) from the Amazons; a Greek Tortoise (*Testudo graeca*), European, deposited; two Common Rattlesnakes (*Crotalus durissus*), two Water Vipers *Ancistrodon piscivorus*), two Copper-head Vipers (*Ancistrodon contortrix*), two Mocassin Snakes (*Tropidonotus fasciatus*), a Hog-nosed Snake (*Heterodon platyrhinos*) from North America, received in exchange.

OUR ASTRONOMICAL COLUMN.

Ephemeris for observations of Eros.

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THE STABILITY OF A SWARM OF METEORITES AND OF A PLANET AND SATELLITE.

THE problem of the stability of a swarm of meteorites which is under the action of its own gravity and the attraction of the sun, that is to say the determination of the condition under which the swarm will remain unbroken up by the tidal action of the sun, has been dealt with by Schiaparelli, M. Luc Picard and M. Charlier (*Bulletin de l'Académie de St. Petersbourg*, t. xxxii. No. 3). The result obtained by the first assigns a much wider limit of stability to such a system than that arrived at by the other two investigators mentioned; but there cannot, I think, be any doubt of the greater correctness in actual cases of the narrower limit. The problem is intimately related to the still more interesting question of the stability of the earth-moon system, which was treated by Mr. G. W. Hill in a remarkable paper in the *American Journal of Mathematics* for 1878. This again is, in another form, the problem treated still earlier with a special object in view by Edouard Roche (*Mém. Acad. de Montpellier*, vol. i. 1847-50; see also *Annales de l'Observatoire*, t. v.), when he arrived at his result concerning the limiting relation between the distance of a satellite from a primary and the diameter of the primary, which must hold in order that the satellite, held together by its own gravitation only, may just not break up under the tidal forces due to the primary, and his corresponding result for a planet's or satellite's atmosphere.

These investigations, though of great general interest, are not so well known as might be expected, and one object of this paper is to give some slight account of them. An abstract of the work of Charlier and Hill is given also in Dr. Routh's recently published work on "Dynamics of a Particle." But I wish also to point out how the main conclusions of Charlier, that of Roche with respect to a planet's atmosphere, and more indirectly the result of Hill, can be obtained by means of elementary considerations.

The problems just referred to have been treated by very different methods. Schiaparelli's discussion is a direct attack of a somewhat long and involved nature; those of MM. Picard and Charlier (*Bulletin de l'Académie de St. Petersbourg*, t. xxxii. No. 3; see also Tisserand, *Mécanique Céleste*, t. iv.) make use of the method of revolving axes. The radius vector from the centre of the sun to the centre of the meteoric swarm is supposed to revolve with angular velocity, n say, about the centre of the sun as a fixed point; then the motion of a particle of the swarm is referred to three directions at right angles to one another having their origin at the centre of the swarm, and turning with the radius vector just specified. These axes may be taken as an axis of ξ towards the sun, an axis of η at right angles to this in the plane of motion of the centre, and an axis of ζ at right angles to this plane. Then equations of motion relative to these moving axes are written down for a particle the component distances of which from the centre are ξ, η, ζ, it being supposed in the first place that the distance r of the centre of the swarm from the sun, and the angular velocity n of the radius vector are both variable. Approximate values of the forces are obtained by supposing that ξ, η, ζ are small in comparison with r, and that r, and therefore also n, is constant. When account is taken of the condition that must hold for the central particle, the equations assume the very simple form

$$\ddot{\xi} - 2n\dot{\eta} - (3n^2 - \mu)\xi = 0, \quad \ddot{\eta} + 2n\dot{\xi} + \mu\eta = 0, \quad \ddot{\zeta} + (n^2 + \mu)\zeta = 0.$$

The value of μ is $\frac{4}{3}\pi ks$, where k is the gravitation constant and s is the average density of the portion of the swarm within the spherical surface on which the particle lies, supposed symmetrical about the centre. Considering only particles in the plane of ξ, η, the values of these co-ordinates are supposed to oscillate about certain constant values, so that $\xi = a\cos(\omega t + \epsilon)$, $\eta = b\sin(\omega t + \epsilon)$. That is, each particle is supposed to revolve in an ellipse, the centre of which is the centre of the swarm, and of which one axis is along the line of centres and the other perpendicular to that line. The ellipse is a circle if $a = b$, and ω is then the angular velocity of the *relative* motion of the particle about the centre. These values substituted in the first two equations of motion lead to the condition

$$(\omega^2 - \mu)(\omega^2 + 3n^2 - \mu) - 4\omega^2 n^2 = 0.$$

Now ω is $2\pi f$, if f be the frequency of oscillation; and if the oscillation be stable, f will have a positive real value. The roots of the quadratic in ω^2 just written must therefore be real and positive; and it is not hard to see that the required condition for this is $\mu > 3n^2$. This gives, when μ is replaced by $\frac{4}{3}\pi ks$, and n^2 by $k\mathrm{M}/r^3$, where M is the mass of the sun (for we have for the central particle $n^2 r = k\mathrm{M}/r^2$), the inequality

$$\tfrac{4}{3}\pi sr^3 > 3\mathrm{M}.$$

In order, therefore, that the swarm of small particles may keep together, it is necessary that its average density be greater than that of a spherical distribution of matter of radius equal to the sun's distance and of three times the sun's mass. The problem for an elliptic orbit of eccentricity e has been considered by M. Callandreau (*Bulletin Astronomique*, 1896). The condition $\mu > 3n^2$ is in this case replaced by $\mu > 3n^2 + 5e^2n^2$. The swarm is therefore rendered less stable by the eccentricity.

It is to be remembered that the effect of the distortion of the swarm by the tidal force of the sun is neglected, and it does not seem of much importance to consider eccentricity of orbit so long as the assumption of sphericity of figure is maintained.

Since the equation of condition stated above must be satisfied, only values of ω consistent therewith, and with the inequality $\mu > 3n^2$, are admissible. Thus if $\omega = 0$, that is if there be no revolution of any particle about the centre of the swarm, the equation gives $\mu = 3n^2$, and the inequality is not fulfilled. This is a limiting case between stability and instability.

Now let the differential equations of motion referred to above (from which the more roughly approximate equations quoted are derived) be modified for the case in which the swarm is replaced by a planet of given mass m, and the particle considered by a satellite of mass m' at the external point ξ, η, ζ, then let them be multiplied by $\dot{\xi}$, $\dot{\eta}$, $\dot{\zeta}$ respectively, integrated, and added. Thereby will be obtained the equation of kinetic energy for the relative motion, commonly called Jacobi's equation. This has, if $\dot{\xi}^2 + \dot{\eta}^2 + \dot{\zeta}^2$, the square of the resultant relative velocity, be denoted by v^2, the form

$$v^2 - \left[2\frac{\mu}{\rho} + 2\frac{r^3n^2}{r_1} + n^2\left\{(r-\xi)^2 + \eta^2\right\}\right] + \mathrm{C} = 0$$

where

$$\mu = k(m + m'), \rho = \sqrt{\xi^2 + \eta^2 + \zeta^2}, r = \sqrt{(r-\xi)^2 + \eta^2 + \zeta^2},$$

C is a constant, and r is, as before, the distance of the centre of the sun from that of the planet.

Now when v^2 has a given value, the satellite must have its centre on the surface of which the equation is obtained by placing that value in the equation just written. Hence, since v^2 is positive, the satellite cannot pass across the surface for which $v^2 = 0$, that is the surface for which

$$2\frac{\mu}{\rho} + 2\frac{r^3n^2}{r_1} + n^2\left\{(r-\xi)^2 + \eta^2\right\} - \mathrm{C} = 0;$$

by putting $\zeta = 0$ in this we obtain the equation of the curve in which the surface intersects the plane of ξ, η. An investigation of the surface shows that if C be positive the surface consists of three sheets, of which two are closed and surround the sun and the planet respectively; and the third is asymptotic to a surface of revolution about an axis passing through the sun's centre perpendicular to the ecliptic, and surrounds the two closed surfaces. Within the closed surfaces, or outside the third surface, v^2 is positive; between the closed surfaces and the outer asymptotically cylindrical surface v^2 is negative, and therefore v is imaginary. The satellite must therefore be within one of the closed surfaces, or beyond the outer surface; in either case it cannot cross the surface of zero velocity.

When the proper values of the quantities for the earth-moon system are inserted, it is found that the moon is within the closed sheet surrounding the earth, from which, therefore, it cannot escape. The distance of the moon's centre from the earth, Mr. Hill has calculated, cannot exceed 109·694 equatorial radii of the earth. The result is based, of course, on the assumption that the eccentricity of the earth's orbit may be neglected.

If, besides neglecting the eccentricity, we suppose the moon to move in the plane of the ecliptic, and to be so distant that we may neglect terms in η, the equation of the curve of no velocity in the plane of the ecliptic is

$$\frac{\mu}{\rho} + \frac{3}{2}n^2\xi^2 = c,$$

or if $\xi = \rho\cos\theta$

$$3n^2\cos^2\theta \cdot \rho^3 - c\rho + 2\mu = 0,$$

where c is another constant.

The roots of this cubic in ρ are all real if $\cos^2\theta > c^3/81n^2\mu^2$, and the rule of signs shows that there is only one negative root. The curve of no velocity consists then of a closed branch round the origin of co-ordinates, the centre, E, of the earth in the present case. Besides this there are two infinite branches which are asymptotic to the parallel lines AB, A'B' represented by

$$3n^2\xi = c.$$

Thus the curve is as roughly represented in Fig. 1. The line CD shows the direction of the radius vector from the sun.

Between the closed curve and the infinite branches v is imaginary, and the satellite must be either within the closed branch or beyond the boundary represented by the infinite branches. The calculation gives very approximately 110 equatorial radii of the earth for the greatest distance of any point of the closed branch from the centre. The form of this branch is that of an oval, being slightly longer in the direction towards the sun than in the transverse direction.

The theorem of Roche which we discuss here is contained in the statement that the atmosphere of a satellite cannot be held together merely by the gravitational attraction of the satellite unless the inequality

$$\frac{m}{M} > (2 + c)\frac{a^3}{r^3}$$

is fulfilled, in which m is now the mass of the satellite, M that of the planet, c the ratio of the square of the angular velocity

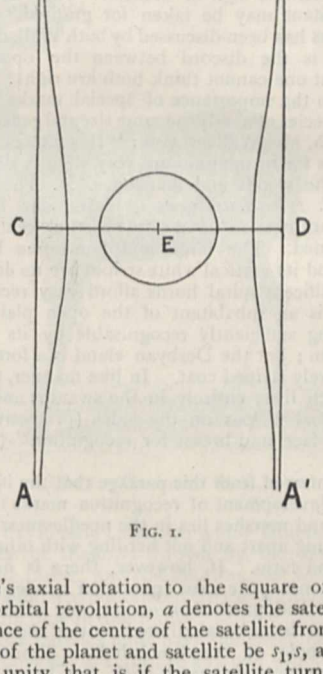


FIG. 1.

of the satellite's axial rotation to the square of the angular velocity of its orbital revolution, a denotes the satellite's radius, and r the distance of the centre of the satellite from the planet. If the densities of the planet and satellite be s_1, s, and their radii a_1, a, and c be unity, that is if the satellite turns always the same face to the primary, we have for the inequality

$$\frac{r^3}{a_1^3}\frac{s}{s_1} > 3, \text{ or } r > 1{\cdot}44a_1\sqrt[3]{s_1/s}.$$

It should be mentioned that Roche's investigations embraced much more than this; they included the determination of the figure of a fluid satellite, and entered into other matters which cannot be discussed here.

To deal with these questions in an elementary way, consider the important particular case of a spherical swarm of radius a moving round the sun, and turning as a whole about an axis perpendicular to the orbit in the period of revolution, so that it turns the same face always towards the sun. This is, of course, a less general problem than that considered above; it is indeed the case of that problem in which ω is zero It is interesting to see from the more general investigation that the condition obtained by the consideration of this case is sufficient to give stability for any value of ω provided it fulfils the equation of condition stated above. We shall obtain also by the elementary process a wider condition for the case in which ω is not zero. This will give the inferior limit assigned by Roche to the distance of a satellite from its primary.

A particle, of unit mass, say, at the centre, C (Fig. 2), at distance SC ($=r$) from the sun, is in relative equilibrium under the sun's attraction and the so-called centrifugal force. That is, we have for that particle

$$\frac{k\mathrm{M}}{r^2} - n^2 r = 0.$$

Again, a particle on the outside of the swarm at the point nearest the sun is at a distance $r-a$, and under attraction $k\mathrm{M}/(r-a)^2$. Hence there is a preponderance of attraction over the acceleration $n^2(r-a)$ towards S. This excess is

$$\frac{k\mathrm{M}}{(r-a)^2} - n^2(r-a) = k\mathrm{M}\left\{\frac{1}{(r-a)^2} - \frac{1}{r^2} + \frac{a}{r^3}\right\}$$
$$= 3k\mathrm{M}\frac{a}{r^3}$$

nearly. This must at least be balanced by the attraction towards the centre, C, exerted by the swarm, if the particle is not to leave the swarm. Hence we must have $\frac{4}{3}\pi s k a^3/a^2 > 3k\mathrm{M}a/r^3$, or

$$\tfrac{4}{3}\pi s r^3 > 3\mathrm{M},$$

as before. The same result would be obtained for a particle at B. In that case the attraction of the sun $k\mathrm{M}/(r+a)^2$ would be insufficient to supply the acceleration $n^2(r+a)$ towards the sun. The condition that this should be supplied by the attraction of the swarm is that $\frac{4}{3}\pi s r^3$ should be at least equal to 3M.

This result holds, of course, for all particles within the swarm on the line SC, for no particle experiences any force on the whole from the spherical layer outside it.

It is to be observed that a particle at A or B (or on the line SC) is in greater danger of leaving the swarm from the causes

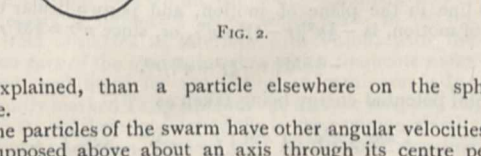


FIG. 2.

just explained, than a particle elsewhere on the spherical surface.

If the particles of the swarm have other angular velocities than that supposed above about an axis through its centre perpendicular to the plane of the orbit, the investigation will run as follows. Suppose applied to each of the particles a force per unit mass equal and opposite to that, n^2r, exerted by the sun on the central particle. This will have no effect on the relative motions of the particles or on the figure of the swarm. Upon the particle nearest the sun the force per unit mass toward the sun is now

$$\frac{k\mathrm{M}}{(r-a)^2} + \omega_1^2 a - n^2 r = 2k\mathrm{M}\frac{a}{r^3} + \omega_1^2 a$$

if ω_1 be the angular velocity *in space* of the radius vector drawn from the centre to the particle (that is, not the relative angular velocity ω above, but $\omega + n$). This must at least be balanced by the attraction towards the centre exerted by the swarm if the particle is not to leave it. Thus we have $\frac{4}{3}\pi k s a > 2k\mathrm{M}a/r^3 + \omega_1^2 a$, or since $k\mathrm{M} = n^2 r^3$

$$\tfrac{4}{3}\pi s r^3 > \left(2 + \frac{\omega_1^2}{n^2}\right)\mathrm{M}.$$

Thus if the swarm as a whole make one rotation in the period of revolution round the sun, $\omega_1^2/n^2 = 1$, and we obtain the same result as before.

Let now the swarm of particles be replaced by a spherical planet with an atmosphere composed of discrete small particles, the whole being held together by gravitational attraction alone. Then if the mass of the planet be denoted by m, the inequality $\frac{4}{3}\pi s r^3 > 3\mathrm{M}$ becomes $\frac{4}{3}\pi s a^3 > 3\mathrm{M}a^3/r^3$, that is $m/\mathrm{M} > 3a^3/r^3$. This is to be fulfilled if the atmosphere is not to be dissipated by tidal

action. The same thing will, of course, hold for a primary and the atmosphere of a satellite.

In the more general case, that in which the satellite has rotational velocity ω about its axis (supposed perpendicular to the plane of the orbit), we have, assuming that the satellite is spherical and denoting ω_1^2/n^2 by c, $m/M > (2+c)a^3/r^3$. This agrees with the former result when $c=1$. These results were first obtained by M. Roche.[1]

The figure of a fluid satellite is determined by finding a surface to which the resultant of the gravitational pull of the primary on unit mass, a force n^2r equal and opposite to the gravitational pull on unit mass at the centre, the gravitational force per unit mass exerted by the matter of the satellite itself, and the centrifugal force of unit mass, is everywhere perpendicular. A first approximation to the force due to the satellite itself is obtained by neglecting the deviation from sphericity, as is done above. But into this discussion we cannot here enter. It can only be stated that the final result, taking into account the distortion of the satellite, is that the satellite will be broken up if it approaches closer to the primary than the limit given by the inequality

$$r > 2{\cdot}44 \sqrt[3]{s_1/s_1}.$$

Now imagine a planet and a satellite moving round the sun, the satellite being destitute of relative velocity. The satellite may, for example, be regarded as a particle (of unit mass say) of a ring of small mass composed of particles surrounding the primary at a distance a, the whole turning, if that were possible, with angular velocity equal to that of the primary round the sun. By what we have seen above, the excess of solar attraction over the sunward acceleration is, for a particle on the side nearest the sun, $3k\mathrm{M}a/r^3$. This must be balanced by the attraction km/a^2, so that we have the equality $km/a^2 = 3k\mathrm{M}a/r^3$.

From these expressions for the forces we see that the potential energy, with a term for centrifugal force included, may be taken, for unit mass of the infinitesimal satellite on the line of centres at the point nearest the sun, as $-km/a - \frac{3}{2}k\mathrm{M}a^2/r^3$. This is an example of the almost self-evident principle, known as the theorem of Coriolis, that if there be included a term in the potential energy which will give the components of centrifugal force, we may write down the equation of relative kinetic energy, just as if the rotating axes were fixed. The potential energy thus required for the centrifugal force on a particle of unit mass at a point at distances ξ, η, ζ from the planet's centre, measured respectively along the line of centres, perpendicular to this line in the plane of motion, and perpendicular to the plane of motion, is $-\frac{1}{2}n^2\{(r-\xi)^2+\eta^2\}$, or, since $n^2r = k\mathrm{M}/r^2$,

$$-\tfrac{1}{2}k\mathrm{M}\{(r-\xi)^2+\eta^2\}/r^3.$$

The total potential energy being taken as

$$-\left[\frac{km}{\rho}+\frac{k\mathrm{M}}{r_1}+\frac{1}{2}\frac{k\mathrm{M}}{r^3}\left\{\left(r-\xi\right)^2+\eta^2\right\}\right]$$

(with, as before,

$$v^2 = \dot\xi^2+\dot\eta^2+\dot\zeta^2,\ \rho^2 = \xi^2+\eta^2+\zeta^2,\ r_1^2 = (r-\xi)^2+\eta^2+\zeta^2,$$

and $n^2 = k\mathrm{M}/r^3$), the equation of relative kinetic energy is

$$\frac{1}{2}v^2 - \left[\frac{km}{\rho}+\frac{k\mathrm{M}}{r_1}+\frac{1}{2}\frac{k\mathrm{M}}{r^3}\left\{\left(r-\xi\right)^2+\eta^2+\zeta^2\right\}\right]+\mathrm{C}=0,$$

which, for an infinitesimal satellite, is Hill's equation as given above.

For the moon, which has mass m' sensible in comparison with the mass, m, of the earth, the first term in the square brackets should be $k(m+m')/\rho$.

It may be noticed by the dynamical student that if the above expression for the potential energy be denoted by V, we have not $\ddot\xi = -\partial\mathrm{V}/\partial\xi$, &c., for the equations of motion, but

$$\ddot\xi - n\eta = -\partial\mathrm{V}/\partial\xi,\ \ddot\eta + n\xi = -\partial\mathrm{V}/\partial\eta,\ \ddot\zeta = -\partial\mathrm{V}/\partial\zeta.$$

A. GRAY.

[1] I have found since the above was written that the same elementary view of this matter is given by Roche himself in his paper "Recherches sur les Atmosphères des Comètes," *Annales de l'Observatoire*, t. v. 1859. Perhaps I may here direct attention to a valuable paper by Roche (which may, however, though I have not seen it referred to, be well known to astronomers), entitled "Essai sur la Constitution du Système Solaire," *Mém. de l'Acad. de Montpellier*, t. viii. This gives a general account of the author's cosmogonic researches.

ANTELOPES AND THEIR RECOGNITION MARKS.

THE Tragelaphine Antelopes hold a unique position amongst the hollow-horned ruminants. No other group can show species so sharply contrasted in size and build as the massive eland rising over sixty inches at the withers, and the dainty little bush-buck which falls short of half that height. Only the Indian black buck amongst the gazelles can match the nylghaie and nyala for diversity of sexual colouring; and for elegance of form, coupled with beauty of marking and grandeur of carriage, the kudu is surpassed by no species of mammal.

Apart from certain features presented by the skull and horns, the affinity between the species here mentioned is attested by the markings of the skin. On a ground-colour shading from slate to chestnut are distributed certain white spots, patches or stripes, which crop up so persistently in the different genera as to leave no doubt they are a heritage from a common ancestor. A comparison between the skins of the existing species suggests that this ancestor was coloured somewhat as follows:—Body and head yellowish red; flanks and hind-quarters striped with white; on the throat two white patches, one at each end; one or two spots on the cheeks, a V-shaped stripe between the eyes, a white chin, a white upper lip; legs paler on the inner side, quite white at base close to chest and groin, and with two white spots on the pasterns in front.

Some or all of these markings have been inherited with scarcely an exception by every known species of Tragelaphine. Sometimes the spots on the head, sometimes the stripes on the body, sometimes the patches on the throat are suppressed; but even in extreme cases of suppression, a spot here, a stripe there, persists as a tell-tale sign of descent. The usefulness of characters so constant may be taken for granted. The nature of their usefulness has been discussed by both Wallace and Darwin; but so great is the discord between the opinions of these authorities that one cannot think both are right.

Referring to the importance of special marks for recognition where many species of nearly the same size and general form inhabit the same region, Mr. Wallace says: "It is interesting to note that these markings for recognition are very slightly developed in the antelopes of the woods and marshes. . . . The wood-haunting bosch-bok (*T. sylvaticus*) goes in pairs, and has hardly any distinctive markings on its dusky chestnut coat, but the male alone is horned. The large and handsome kudu frequents brushwood, and its vertical white stripes are no doubt protective, while its magnificent spiral horns afford easy recognition. The eland, which is an inhabitant of the open plain, is uniformly coloured, being sufficiently recognisable by its large size and distinctive form; but the Derbyan eland is a forest animal, and has a protectively striped coat. In like manner, the fine Speke's antelope, which lives entirely in the swamps and among reeds, has pale vertical stripes on the sides (protective), with white markings on face and breast for recognition" ("Darwinism," p. 220).

It may be inferred from this passage that the interest attached to the slight development of recognition marks in the antelopes of the woods and marshes lies in the needlessness of such marks for species living apart and not herding with others of the same general size and form. If, however, there is no likelihood of confusion, it is not quite clear from what species the horns of the kudu serve to distinguish their owner, nor what significance in this connection is to be attributed to the occurrence of horns only in the male of the bosch-bok. Similarly, it is not clear what use Speke's marsh-buck can have for recognition marks. If, however, the spots on the face and throat subserve recognition in this species, we must also conclude they are retained for that purpose in the bongo (*T. euryceros*), the lesser kudu, the nyala (*T. angasi*), in which they are very conspicuous, as well as in the various smaller kinds of bush-buck, which in other parts of Africa live the same life as the bosch-bok of the Colony. Surely, too, Derby's eland is at least as recognisable by its large size and distinctive form as the Cape species; yet it is adorned with a conspicuous V-shaped stripe between the eyes, and the lower throat-patch forms a white collar, standing boldly out against the black hue of the neck.

In short, if the marks in question have been preserved for recognition, it is singular that they are exceptionally well developed in the species that live in pairs or small parties by themselves in thick bush—species which, according to the hypothesis, have little, if any, need of them. It is conceded, of course, that the spots on the head and throat, like the stripes on the body,

patches on the rump or any other visible external feature, including large ears, may, if required, serve as marks of identity; but in the case of the Tragelaphines, at least, it is hard to believe that that is any more their primary function than it is the primary function of large ears.

A mass of evidence can be brought forward in favour of Wallace's view that the body-stripes of these antelopes are protective; but there appear to me to be equally strong reasons for classifying the face and foot markings in the same category, and for regarding them as representing spots or streaks of sunlight passing through foliage or reflected from leaves.

It is possible, perhaps probable, that the other white patches on a typical Tragelaphine serve the same end; but their situation forcibly suggests that they have a still deeper significance. I believe they come within the scope of Thayer's hypothesis of concealment by the counteraction of light and shade. A convex body stands out amid surroundings of its own colour on account of the contrast between the light that is reflected from its upper surface and the shadow that pervades it below. Take away the light by darkening the upper side and the shadow by lightening the lower, and the body will vanish from sight with the destruction of its visible shape. By applying this principle to a typically marked Tragelaphine, the lesser kudu for example, it will be seen that the white is laid on where shadows are thrown; that the white rim on the upper lip and the white chin must counteract the shadows caused by the fold of the

FIG. 1.—The Lesser Kudu, ♂.

mouth and by the muzzle; the two white blotches on the neck must counteract the shadows thrown by the head and by the curvature of the throat, and the shadows cast by the breast and groin must be similarly obliterated by the white patches on the inner side of the base of the limbs.

That the white patches must have the effect here assigned to them will be obvious, I think, to any one who, with Thayer's hypothesis in mind, looks at a lesser kudu when it is standing full-face. The reason for the presence of marks concealing the animal from this point of view will be referred to later on.

If the markings of the Tragelaphines have the significance here attached to them, they should be better developed in the species that live in the bush than in those that frequent the open. Let us see in a few cases to what extent they are correlated with habit. Two well-marked species of eland live in Africa, to wit, Derby's eland (*T. derbianus*) from Senegambia and the commoner form (*T. oryx*) which, with its subspecies, ranges throughout the whole of East and South Africa. The former, according to Winwood Reade, "lives in the forest, and never of its own accord enters the plain." It is reddish in colour, with a black neck, a white collar, eye-stripes and many white stripes on the flanks and hind-quarters. Of the common eland the typical "dun coloured" desert form is, according to Selous, "particularly plentiful in the dry desert country through which the Chobe runs," and examples "from the Kalahari desert have no sign of a stripe." Farther to the north, both in Angola, South-east and East Africa, this unmarked type is replaced by its ancestral form, Livingstone's eland, which in colour and habits is intermediate between the Cape and Senegambian species. The skin is always marked with narrow white stripes, and the V-shaped mark between the eyes is often present. In British East Africa this eland, according to Jackson, was found in "sparsely timbered country and open bush bordering the plain rather than the plains themselves," and in Angola (Penrice) "it seems most partial to a thinly timbered country." There is thus a complete gradation from the strongly marked forest species through the weakly marked species frequenting the open bush to the unmarked desert species.

Take again the kudus. Both the species are well marked with white stripes on body and head, but the smaller (*S. imberbis*) is much more strikingly marked than the larger (*S. strepsiceros*), having more stripes on the body and two patches on the throat. In Somaliland, where both species occur, the larger lives, according to Swayne, in the mountains, on very broken ground where there is plenty of bush; and sometimes indeed ventures into the open plain (Inverarity). The lesser kudu, on the contrary, "is found in thick jungles . . . especially where there is an undergrowth of the slender pointed aloe which grows from four to six feet high" (Swayne). Both Swayne and Inverarity, moreover, bear witness that this species will allow a hunter to get within a few yards before dashing away—a notorious habit with protectively coloured animals. Evidence of a like kind is furnished by other species of Tragelaphines. The beautifully marked nyala (*T. angasi*) and bongo (*T. euryceros*) live in dense thickets; and the lovely little bush-bucks (*T. sylvaticus, scriptus*, &c.) seldom venture out of cover except at night-time to feed. On the other hand, the nylghaie, an aberrant member of the same tribe, is without body-stripes, and lives for the most part in more or less open country in India, and is not a typical denizen of the thick jungle at all.[1]

Further evidence on this head is supplied by another set of facts. Ungulates which live in thickets or rough ground affording cover to enemies have larger ears and a keener sense of hearing than those of the plains or high mountains where intruders have little chance of concealment. Note the small ears of the camel, a typically desert form; or of goats and sheep which from the mountain peaks can sweep the surrounding country for miles with their eyes and seek safety in flight long before the foe gets within ear shot. Compare also the small equine ears of Burchell's zebra, which herds in the open plain free from obstacles to interfere with vision, with the longer asinine ears of the mountain zebra which frequents rocky broken ground well fitted for the hiding of carnivores. In all the brilliantly marked Tragelaphines the ears are long and expanded, but in the nylghaie, and especially in the common eland, they are short and narrower. Indeed, one of the chief structural differences between Derby's eland and the Cape species is found in the size of the ears.[2]

The co-existence of white marks with long ears and a bush-life bears out the supposition that the marks, like the ears, are primarily for protection, and that if subservient to purposes of recognition they are merely of secondary importance in that capacity.

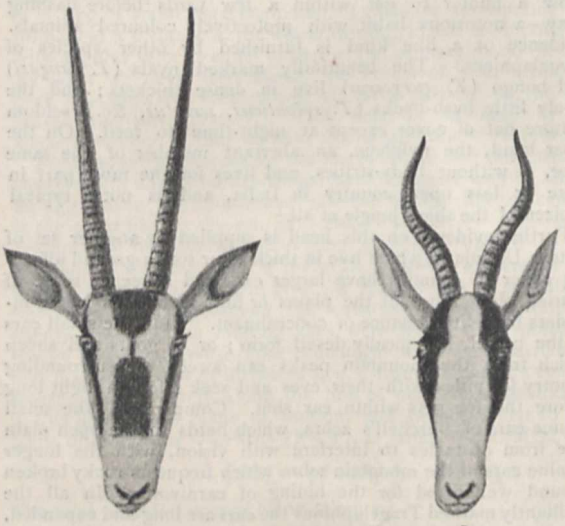
I strongly suspect, too, that the markings of the sable, roan, gemsbok and bontebok are for concealment, and not for recognition as Mr. Wallace supposes. The theory of recognition marks as applied to these antelopes assumes the need of some patch or spot to enable the members of a species to identify their own kind amongst the herds of other sorts living in the same place. The theory would rest upon a securer basis, if it could be shown that closely allied species feed together. But nothing, I suppose, is more certain than that, as a very general, perhaps invariable, rule, closely allied and similar species are not found together. If, for example, the gemsbok and the

[1] An apparent exception to the rule that the development of white stripes and spots is correlated with a jungle life is found in the Sitatunga and Speke's marsh-buck, which "live in vast reed beds and papyrus swamps, and only come into the open at night" (Selous). Yet the stripes fade away in the adults of both sexes. Why is this? Possibly because these animals depend for concealment, not so much upon coloration that harmonises with that of the vegetation, as upon a newly acquired and efficient habit of hiding under the water itself, with only the end of the nose jutting above the surface (Selous and Gedge).

[2] Compare in this connection the small ears of the orang with the large ears of the chimpanzee. The former lives a more arboreal and therefore safer life than the latter, which requires quick hearing to enable it to escape to the trees when feeding on the ground.

beisa lived side by side in the Kalahari, or Peters's palla and the common species in Rhodesia, there would perhaps be strong reasons for thinking that the differences in the facial bands, which enable us to recognise these species apart, serve the same end where the antelopes are themselves concerned. But the gemsbok and the beisa, the common and Angolan palla, never cross each other's path. Again, in cases where the geographical areas of two forms, closely allied, but distinguishable by bands or patches, meet, the two forms frequently interbreed, and so falsify the contention that marks keep like to like.

That ungulates of different sorts herd together is well known; we read, for example, of zebras, gnus, pallas, spring-boks and buffaloes feeding in each other's company on the veldt. But so distinct from each other in form are these animals and others that might occur with them, that it is rating their visual powers very low—much lower, indeed, than our own—to hold that they require special patches to keep them from committing the errors of identification which the hypothesis assumes they are liable to fall into. I believe, then, that the need for recognition marks in the case of antelopes has been much over-rated,[1] and is too slight to warrant the belief that the facial and other stripes of, say, the gemsbok or sable have been perfected by their usefulness as such. On the other hand, when we see that the pattern of the zebra is for concealment, that the network of white stripes on the giraffe blends with the lights passing



A B

FIG. 2.—A, Face of the Beisa; B, face of the Bontebok.

through the intercrossing branches of trees, that the colour and shape of the feeding hartebeest are like those of the ant-hills, all these and other facts attesting the importance of concealment, we are justified in suspecting that the white blaze of the bontebok and the facial bands of the gazelles and oryxes are developed for concealment and not for recognition.

The markings take the form of strongly contrasted bands of white and black, or brown. Objects banded in this way are, as a rule, more, and not less, difficult to see in their natural surroundings than those that are uniformly coloured. There is little of the gloss on the coat of a grey or white horse that is seen on a bay or black, because white hair reflects the light less vividly than dark. Hence alternating bands of these hues impart a blurred irregular aspect to a body, destroy the apparent evenness of its surface and break up the continuity of its outline. In an uncertain light a zebra's stripes[2] "merge into a grey tint," and mutually counteract each other, so that the animal is nearly invisible.

The stripes on the head of a gemsbok or sable are in a general way so like those on a zebra's coat that they must, one would think, have the effect of making the head inconspicuous. To explain the prevalence of such marks upon the head and fore-part of the body, of which the quagga furnishes an illustration, the following suggestions may be made.

Once aware of an enemy's presence, an antelope has three chances of escape—concealment, flight and self-defence. Concealment is often the wisest course to pursue, especially where females and young are concerned. For concealment perfect stillness is of all things most important. Movement means detection, and detection may mean death. But it is necessary at the same time for every movement of the enemy to be scrutinised, so that the right moment for flying may be seized, when the necessity for flight becomes apparent. For this purpose the face must be turned towards the enemy and both eyes be kept upon him. In this watchful attitude little of the foreshortened body is visible from the enemy's point of view, and if the head of the antelope be carried low with the nape in a line with the spine, practically nothing of the animal is exposed but the head and the fore-legs. Hence the special importance of protective markings on these parts.[1] Again, when lying on the ground the body will often be hidden by low scrub or, if cover be absent, may simulate a mound of earth or a termite's nest[2]; but the head, if protectively coloured, may with safety be raised to keep an eye on the surrounding country and guard against surprise.

The sexual colours of the Tragelaphines still remain to be touched upon. Darwin believed that the markings of the kudu, harnessed bush-buck, &c., were in the first instance acquired by the male, then intensified by sexual selection, and partially transferred to the female. Against this hypothesis may be urged the evidence already adduced in favour of their protective[3] value, and the distinctness they exhibit in the newly-born or even fœtal young. Nevertheless a difference of colour, small or great, but as yet unexplained, does exist between the males and females of all the species of the group. It is noticeable, too, that the deviation affects the male; that it takes the direction of nigrescence, but by no means always of beauty, and that the female adheres to the typical coloration of the group.

There is no evidence, so far as I am aware, that the assumption of a dark coat by the male is connected with any peculiarity in mode of life of this sex, which would attest its use for concealment. On the contrary, since the colour—at least, in the case of the nylghaie ("Descent of Man," p. 535)—becomes intensified at the breeding season, without the growth of new hair, and has its appearance arrested by emasculation, its significance appears to be purely sexual and the outcome or accompaniment of "male katabolism." If so, it may have been intensified and fixed by the exercise of choice on the part of the females, or by the destruction or expulsion of their paler, less vigorous rivals by the stronger and darker males, which thus secured the females for themselves and left the greatest number of offspring.

It is significant that the three species of antelopes, namely the nyala, the nylghaie and the Indian black buck, in which the sexes differ strikingly from each other—differ indeed to an extent that is equalled by few species of mammals and surpassed by none—the female is without horns or other weapons of defence. This defencelessness, coupled with the exigencies of maternity, has compelled an adherence on her part to the normal protective coloration of the group; whereas the males, powerfully built and strongly horned, have been able to dispense to a great extent with colours that harmonise with those of the environment.

Warning characters are rare in mammals; but the difference in colour between the bull and cow of the species just mentioned may conceivably benefit the former at the expense sometimes of the latter by serving to distinguish him, the horned powerful fighter and dangerous antagonist when brought to bay, from her, the weak and defenceless one who may be attacked and pulled down with impunity. Why not?

R. I. POCOCK.

[1] If the American prong-buck were an inhabitant of Africa, I presume that its conspicuous patterns, possibly indeed the unique shape of its horns, would be cited as evidence supporting the theory of recognition marks. But in the prairies of the United States there are no species that resemble it in size and form, so as to create confusion as to identity. The species furnishes a good instance of Thayer's principle.

[2] Mr. Wallace is surely "putting the cart before the horse" in the passage where he speaks of the coloration of the zebra as an instance of a style of marking for recognition becoming also protective.

[1] Presumably it is for an analogous reason that the tiger has a pair of sunlight patches on its face, so that its chances of concealment may be increased when watching for prey or creeping towards it.

[2] In the case of the gemsbok, beisa and some gazelles the black longitudinal stripe passing along the side may enhance this resemblance by representing the shadow that is often seen where a boulder or mound meets the soil. The darkening of the coat on this area of the body, such as is seen, for instance, in the Asiatic wild ass (Kiang), should have the effect of deadening the light reflected from the bulging flank.

[3] Here and elsewhere in this article I have purposely used the word "protective" as the equivalent of procryptic or celative, which are less familiar to general readers.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE geologists had a busy and profitable week at Bradford, and an air of business-like application to work pervaded their meetings from first to last. The programme ought to have been long enough to satisfy even the most devoted adherent of Section C; but apparently there was no sense of satiety, since on two or three occasions when it was proposed from the platform that communications should be taken as read, there were protests raised by the audience, who seemed determined to carry matters through with true North-country thoroughness, and wished to hear everything. And indeed it may be said that there was scarcely a paper in the long list which did not contain scientific matter well worthy of discussion, though it must be acknowledged that in several instances the matter was not particularly novel. It was only by the strict enforcement of a time-limit upon readers of papers and debaters, and by sessions on the mornings of Saturday and Wednesday as well as lengthy sittings on the other days of the meeting, that the business was got through. Under these circumstances it was inevitable that some excellent papers scarcely received full justice; but the discussions were nevertheless unusually full of vigour, and what was still better, entirely lacking in acrimony.

The fine weather of the week, which was so favourable to the short afternoon excursions, now a recognised and highly valued feature in the affairs of the section, had probably much effect in fostering the prevailing good-humour, while the personality of the president was a strong influence in the same direction, especially in the discussions.

To particularise all the papers within the space-limits of this article is impossible, and we can only attempt to convey a general impression of the proceedings, with brief reference to the points of main interest.

On Thursday, as a fitting appendix to the wide-reaching generalisations of the president's address, already printed in these pages, we had a series of papers from Prof. J. Joly dealing with geological problems from the standpoint of the physicist. In one of these, "On the geological age of the earth, as indicated by the sodium contents of the sea," Prof. Joly reiterated the calculations and conclusions which have recently attracted so much attention in geological circles; in another, "On the inner mechanism of marine sedimentation," he showed the chemical and physical reasons for the rapid precipitation of fine solid matter brought down in suspension by rivers into the sea; a third of kindred character gave the result of "experiments on denudation by solution in fresh and salt water"; and a fourth, which was especially attractive to the petrologists and mineralogists, dealt with "the viscous softening of rock-forming minerals at temperatures below their normal melting point," showing how certain minerals could be observed to attain a plastic state some time before actually melting.

At the same meeting Prof. W. B. Scott, of Princeton, gave a highly interesting account, with lantern illustrations, of recent explorations in Patagonia conducted under the direction of Mr. J. B. Hatcher. Besides correcting previous errors as to the age of the deposits, the records and the rich collections of fossils obtained by this expedition have sufficed to prove a close connection between Australia, New Zealand and South America in Miocene times, and in several other respects to modify profoundly our previous ideas of South American geology, and incidentally to show how much geologists have still to learn in every way from the unexplored tracts of the earth's surface.

On Friday, Prof. J. Milne led off in his usual happy vein with an account of the year's work of the Seismological Committee, and was followed by Mr. Clement Reid, who showed how well-chosen, from geological reasons, was the site for instrumental observation, by the same committee, of the Upway disturbance. There then followed a series of papers and reports on the Mountain-limestone district of north-west Yorkshire and its underground waters, Mr. S. W. Cuttriss giving an account of the adventurous exploration of the deep pot-holes and caves of this district by himself and other members of the Yorkshire Ramblers' Club, and the Rev. W. Lower Carter and Mr. A. R. Dwerryhouse presenting the results obtained by a local committee and by a committee of the Association in the investigation of the subterranean drainage of the limestone. Being well-illustrated by lantern slides, these papers besides attaining their more direct purpose served to give the strangers an idea of the general characteristics of the district which was afterwards to be visited by geological excursion parties. By the use of suitable chemical reagents the course of the water from its disappearance in "sink holes" of the limestone to its reappearance in springs at lower levels has in several instances been traced; it has been shown that the main direction of underground flow is along the master-joints of the limestone; and a subterranean watershed of which there is no indication at the surface has been traced for some distance. These experiments are to be continued, and a grant of 50*l.* was made by the Association towards this end.

Among other papers taken on Tuesday were two by Mr. E. Greenly, giving further results of his painstaking researches in Anglesey. In one of these he dealt with the ancient surfaces or peneplains which he thinks can be recognised in North Wales; the older plain he is inclined to regard as of sub-Carboniferous age, and the later as Mesozoic, possibly Cretaceous. There was an interesting discussion on this paper, in the course of which Mr. Greenly acknowledged that his views were only tentatively held, and might require modification. Dr. G. Abbott then gave an account of his investigation of the concretionary structures of the Magnesian Limestone of Durham, illustrating his subject by lantern-slides and the exhibition of a large series of specimens.

Saturday's business began with a paper by the President, "On a concealed coalfield beneath the London basin," in which it was urged, on data not altogether convincing, that if a boring were made in the vicinity of Enfield Lock on the Lea, it might be expected to reach Coal-measures. As a speaker in the discussion remarked, such a boring would no doubt reveal something interesting, but whether Coal-measures was another matter. Then followed a paper by Mr. R. H Tiddeman "On the formation of reef-knolls," which was practically a criticism of Mr. J. E. Marr's views as to the development of these structures in the Mountain-limestone of West Yorkshire and Lancashire by earth-movement, and a reiteration of the author's earlier contention that they were originally formed as mounds on a slowly sinking sea-bottom. As Mr. Marr was present to champion his own cause, the paper was followed by a brisk but friendly discussion, which was prolonged on a later day in the open air, when some of the mounds at Cracoe near Skipton were visited by a few members interested in the subject. No definite conclusion was reached, but the necessity for further investigation was made evident, and it was suggested that the truth might lie in a combination of the two hypotheses.

Another paper taken on Saturday was that of Mr. W. Gibson, "On rapid changes in the thickness and character of the Coal-measures of North Staffordshire," in which it was shown that the areas of maximum and minimum deposit in these rocks correspond respectively with a syncline and anticline, thereby suggesting that local areas of deposit were being marked out by contemporaneous movements of elevation and depression, thus fulfilling in North Staffordshire the conditions characteristic of the Carboniferous rocks of the Midlands generally. These results have an important practical application, inasmuch as the unexplored coal-field to the westward, which occupies a syncline, may thereby be expected to exhibit an increase in the thickness of the strata. At the same meeting, Rev. J. F. Blake brought forward some revolutionary suggestions in regard to the registration of type-specimens, among other proposals urging that a new class of "adopted" types should be recognised and registered where the original types were missing or inadequate, and that the type should consist of a single specimen. As Prof. Blake has now been elected a member of the committee of the Association at present in existence for furthering the registration of type-specimens, we may hope that his interest in the matter may bear fruit.

On Monday there was a crowded audience to hear the joint discussion with the botanists on the conditions during the growth of the forests of the Coal-measures. The discussion was opened by Mr. R. Kidston, who gave a succinct account of the plant-life of the period, illustrated by fine lantern slides. Mr. A. Strahan then dealt with the physical conditions, and gave his adherence to the "drift" as opposed to the "growth-in-place" theory of the origin of coal-seams, summing up the normal sequence of events in the formation of a seam as follows:—First, the out-spreading of sand and gravel with drifted plant remains; followed by shale as the currents lost velocity; and then a growth of presumably aquatic vegetation in extremely shallow water into which wind-borne vegetable dust and floating vegetable matter was carried; after which renewed subsidence brought in the sand and mud-laden currents again and the whole process was re-commenced. Mr. A. C. Seward followed with a clear statement

of the botanical evidence bearing on the climatic and other physical conditions under which coal was formed; and Mr. J. E. Marr continued with a general outline of the geological evidence, laying stress on the peculiar coincidence during the Carboniferous period of a dominant vegetation of giant cryptogams with extensive plains of sedimentation and suitable climatic conditions. The debate thus initiated was then thrown open to the meeting and was carried on briskly by numerous speakers, among whom were Dr. Horace Brown, who gave the result of his experiments on the growth of plants in an atmosphere containing a slight excess of carbonic acid gas, and showed a series of lantern slides illustrating these experiments; Prof. P. F. Kendall, who supported the growth-in-place theory for most coals except cannel-coal; Mr. R. D. Oldham, who referred to the absence of seat-earths or under-clays to the seams in the Indian coal-fields; Dr. D. H. Scott, Dr. H. Woodward, Dr. H. O. Forbes, Dr. Wheelton Hind, Dr. Le Neve Foster, Mr. W. Cash, and others. In winding up this somewhat discursive debate, which had occupied the whole of the morning, the president leant strongly towards the growth-in-place theory, and this view was evidently also in favour with the greater portion of the audience.

Dr. E. D. Wellburn next gave two papers on the fossil fish of the Yorkshire Coal-field and of the Millstone Grits. Mr. J. J. H. Teall, President of the Geological Society, then described the plutonic complex of Cnoc-na-Sroine (Sutherlandshire), and discussed the three possible ways in which it may have originated, viz. by (1) successive intrusions; (2) differentiation *in situ*; or (3) modification of the original magma by the absorption of adjacent basic rocks, the conclusion being that the first method has not in this case played an important part, and that the second, coupled perhaps to some extent with the third, has been the main agent in forming the complex. Prof. K. Busz, of Münster, followed with a paper on a granophyre dyke intrusive in gabbro at Ardnamurchan (Scotland), in which it was shown that the granophyre in question has absorbed a considerable quantity of basic material from the previously consolidated gabbro, and has thereby added hornblende and mica to its proper constituents. Both papers provoked lively discussion.

Tuesday was essentially the glacialists' day and they made vigorous use of it, occupying nearly the whole session. Time was found, however, at the opening for a paper by Miss Igerna B. J. Sollas, "On *Naiadites* from the Upper Rhætic of Redland, Bristol"; and there was another break at the close, when Prof. A. P. Coleman, of Toronto, gave an account of the recent discovery of a ferriferous horizon in the Huronian north of Lake Superior, where a band of iron-bearing sandstone and jasper has already been traced for sixty miles in the Michipicoton district, and promises to be of great value from both the economic and the scientific standpoints, as it furnishes an easily-recognised horizon, probably equivalent to that containing the most famous iron mines of the United States, and affords an excellent clue to the stratigraphy.

Of the glacial papers, the first, by Mr. F. W. Harmer, was a theoretical discussion of the influence of winds upon climate during past epochs, in which it was sought to restore hypothetically the distribution of cyclonic and anti-cyclonic areas during the Pleistocene period, and to explain in this manner the phenomena of interglacial periods, which the author believes to have occurred alternately in the eastern and western continents, the conditions of comparative warmth and cold during this period having been local and due directly to meteorological causes. Then followed a series of excellent papers on the glacial phenomena of the West Riding, by Dr. Monckman, Mr. E. Wilson, and Messrs. A. Jowett and H. B. Muff, in which particular attention was drawn to the former existence of glacially-dammed lakes in the side valleys draining to the Aire, and to the overflow channels cut by the streams which had their source in these lakes. The glaciation of the East Riding was afterwards dealt with in two papers by Mr. J. W. Stather; and Mr. R. H. Tiddeman brought forward evidence proving that the raised beach of Gower in South Wales, with the bone-beds which rest upon it in the caves, must be either of pre- or inter-Glacial age, since they are overlain by glacial drift; this matter is of much consequence in the correlation of Pleistocene deposits of the unglaciated parts of our island with those of the glaciated tracts.

At the final meeting on Wednesday morning, Mr. R. D. Oldham discussed the mode of formation of the Basal Carboniferous Conglomerate of Ullswater in the light of his Indian experience, and suggested that it was a torrential deposit formed on dry land near the foot of a range of hills, in a generally dry and hot climate varied by seasonal or periodical bursts of rain. In a second paper Mr. Oldham called attention to good examples of new beach-formation on the shores of Thirlmere Reservoir, and recommended that a photographic survey should be made from time to time to record the progress and growth of this beach. Mr. W. H. Crofts followed with a careful and well-illustrated account of sections in Glacial and post-Glacial deposits in a new dock at Hull; and Mr. A. C. Seward gave a summarised description of the Jurassic flora of the Yorkshire coast, with many fine lantern illustrations. Mr. G. W. Lamplugh afterwards reviewed the evidence as to the age of the English Wealden series, and supported the long-accepted but recently questioned view that the whole of the time-interval between the closing stages of the Jurassic and the commencement of the Aptian is represented.

The reports of committees of research read during the meeting included, among others, Prof. W. W. Watts', on the collection and preservation of geological photographs; Prof. P. F. Kendall's, on erratic blocks of the British Isles; Dr. Wheelton Hind's, on life-zones in British Carboniferous rocks; and Prof. A. P. Coleman's, on the Pleistocene beds of Canada.

The short afternoon excursions were under the leadership of Mr. J. E. Wilson, Mr. H. B. Muff and Dr. Monckman, who were thus able to show in the field some of the phenomena which they had described in their papers. These excursions were well attended and much appreciated by the visitors from a distance, who in this way were enabled rapidly and pleasantly to gain a grasp of the leading features of the local geology.

A well-arranged temporary museum, under the supervision of Mr. J. E. Wilson, for the exhibition of specimens illustrating the papers and the coal-discussion, was located in a large room adjoining the section room, and was especially serviceable in enabling those interested in the particular subjects illustrated to examine the material at their leisure and to compare notes upon it with the exhibitors. The lantern, so often a source of annoyance at the sectional meetings, was ably managed throughout; and indeed the whole of the local arrangements for the accommodation of the section were admirably planned and carried out, the only drawback being that the noise of heavy traffic on the stone pavement outside was at times troublesome.

To sum up the week's work, it may be remarked that there was an unusual number of papers dealing with subjects of broad general interest and therefore well suited for public discussion, and a scarcity of those detailed studies in stratigraphy or classification which, though probably of more permanent scientific value, are ill-adapted for presentation at these meetings; the local papers also were numerous and well above the average in character; petrology and palæontology were both adequately represented; but systematic geology received little attention.

The morning meetings were well attended throughout, but, as usual, in the afternoons only the devoted nucleus of the section remained.

ZOOLOGY (AND PHYSIOLOGY) AT THE BRITISH ASSOCIATION.

THE opening day (Thursday) was devoted to the president's address in the morning and the reports of various committees in the afternoon. The reports were as follows:—

(1) Bird migration in Great Britain and Ireland.—Mr. Eagle Clarke has completed the extraction of the voluminous records of occurrences of birds in Great Britain and Ireland from the periodical literature of 1880-1887. The information thus provided supplements in a most useful manner the original Lighthouse data, and renders it possible for the first time to write an authoritative history of the migrations of each British bird. Mr. Clarke begins the series with a summary of details of the various migratory movements of (i) the Song-Thrush (*Turdus musicus*) and (ii) the White Wagtail (*Motacilla alba*).

(2) Investigations at the Naples Zoological Station.—The utility of the British Association's table was again demonstrated by the number of naturalists who had occupied it during the year. Reports on work done there were submitted by Mr. H. M. Kyle (anatomy of flat-fishes), Mr. E. S. Goodrich (structure of certain polychæte worms), Prof. W. A. Herdman (Compound Ascidians), Mr. R. T. Günther (anatomy of *Phyllirhoë* and certain Cœlenterates), Dr. A. H. R. Buller (fertilisation process

in Echinoidea) and Prof. Ramsay Wright (methods of preservation of specimens).

(3) Investigations at the Plymouth Marine Laboratory.—The British Association table was occupied by Mr. A. D. Darbishire, who investigated the natural history of *Pinnotheres* and the myology of *Calanus*; and by Mr. W. M. Aders, who studied the spermatogenesis of Cœlenterates.

(4) Index Animalium.—Mr. C. Davies Sherborne has made great progress in this important work, and the first part of his catalogue of post-Linnæan names up to the year 1800 is now ready for printing.

(5) Plankton of the English Channel.—Mr. Garstang has completed the five quarterly surveys provided for, and a final report will be presented at the Glasgow meeting.

(6) Zoology of the Sandwich Islands.—Mr. R. C. L. Perkins is again at work in the islands, and reports that already the forests are being extensively destroyed and replaced by sugar cane. It is fortunate for science that the committee foresaw this event, and were enabled to begin their investigations before it was too late. Four parts of the second volume of the "Fauna Hawaiiensis" have been published during the year.

On Friday, Prof. W. B. Scott, of Princeton University, U.S.A., gave an account of the Miocene fauna of Patagonia, based on an elaborate investigation of the Santa Cruz beds. The fauna was characterised by the abundance and variety of Marsupials of Australian type, of Edentates (ground-sloths, glyptodons, and armadillos), of porcupine-like Rodents and primitive Ungulates. There was no trace of tree-sloths and anteaters, of rats, mice, squirrels, hares and rabbits, or of carnivorous Eutheria. The place of the latter was taken by flesh-eating Marsupials, as in Australia to-day. South America was usually regarded as having no Insectivora, but some of the small mammals examined by him appeared to belong to this class. Among the hoofed animals one series was of particular interest in showing the complete evolution of a one-toed type from three-toed ancestors. This monodactyle positively "out-horsed the horse," for even the splints had gone. Yet morphologically it was no horse. It furnished the most conclusive instance he knew of convergent evolution in widely separated groups of animals. In conclusion, Dr. Scott showed that, after the removal of the Miocene barrier, the true carnivora of the modern fauna, together with the llama, deer, tapir, peccary, and the hares and rats, immigrated from North America, while the giant sloths and glyptodons extended their range to the northward.

Dr. Gregg Wilson exhibited a number of eggs and embryos of *Ornithorhynchus*, and described the water-side burrows and nests made by this lowly mammal. The duckmole protects its eggs and nest by blocking the passages between the nest and the entrances with solid walls of earth.

Prof. W. C. McIntosh communicated (through the secretary) a paper on some points in the life-history of the littoral fishes, in which he discussed the mortality of certain shore fishes at different stages of growth.

Major Ronald Ross then delivered a formal lecture on malaria and mosquitoes, dealing more particularly with the life-history of the sporozoan whose reproduction in the blood is the cause of malarial fever, and with the part played by the mosquito *Anopheles* in transferring the parasite by means of its so-called "salivary" secretion to the blood of fresh human hosts. Native children were the chief source of infection, since their blood swarmed with the parasites. The prevalence of malaria, however, might be reduced by efficient surface-drainage, which would check the multiplication of mosquitoes by destroying the pools and ditches in which their larvæ were developed.

In the afternoon Prof. S. J. Hickson exhibited microscopic preparations of *Dendrocometes*, demonstrating the existence of micronuclei in this suctorian, and the remarkable fusion of the macronuclei during conjugation. He advocated the employment of brazilin with iron-alum as a convenient substitute for the iron hæmatoxylin method of staining.

Dr. J. F. Gemmill described the anatomy of the head in cyclopean trout embryos. The cerebral lobes are more or less united, and the *trabeculae cranii* are fused together anteriorly, and bent down below the median eye or eyes. The infundibulum and pituitary body are entirely absent; the optic nerves are rudimentary or absent, and the eyes, though provided with retina and choroid, have no choroidal fissure. In some specimens the mouth opening is absent, and the lower jaw arch greatly shortened.

Prof. R. Burckhardt of Basel communicated two papers on some causes of brain-configuration in selachians, and on the systematic value of the brain in selachians. He showed the profound influence of the position of the eyes and other superficial organs upon the shape of the brain, and advocated the employment of cerebral characters in the classification of cartilaginous fishes.

On Saturday, the papers were of a more or less physiological character, as follows:—

Prof. Marcus Hartog: "On a peptic zymase in young embryos," in which the author announced the confirmation of his discovery in 1896 of a peptic zymase in young embryos of the frog, in the entire embryo of the chick after twenty-four hours, and in the extra-vascular blastoderm of the three days' chick. He concluded that the law holds good for animals, as well as plants, that the cell cannot directly utilise the reserves it contains, but only the products of their hydrolysis, and this hydrolysis is not a function of the living protoplasm, but of the zymases it forms. These facts also explain apparent exceptions to Herbert Spencer's law of division at the doubling of the volume. A cell that is only accumulating reserve material has no need to constantly readjust its surface to its volume. When, however, the formation of a zymase enables it to utilise its reserves, and its protoplasm grows at the expense of the products of their digestion, the need for augmented surface declares itself, and we get the repeated cell divisions so marked in the "segmentation" of the embryo.

Dr. R. Irvine: "On the mechanical and chemical changes which take place during the incubation of eggs." Hen's eggs during incubation lose weight daily, principally through the oxidation of their carbon and hydrogen, parts of which pass off as CO_2 and H_2O through the shell. The percentage of ash is increased by absorption of lime from the shell.

Prof. Gotch described some recent experiments on the physiological effect of local injury in nerve which led to the important conclusion that an electrical disturbance was not always a concomitant of the passage of a nervous impulse.

In addition to the above, Prof. Johnson Symington read papers on the articulations between occipital bone and atlas and axis in the mammalia, and observations on the development of the cetacean flipper, and exhibited a convenient hand-magnifier for demonstrating slide-preparations to lecture-classes (Erbe, Tübingen).

The reports of committees on the following subjects were also communicated:—(1) The physiological effects of peptone when introduced into the circulation (Prof. W. H. Thompson). (2) Comparative histology of the suprarenal capsules (Mr. Swale Vincent). (3) The vascular supply of secreting glands (Dr. J. L. Bunch). (4) Electrical changes in mammalian nerve (Dr. J. S. MacDonald), and (5) The comparative histology of cerebral cortex (Dr. G. Mann).

On Monday, Mr. R.T. Günther read a note on *Mnestra parasites*, Krohn, in which he submitted reasons for referring this parasitic medusa to the family Cladonemidæ (Anthomedusæ), owing to its possession of compound tentacles with clavate appendages and other cladonemid characters.

Prof. L. C. Miall reviewed the respiratory organs of aquatic insects. He contrasted the slight nature of the adaptations to aquatic life which are exhibited by adult insects with the remarkable modifications for the same end which occur in insect larvæ. He explained the difference as probably due to the fact that profound structural changes in adult insects would interfere with their powers of flight, which were of importance for mating and other purposes. Among larvæ there were two principal lines of modification, (1) specialisation of the spiracular apparatus by which air could be inspired directly from the atmosphere through the surface film of water, and (2) development of a closed tracheal system, by which air was extracted from its solution in the surrounding water. This latter series culminated in a purely vesicular system, destitute of tracheæ, and finding its nearest parallel in the air-bladder apparatus of physoclist fishes.

Mr. T. H. Taylor described the tracheal gills of *Simulium*, whose mode of respiration presented peculiar difficulties still unsolved.

Mr. J. J. Wilkinson described the pharynx of *Eristalis*, and Mr. N. Walker the structure and life-history of the gooseberry sawfly.

In the afternoon Mr. Stanley Gardiner opened with the interim report of the committee appointed to investigate the

structure, formation and growth of the coral reefs of the Indian Ocean. Special attention was given to the island of Minikoi, in the Laccadive group. It was clear from their observations that in this atoll there had been an elevation of the original reefs to a height of at least 25 feet above low tide level. All their evidence showed that the lagoons of atolls were generally formed by the solution of the central rock of originally more or less flat reefs.

Prof. R. Burckhardt followed with a paper on the anatomy and systematic position of the Læmargidæ. He recorded the discovery of luminous organs in nine species of Læmargidæ and Spinacidæ. The affinity of these families of sharks was further evidenced by his discovery of a cartilage hook in the dorsal fins of *Laemargus*.

Prof. Burckhardt also showed photographs and other illustrations of the nestling kagu (*Rhinochetus*), a rare flightless bird of New Caledonia.

Prof. R. J. Anderson described the dentition of the seal; and Mr. Graham Kerr, on behalf of Mr. G. E. H. Barrett-Hamilton, exhibited some skulls of Antarctic seals (chiefly Phocidæ) brought home by the Belgian expedition.

On Tuesday, Mr. N. Annandale exhibited a number of photographic slides illustrating the appearance and habits of some Malay insects under natural conditions. One striking series represented the pupa of a Mantis (*Hymenopus bicornis*) seated on an inflorescence of the so-called "Straits Rhododendron" (*Melastoma polyanthum*), a detailed resemblance to which is brought about by the colour and shape of the insect, and by the extraordinary attitude which it adopts upon the flower.

Prof. E. B. Poulton also showed a large number of slides, representing the collections of insects made by Mr. G. A. K. Marshall in Mashonaland and Mr. R. Shelford in Borneo, as arranged in the Oxford Museum to illustrate the general principles of Müllerian mimicry. An interesting series of mutilated butterflies caught at large showed the comparative rarity of indiscriminate injuries by birds, and the frequency with which enemies aimed at the conspicuously marked tips of the fore-wings and at the back of the hind-wings, where tail-like processes were so commonly developed, these being just the places where the bites would be least dangerous to the insects.

Other slides, illustrating mimicry and protective resemblance, were exhibited by Mr. Mark L. Sykes; and Prof. Lloyd Morgan described some recent experiments upon newly-hatched chicks, which showed that the avoidance of distasteful forms by birds is not instinctive, but the fruit of experience. Chicks fed for a time on palatable food placed on black-and-orange banded slips of glass did not hesitate to attack the distasteful caterpillars of the cinnabar moth when these were eventually offered them; whereas chicks which had been accustomed to associate the same coloured slips with bad food refused to attack the similarly striped caterpillars. These observations provided a sound experimental basis for the Müllerian theory of mimicry.

Mr. F. W. Gamble described the results of investigations made by Mr. F. W. Keeble and himself on the colour changes of various prawns, especially *Hippolyte varians*, his paper being illustrated by a series of living specimens as well as by lantern slides. The prawns adapted their colours to those of surrounding weeds; but, whatever their colour during the day, they always assumed a characteristic blue colour at night. This change, in newly-caught specimens, came on at the proper time quite independently of the darkness, and the morning phase would be resumed at daybreak, even when the animal was kept in the dark. After a few days under such unnatural conditions, however, the periodicity became altered.

A paper, by Dr. Æneas Munro, on the locust plague and its suppression concluded the business of the section.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE work in Section E at the Bradford meeting was somewhat limited in amount, but its quality was in no way below the average. In fact, the number of "popular" papers was smaller than usual, while those of a more serious character predominated. The section was excellently housed in the Church Institute, and the meeting began with a presidential address of quite a novel character. Sir George Robertson took the British Empire as his text, and laid great stress on the relative shrinkage of distances by the improvement of means of communication by land and sea, a fact which in great measure neutralised such ill effects as might arise from continuous expansion of territory.

The keynote struck by the president was geography as the science of distances, and in unison with it a series of papers dealt with problems of which distances and means of transport were the essential features. Mr. E. G. Ravenstein discussed the question of foreign and colonial surveys in a comprehensive paper, in which he pointed out the manner and extent of the official surveys of the chief countries of the world. While recognising that the British Ordnance Survey fell short of perfection, he considered that its accuracy was not equalled by the maps of any other country. He strongly urged the adoption of a more systematic method of surveying in Africa, in many parts of which the only existing maps were produced by travellers with inadequate assistance and many other things to do. In commenting on the paper, Colonel Johnston, the Director-General of the Ordnance Survey, explained the position of South Africa with regard to its surveys. He said that a nearly perfect system of triangulation had been carried out, but this has not yet been utilised by being made the foundation of a detailed survey.

Mr. B. V. Darbishire read a paper on military maps, with special reference to the use of the Ordnance Survey Maps in field manœuvres.

Colonel Sir Thomas H. Holdich discussed the question of a railway connection between Europe and India. He considered the northern approaches to India across Kashmir or the Hindu Kush from the Oxus valley to be impracticable. On the other hand there appeared to be no insurmountable difficulty in the way of a connection by the Hari-rud valley, through which approach a distance of only 500 miles intervened between the farthest outposts of the existing railways, Kushk on the Russian side and New Chaman on the Indian. The new line would pass by Kandahar. This line could, in the opinion of the author, be made to pay by local traffic, and he believed it would strengthen rather than weaken the defences of India.

Mr. C. Raymond Beazley read a paper, which was largely historical and statistical, on the Trans-Siberian railway.

Mr. G. G. Chisholm gave a very timely forecast of the probable economic changes which may be expected to result from the imminent development of the resources of China by modern methods. These would include, in his opinion:—A rise in prices in China, especially in the industrial regions; a demand for food-stuffs not likely to be supplied by China itself; a great stimulus to the food-producing regions most favourably situated for meeting this demand, more particularly Manchuria, Siberia, and western North America; and the creation of a tendency to a gradual but prolonged rise in wheat and other grain prices all the world over, reversing the process that has been going on since about 1870.

Mr. Edward Heawood treated of the commercial resources of tropical Africa, and his paper also partook of the spirit of forecast, his expectations being that Africa will greatly increase in importance by the cultivation of tropical plantations.

The travel papers which excited the most interest were those contributed by Mr. Borchgrevink on his expedition to the Antarctic regions and by Captain H. H. P. Deasy on his journeys in Central Asia. Both were illustrated by remarkably fine lantern slides. As the facts which they recounted have already been published, it is unnecessary to summarise them here.

Physical geography occupied a large part of the time of the section, and, with regard to this part of the work, it is impossible to refrain from expressing the desire that some arrangement might be come to with regard to the section in which papers lying on the borderland between different subjects should be treated. With regard to meteorology, for instance, might it not be arranged to read all climatological papers—the essential principle of which is geographical distribution—at Section E, and only the theoretical papers or those dealing with instruments and atmospheric physics at Section A?

On this occasion the report of the committee on the climate of tropical Africa, of which Mr. H. N. Dickson is secretary, was read to Section E, and a remarkable discussion of the geographical distributions of relative humidity was presented by Mr. E. G. Ravenstein to the same section. In this he said that, notwithstanding the paucity of available material, he had ventured, in 1894, to publish in Philip's "Systematic Atlas," a small chart of the world showing the distribution of humidity, and he now placed the results before this meeting with some diffidence. His charts brought out the broad features of the subject, and to reduce the sources of error

he had limited himself to indicating four grades of mean annual humidity, the upper limits of which were respectively 50 per cent. (very dry), 65 per cent., 80 per cent., and 100 per cent., (very damp). The relative humidity over the oceans might exceed 80 per cent., but in certain regions ("horse latitudes") it was certainly much less, and in a portion of the Southern Pacific it seemed not to exceed 65 per cent. One chart exhibited the Annual Range of Humidity, viz. the difference between the driest and the dampest months of the year. In Britain, as in many other parts of the world, where the moderating influence of the ocean was allowed free scope, this difference did not exceed 16 per cent., but in the interior of the continents it occasionally exceeded 45 per cent., spring or summer being exceedingly dry, whilst the winter was excessively damp, as at Yarkand, where a humidity of 30 per cent. in May contrasted strikingly with a humidity of 84 per cent. in December. This great range directed attention to the influence of temperature (and of altitude) upon the amount of relative humidity, for during temperate weather we were able to bear a great humidity with equanimity, whilst the same degree of humidity, accompanied by great heat, may prove disastrous to men and beasts. Hence, combining humidity and temperature, the author suggested mapping out the Earth according to sixteen *hygrothermal types*, as follows:—(1) Hot (temperature 73° and over) and very damp (humidity 81 per cent. or more): Batavia, Camaroons, Mombasa. (2) Hot and moderately damp (66–80 per cent.): Havana, Calcutta. (3) Hot and dry (51–65 per cent.): Bagdad, Lahore, Khartum. (4) Hot and very dry (50 per cent. or less): Disa, Wadi Halfa, Kuka. (5) Warm (temperature 58° to 72°) and very damp: Walvisch Bay, Arica. (6) Warm and moderately damp: Lisbon, Rome, Damascus, Tokyo, New Orleans. (7) Warm and dry: Cairo, Algiers, Kimberley. (8) Warm and very dry: Mexico, Teheran. (9) Cool (temperature 33° to 57°) and very damp: Greenwich, Cochabambo. (10) Cool and moderately damp: Vienna, Melbourne, Toronto, Chicago. (11) Cool and dry: Tashkent, Simla, Cheyenne. (12) Cool and very dry: Yarkand, Denver. (13) Cold (temperature 32° or less) and very damp: Ben Nevis, Sagastyr, Godthaab. (14) Cold and moderately damp: Tomsk, Pike's Peak, Polaris House. (15) Cold and dry. (16) Cold and very dry: Pamirs.

The actual mean temperature of the Earth amounted, according to his computation, to 57° F., and this isotherm, which separated types 8 and 9, also divided De Candolle's "Mikrothermes" from the plants requiring a greater amount of warmth.

Mr. Vaughan Cornish described his recent observations on snow ripples with beautiful photographic illustrations, and Prof. J. Milne gave an account of the large earthquakes recorded in 1899. Mr. R. T. Günther described the peculiar character of the coast of the Phlegræan Fields near Naples, and showed that by observations of the numerous submerged buildings of that district it might be possible to determine the date and duration of the fluctuations of the land and sea level during the last twenty centuries. The Association subsequently voted a money grant to assist him in carrying out the researches which he had suggested.

Dr. H. R. Mill exhibited and described the new insulating water-bottle designed by Profs. Pettersson and Nansen, and made by Messrs. Ericsson, for obtaining water-samples from any desired depth and bringing them up without change of temperature. The new apparatus was tested by Prof. Nansen last August on board the *Michael Sars* in the North Atlantic, and found to be completely satisfactory.

Dr. Mill also read a paper on the treatment of regional geography, in which he laid down the general principle that the fixed conditions of the land surface had first to be described, and then the mobile distributions, which were modified by the fixed forms. As an example, he dwelt at some length on the configuration of a section of the South Downs and the effect of this configuration in determining the distribution of rainfall in the district, a problem which he hoped to treat in greater detail at a future date.

Mr. J. E. Marr described the typical land form known as a moel, with special reference to the forms it assumed when dissected by sub-aërial erosion.

Two educational papers of much interest were read. One by Mr. T. G. Rooper dealt with the progress made in teaching of geography in the elementary schools of the West Riding since 1883. He illustrated it by the exhibition of a series of remarkable relief models on different scales produced by school teachers and used by them in their regular work. Some of these were of typical features, such as the Red Tarn, to typify a mountain lake, others of the actual school district taken from the Ordnance map, and others, on a small scale, of large parts of the country. The second paper was by Mr. E. R. Wethey, who gave a demonstration of his method of teaching commercial geography by the use of lantern maps, diagrams and pictures, a large number of which, in novel and striking forms, he showed upon the screen.

Educational questions have always occupied a considerable share of the time of Section E, and the committee very cordially supported the proposal to recommend the Council of the Association to form a new Section for the discussion of education in a more complete and technical manner than could be secured in a gathering of votaries of one isolated branch of science.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. E. S. Goodrich has been elected to a fellowship in natural science at Merton College.

CAMBRIDGE.—In his annual address to the Senate at the opening of the term, the Vice-Chancellor announced that the Benefactor Fund amounted to 55,000*l.*, and that the Squire Trustees had agreed to contribute 15,000*l.* towards the erection of the Law School. The plans for the Botanical and Medical Departments have been approved, and building will shortly commence; but fresh benefactions are still needed to meet the urgent demands for further accommodation.

The new Department of Agriculture, under the able guidance of Prof. Somerville, is now well started. The funds at its disposal have enabled it to secure an efficient staff, and it is provided with an excellent experimental farm. The University has sought to encourage the study by establishing a special amination in agricultural science for the B.A. degree.

Dr. L. Humphry has been appointed assessor to the Regius Professor of Physic; Sir G. G. Stokes and Prof. Darwin electors to the Isaac Newton Studentship in Physical Astronomy; and Dr. Tatham an examiner for the diploma in Public Health. Mr. Leathem (St. John's) and Mr. Grace (Peterhouse) have been appointed moderators, and Mr. Whitehead (Trinity) an examiner, for the Mathematical Tripos.

Rooms for work in clinical pathology, bacteriology, &c., have just been erected by the staff and presented as a gift to Addenbrooke's Hospital. They will be open for work, under the direction of Prof. Sims Woodhead, during the present term.

At Emmanuel College a research studentship of 100*l.* has been awarded to Mr. J. Mellanby. Grants have been made from the studentship fund of 60*l.* to Mr. G. F. Abbott, and of 40*l.* to Mr. D. G. Hall. At Queen's College the Rev. C. H. W. Johns has been elected to the office of lecturer in Assyriology.

MR. C. R. P. ANDREWS, of St. John's Training College, Battersea, has been appointed first principal of the new Government training college to be opened at Perth, Western Australia.

DR. SAMSON GEMMELL, of Anderson's College, Glasgow, has been appointed professor of clinical medicine in the University of Glasgow, in succession to Prof. McCall Anderson.

DR. CULLIS, professor of mathematics at the Hartley College, Southampton, has been appointed professor of mathematics at the Presidency College, Calcutta.

MR. J. F. HUDSON, late lecturer in mathematics at Jesus College, Oxford, has been appointed professor of mathematics at the Hartley College, Southampton.

MR. J. STUART THOMSON, formerly demonstrator of zoology at the School of Medicine of the Royal Colleges, Edinburgh, has been appointed lecturer in botany and zoology at the Municipal Science, Art and Technical Schools, Plymouth.

THE School of Engineering of Columbia University, New York, announces a new course of study dealing with the construction of automobiles, self-propelling road engines and railway cars.

PROF. GOSS has been made dean of the Engineering Schools of Purdue University, Lafayette, Ind., and Prof. L. C. Glen, of South Carolina College, has been appointed to the chair of geology in Vanderbilt University.

MR. PERCY H. FOULKES has been elected first principal of the Harper Adams College, Newport, Salop. He will enter

upon his duties on January 1, 1901, soon after which date the college will, it is expected, be ready to receive pupils.

AT a general meeting of Convocation of the University of London, held on Tuesday last, the following were elected to serve as members of the Senate under Section 12 of the statute of the reconstructed University:—Mr. John Fletcher Moulton, Dr. J. D. McClure, Sir A. Kaye Rollit, Dr. T. B. Napier, Dr. J. B. Benson, Dr. T. L. Mears, Sir H. H. Cozens-Hardy, Dr. T. Barlow, Mr. J. F. Payne, Sir Philip Magnus, Dr. S. Bryant, Dr. C. W. Kimmins, Dr. F. Clowes, Prof. Silvanus Thompson, Dr. F. S. Macaulay, and Mr. J. W. Sidebotham.

DURING the past week very many addresses have been delivered to students at the opening of the winter sessions of the various science, technical and medical schools in London and the provinces, in the course of which much excellent advice has been given. An article dealing with some of the utterances made to medical students is to be found in another part of the present issue. In this column we refer, and only very briefly, to two addresses given to students of other branches of knowledge, viz. those by Sir Alexander Binnie at the opening of the Central Technical College, on October 2, and by Prof. Le Neve Foster at the distribution of medals, prizes, &c., to the students of the Royal College of Science, on October 4. The subjects chosen for their addresses by both speakers were well suited to the occasion, and should prove of much service to the audiences who listened to them. Prof. Foster took as his topic "Common Sense," in the course of which he referred to the remark of Prof. Huxley that science was organised common sense, and the two or three years' training in science which students received at the college was, therefore, simply training in ordinary common sense. If they wished to succeed in any calling they must exercise the faculty of thought. It was difficult to realise that times were changing, but change was everywhere taking place, and they must throw aside the idea that in the production of British manufactures the methods that had come down to them from their forefathers were necessarily the best. In Lancashire it was said that what Lancashire did to-day Great Britain would do to-morrow. They might say that what the scientific man did to-day the manufacturing man would do to-morrow. The laboratory experiment of to-day was, in fact, the manufacturing process of to-morrow. But if the student desired to take an active part in the improvement of the industrial life of the country and of manufacturing processes, he must work hard and not place too much reliance on his teacher. All that the professor could do was to give the student a general ground-work upon which afterwards by his own experiments he could build up his frame-work of knowledge. Sir A. Binnie in his address contrasted the advantages which students of to-day have over those educated in the middle of the present century, and urged upon his hearers not to confine themselves merely to the curriculum of study laid before them, or to take too narrow a view or devote themselves exclusively to one particular branch of learning. The aim of the speaker was to impress upon his audience that to be a true student of science the mind must be opened out and widely cultivated by observation to grasp every detail, as it often occurs that it is among the almost unnoticed minutiæ of a particular science that those wonderful correlations that lead in the future to wide results are to be found. He spoke of the necessity of acquiring a wide and broad view of the subjects which should engage the student's attention for the reason that he felt that education could only be complete when studied as a whole, and the beauty of all the different sciences brought clearly before the mind. Further, one can never tell, when entering upon active work, into what avenues or by-paths of practice he may be led, and to illustrate this Sir A. Binnie referred to his own experience. He also urged upon his hearers to study the history of their profession, and of the various discoveries which have been made in the different branches of science to which they would apply themselves. Altogether the students are to be congratulated upon the helpful advice tendered to them.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 1.—M. Maurice Lévy in the chair.—On the absorption of free oxygen by normal urine, by M. Berthelot. Normal urine absorbs free oxygen in amounts larger than those corresponding to the solubility of oxygen in water. The acidity is not altered by the absorption.—Remarks on the acidity of urine, by M. Berthelot.—On the distribution of the horizontal component of the earth's magnetism in France, by M. E. Mathias. As the result of work spread over a period of six years in the neighbourhood of Toulouse, it was found that a very simple formula would combine the results of all the observations, namely: $\Delta H = -1'26\,(\Delta \text{ long.}) - 7'42\,(\Delta \text{ lat.})$, in which ΔH was the difference between the measurement for an element at a place X and that of the corresponding element at Toulouse. It was further found that the above formula applies to the whole of France.—On the selenides of nickel, by M. Fonzes-Diacon. Nickel leaflets heated in a current of nitrogen carrying small quantities of selenium vapour give cubical crystals of a selenide of the composition NiSe. Another selenide approximating in composition to Ni_3S_4 is obtained by heating anhydrous nickel chloride in a current of hydrogen selenide at a dull red heat. At 300° C. the diselenide $NiSe_2$ is obtained as a greyish-black, friable mass. All these products heated to a white heat in a current of hydrogen give a sub-selenide, Ni_2Se.—Oxycelluloses from cotton, flax and hemp, by M. Leo Vignon. Purified fibres of various textile material were submitted to the oxidising action of hydrochloric acid and potassium chlorate; the yield in all cases was the same, about 70 per cent.; phenylhydrazine furnished the same osazone. Small differences were observed in the reducing powers of the oxycelluloses from different sources.—On the mutability of *Œnothera Lamarckiana*, by M. Hugo de Vries. This furnishes an example of the rare phenomenon of a state of mutability in a pure species. The new species appears suddenly without preliminary or intermediate stages; the transformed individual shows all the characters of a new type, although the parents and grandparents are absolutely normal. The seeds of the transformed individuals give rise to the new type only, no tendency being observed to revert to the characters of *Œ. Lamarckiana*.—On the Eocene of Tunis and Algiers, by M. L. Pervinquière.—The ravine of Chevalleyres and the retrogression of torrents, by M. Stanislas Meunier. Attention is drawn to the mode of formation of this *col*, the size of which would appear out of all proportion to the small stream to which the ravine is undoubtedly due. The transfer of rock masses, and other effects usually ascribed to glacier action, may be traced to this torrent.—Observations of a meteor which fell on the evening of September 24, by M. Jean Mascart. The meteor, the nucleus of which was star-like and very bright, was seen at 10.16 p.m. on September 24 between Meudon and Bellevue.

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