THURSDAY, MARCH 22, 1906.

THE BANTU SPEECH OF SOUTHERNMOST AFRICA.

A Grammar of the Kafir Language. By J. McLaren, M.A. Pp. xiv+240. (London: Longmans, Green and Co., 1906.) Price 5*s*.

A FAIR-MINDED critic would start a review of this work by a general verdict of praise for its compactness and usefulness. It is an excellent grammar of the Kosa[1] language of that southernmost group of Bantu-speaking negroes known unfortunately by the most inappropriate term, the Arab word Kafir, or "Unbeliever." The group of Bantu peoples who inhabit the coastlands of the southern extremity of Africa, between the Transkei River in Cape Colony and Inhambane in the Portuguese Province of Moçambique, had better be styled generically "Zulu" rather than "Kafir" or "Kafir-Zulu."

The name Kafir (which, if it is still to be used, had better be spelt as in Arabic with the single "f") is derived from the Dutch Caffer and the Portuguese Cafre, and these again from the language of the Swahili Arabs whom the Portuguese encountered as the masters and traders of South-eastern Africa in the beginning of the sixteenth century. These Arabs, who radiated from Zanzibar northwards and southwards, called all the negroes south of the Zambezi delta "Kafir" in the singular and "Kufar" in the plural, and by this name they spoke of them to the Portuguese, who at first made use of the Zanzibar Arabs as pilots and guides along the eastern coast of Africa. The Cape Dutch borrowed the term from the Portuguese, and so passed it on to the English.

The great Zulu race at the present day is divided into three main branches so far as language or dialect is concerned—the *Ronga* or *Tonga* section of South-east Africa (including the Abagaza), between Amatongaland and Sofala; the *Zulus* of Zululand, with their outlying colonies and offshoots in Swaziland, Matabeleland, and across the Zambezi (through British Central Africa to German East Africa); and the *Kosa* Kafirs of Western Natal, Pondoland, and the Transkei territories of Cape Colony. The difference between the Zulu and Kosa dialects is much less than between Zulu and Shi-ronga. Naturally, the Zulu speech that has been dropped down here and there in little colonies in East-Central Africa north of the Zambezi is already departing widely from the Zulu in Zululand, owing to intermarriage with local races.

The original place of origin in Central Africa of the Zulu-Kafir peoples and dialects is still an unsolved mystery; their nearest relations at the present day in vocabulary and grammar (though not in phonology) are the great Basuto group of Central South Africa and the Damara (Ova-herero) of South-west Africa. There is not that marked relationship with the existing tongues in Central Zambezia which one would expect to find, though, of course, as these are equally "Bantu" in form and construction they offer a good deal of resemblance to Zulu, but not more so than is shown by the other Bantu languages of East Africa. Here and there in the dialects of Lake Nyasa and even of the tongues of inner East Africa there are hints of resemblances to the Zulu group in vocabulary. At the same time, many of the peculiar features in vocabulary and grammar of the Zulu language and its kindred dialects are only to be met with elsewhere in the Se-suto forms of speech, and perhaps in the Ochi-herero. The Zulu-Kafir language group offers some archaic features in the form of its prefixes and of certain word-roots. But it is *not* the "Sanskrit of the Bantu," nor nearly so archaic as the languages round Tanganyika and the Victoria Nyanza.

One of the most marked peculiarities of Zulu and Kosa Kafir is the possession of three "clicks." The Shi-ronga dialects of South-east Africa, though closely related to Zulu in vocabulary and grammatical structure, do not possess these clicks, and no trace of them is met with in Se-suto or Ochi-herero, or indeed in any other Bantu language. The general assumption is that the clicks have been borrowed from the Hottentots, and, of course, in the case of the Kosa Kafirs this is conceivable, as for centuries they have bordered on the Hottentot domain. Yet it is rather extraordinary that the Basuto peoples, who in history certainly preceded the Kafir-Zulu in the invasion of South Africa, and who, as may be seen by their physical appearance, have anciently inter-bred with the Hottentots, should not have borrowed any click from Hottentot or Bushman. Likewise the Ova-herero and their allies have been in close contact with Hottentot peoples in South-west Africa without catching the infection of the click. Miss A. Werner, one of the few serious students in Great Britain of Bantu languages, has written several articles on this subject, without, however, arriving at a definite conclusion as to whether the Zulu-Kafir clicks are borrowed from Hottentots or are independent developments of the language, recently acquired *in situ*. The author of the work under review seems to suggest that the three Zulu-Kafir clicks may be explosive pronunciations of the gutturals. If so, they might have developed separately without Hottentot influence.

It is a pity in the work before us that the author has not had the courage to quit South African provincialism and aim at bringing his grammar into accord with the approved classification of the Bantu languages, and a system of spelling, such as that of Lepsius, which is both scientific and logical. A strong man should come forward, and, by his influence, compel all philologists, the whole world over, to adopt the Lepsius alphabet (with two or three trifling changes) as the standard which all persons must adopt in transcribing the languages of the world not already and anciently expressed in Roman letters; nay, more, it is to be hoped one day that all the civilised tongues of the world—English, French, German, Russian, Greek, Arabic, and every other speech with a literature—may be written down in one form of lettering, and according to one standard—perhaps the Lepsius—of expressing sounds by letters.

Meantime, some uniformity of transliteration might

[1] It is more convenient to write this word, which begins with a lateral click [=//osa], with a K. It is usually spelt Xosa in South Africa.

well be enforced in Africa. As it is, there is one method adopted in the Western Congo, another in South Africa, a third in East Africa, and a fourth in West Africa and the Sudan. Mr. McLaren, in the Kafir grammar under review, adopts the South African standard; the three clicks which Lepsius expresses by /, !, and // are rendered (as they have been for half a century) by *c*, *q*, and *x*.

Now throughout Eastern Africa, *c* or *ch* is used to express the palatal consonantal combination of *tʂ* which in South Africa and many West African missionary grammars is rendered by *tsh*; *q* is universally used in North, North Central, and Western Africa (besides by Lepsius) to transliterate the Arabic ق—*qof*, a very explosive *k*, the old meaning of the Mediterranean *q*. *X* is used by the Congo missionaries (following the Portuguese) as an equivalent for the English *sh* (*ʂ*), and by others as a convenient form of the Greek χ to express the strong guttural *kh* (Scotch and German *ch*). On the other hand, *kh*, *sh*, and *zh* in transliterations into Roman letters of Hindustani and Arabic names are intended to be pronounced literally like an aspirated *k*, *s*, and *z*. It is therefore necessary for a logical orthography to adopt *c*, *q*, and *x* for the purposes above mentioned, namely, to represent the English *ch*, the Arabic ق and the Greek χ. Therefore it would be preferable to render the South African clicks by other signs, such as those proposed by Lepsius.

For the practical purposes of those who wish to acquire the Kafir language or arrive quickly at an understanding of its main features, Mr. McLaren's grammar may be very highly commended.

H. H. JOHNSTON.

MINING LAW.

Mining Law of the British Empire. By Charles J. Alford. Pp. xii+300. (London: Charles Griffin and Co., Ltd., 1906.) Price 8*s*. 6*d*. net.

ALTHOUGH admirable treatises on mining law for the guidance of lawyers have been written by Rogers, Walmesley, McSwinney, Bainbridge, Cockburn, and numerous foreign authors, the field has by no means been exhausted; and Mr. Alford's work forms a welcome addition to technical literature. Written with conspicuous literary skill by a mining engineer of wide experience, it gives a concise summary of the various codes of mining law of the British possessions throughout the world, with well considered remarks on their characteristics. The term mining law is taken by the author to mean the enactments that regulate the acquisition and tenure of mining rights. Mining regulations, which control the methods of working mines, receive merely incidental mention. In the case of Great Britain, it is true, the Mines Regulation Acts are quoted at some length as models; but even in this case no reference is made to the Amendment Act of 1903 or to the numerous special statutes, of which fourteen are cited in Sir C. Le Neve Foster's "Ore and Stone Mining," that affect miners and workers in open pits in this country. Indeed, Mr. Alford's chapter on the mining law of Great Britain is the least striking in the book. Mining in Great Britain is so largely a matter of contract between lord and lessee, and so largely concerned with non-metallic minerals, that there is little scope for the comparative treatment of the metal-mining rights and obligations that forms so interesting a feature of the chapters dealing with colonial laws.

The historical study of the inception of mining law receives, as is to be expected in a book of a purely practical character, only brief mention, and the author has refrained from the temptation of citing the ancient statutes set forth in that delightful old work on mining law, the "Fodinæ Regales" of Sir John Pettus, Knight (1670). Originally, the author tells us, the minerals of the country were worked by slaves or serfs for the benefit of the lords of the soil; and Mr. Alford would have added to the interest of his note on the free miners had he mentioned the fact that the last native-born Briton who was a slave in Great Britain died in the reign of Queen Victoria. When the Queen ascended the throne, many men and women were still living who had in their youth borne a legal bondage in the collieries of Scotland. Such miners received wages, but were not allowed to move away from their master's estate. They were bought and sold with the property; and although they were freed from their servitude by an Act passed in 1799, the slave taint stuck to their occupation for many years.

Mr. Alford divides his work into nineteen chapters, dealing respectively with the principles of mining law, and with the mining laws of Great Britain, British India, Ceylon, Burma, the Malay Peninsula, British North Borneo, Egypt (should not a word of explanation have been given that Egypt is not a part of the British Empire?), Cyprus, the Dominion of Canada, British Guiana, the Gold Coast, Cape Colony, Natal, the Orange River Colony, the Transvaal Colony, Rhodesia, the Commonwealth of Australia, and New Zealand. An analysis of the mining laws cited shows a grouping of the principles of their construction into two classes:—(1) that in which the State or a private owner of mining property has the right to grant concessions or leases; and (2) that in which any individual, under specified restrictions, has the right to locate a certain limited area of ground or claim and to work or to dispose of it. It is surprising to learn that five-sixths of all the mining areas of the world are worked under the former system of titles. The concession system of large prospecting areas, followed by mining leases of limited areas, of which the present mining law of Egypt is an example, appears to be the most advantageous system of opening up an unexplored country.

As an authoritative statement of the conditions of tenure of mining property under various laws, Mr. Alford's book cannot fail to prove of great value to all connected with mining in the colonies. The work is most carefully and accurately done. There are, however, a few slight omissions; and in order to make the survey of the mining law of the British Empire complete, the author might with advantage

add, when a new edition is called for, a few particulars of the mining law of Newfoundland, the oldest British colony, where copper and iron-ore mining are actively carried on; of the West Indies, where, in Trinidad and Barbados, asphalt mining is of some importance; of British New Guinea, where gold mines are worked; and of Nigeria, where some tin ore is raised. BENNETT H. BROUGH.

ORGANIC CHEMISTRY APPLIED TO PHYSIOLOGY.

Outlines of Physiological Chemistry. By Dr. S. P. Beebe and Prof. B. H. Buxton. Pp. vii+195. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1904.) Price 6*s.* 6*d.* net.

THE book deals chiefly with the theoretical side of organic chemistry as applied to physiology. The first chapter, of twenty-one pages, contains an account of the following matters:—dissociation in solution, nomenclature of acids, chemical equilibrium, catalysis, colloids and crystalloids, colloidal solutions of metals, aggregation, suspension and precipitation, oxidation and reduction, osmotic pressure, calculations of a formula, reasons why reactions take place, graphic formulæ, and ultimate analysis.

It need scarcely be added that the space is entirely inadequate to treat of such a heterogeneous collection of chemical problems, even were it profitable to put them in such juxtaposition. The student who has made any study of general chemistry does not need the chapter, and one who has not will scarcely be able to grasp it in the condensed and jumbled form in which it is here presented to him for the first time.

It would hence have been no loss if the book had commenced with the elementary organic chemistry of chapter ii., so as to leave all the space for this, which is the proper introduction to the subject of the book.

A description of the groups of organic compounds most interesting to the physiological chemist is given in chapters ii. to v., of the proteid molecule, its component parts and disintegration products in chapter vi., of enzymes in chapter vii., and an outline of the antitoxin theory, &c., under the title of "Disease and Immunity," forms chapter viii. and concludes the volume.

This latter part of the book is on the whole well and clearly written, but it might be made much more interesting by the authors breaking, even more frequently than they do, their intention of saying nothing about practical work. A description of organic compounds and their relationships, without any statement of what experiments the knowledge of these relationships is based upon, forms only dry and unprofitable reading. For example, it would be much better if the reader were told how the purin bases, or hexone bases, are separated, and would not have taken up a vast amount of space. Without some such instruction, these bodies are only uninteresting names which weary the reader.

The style of the authors is also such as may encourage a too-realistic belief in the mind of the junior chemist in the graphic formulæ which form the organic chemist's rosary. Thus at the opening of chapter v. there occurs the statement, "The chains of C atoms have a tendency to curl over and join at the two ends, forming in this way a closed chain." At another passage in the volume one reads of "the excretion of benzene rings." The account of the chemistry of the proteid molecule is very clear and well arranged, and this portion of the book may be recommended to the physiological chemist interested in the organic chemistry of proteids.

BENJAMIN MOORE.

OUR BOOK SHELF.

Lectures on the Theory of Functions of Real Variables. Vol. i. By J. Pierpont. Pp. xii+560. (London and Boston: Ginn and Co., n.d.) Price 20*s.* net.

THIS is emphatically a text-book, deductive in method and Euclidean in arrangement; as such, it has the defects of its qualities, but its merits are undeniable. In this volume the author deals with the elementary notions of rational and irrational number, point aggregates, function, continuity, differentiation and integration. The subject last mentioned occupies pp. 333–560, so that conditions of integrability, change of order of integration, upper and lower integrals, &c., receive a proper amount of attention. It should be noted, too, that although it is confessedly incomplete, the discussion of maxima and minima of functions of two or more variables is satisfactory as far as it goes, a most unusual circumstance as things are at present. Perhaps the most valuable feature of novelty is that the author occasionally criticises arguments once thought sufficient, but now known to be fallacious, illustrating by examples the way in which the defective proofs break down. This is an excellent way of making a student feel the necessity of mastering the more refined methods of recent analysis. There is one point in which the author has not quite done justice to his authorities. After explaining Cantor's theory of irrational numbers, he gives a brief sketch of Dedekind's method of partitions, but he does not give this in its genuine form. The essence of a partition is that it divides all *rational* numbers (with the possible exception of one) into two classes, each element of one class being less than each of the other. After this definition it is proved that the aggregate of partitions is continuous. Prof. Pierpont (p. 82) defines a partition as dividing *all* real numbers into two classes; this enables him to use Dedekind's notation, when convenient, but it does not give a just idea of Dedekind's theory, and this is a pity. For bibliographical details the reader is referred to the "Encyclopädie der mathematischen Wissenschaften"; this is all very well for those who have access to that work, but in the interests of the student it would be well to give a list of the most important original sources. It ought to be said that in his preface the author acknowledges his special obligation to Jordan, Stolz, and Vallée-Poussin; at the same time it is evident that he has made use of this and other material in an independent way.

Sound and Rhythm. By W. Edmunds. Pp. xii+96; and Box of Models of the Human Ear. (London: Baillière, Tindall and Cox, 1906.) Price 2*s.* 6*d.* net.

THIS is an admirable little book. The elements of physiological acoustics are described with remarkable lucidity and accuracy, and there is a wealth of illustra-

tion both in the text and in the diagrams. There are chapters on the nature of sound, waves of sound, musical scales, organ pipes, "time" and movement, the ear, and the voice. Nothing could be happier than the exquisite drawings by Miss Martin Mohun showing an ideal couple—a boy and girl—waltzing and drawing sound curves on the seashore. Mr. Lapidge's diagrams are also excellent. To assist the teacher six models, made by Mr. Lapidge, may be obtained for the illustration of the book for one guinea. These models show the structure of the middle ear and the chain of bones. They are accurate in all anatomical details. The box also contains a nightingale pipe, which is in miniature an adjustable stopped organ-pipe. Mr. Edmunds has succeeded in showing how science may be made interesting to young people. There is a constant appeal to observation and experiment, and the whole subject is treated in such a way as to promote the healthy development of the mental faculties in early life. JOHN G. MCKENDRICK.

Historical and Modern Atlas of the British Empire, specially prepared for Students. By C. Grant Robertson and J. G. Bartholomew. Sixty-four plates. (London: Methuen and Co., 1905.) Price 4*s.* 6*d.* net.

Philips' Model Atlas. Fifty Maps and Diagrams in Colour. (London: George Philip and Son, Ltd. n.d.) Price 6*d.* net.

THE first of these atlases is full of material designed to show students and teachers how intimately the studies of geography and history are related. The excellently executed plates serve as graphic object-lessons demonstrating the interdependence of cause and effect, and are skilfully conceived with a view to impress various important lessons pictorially. The atlas may be commended to the careful attention of both teachers of geography and history.

The sixpenny atlas of Messrs. Philip gives great prominence to photographic relief maps of the countries dealt with, and these plates will prove of great assistance in enabling young pupils to form mental pictures of the distribution of highlands and lowlands in the countries they are studying, thus providing them with a means to understand the direction of flow of rivers, the distribution of rainfall, and other important geographical features. This wonderfully cheap atlas deserves to be used widely in junior classes.

Natural Science in Hygiene, or the Life-History of the Non-Bacterial Parasites affecting Man. By Dr. James Rodger Watson. Pp. vi+62. (Bristol: John Wright and Co.; London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd., 1905.) Price 1*s.* 6*d.* net.

IT is stated in the preface that this little book is intended to place before the student of public health, in a convenient and realistic way, the life-histories of those members of the vegetable and animal kingdoms which by their mode of life are of importance from a public health point of view, and with which he is expected to make himself familiar.

If by "student of public health" is meant the medical man who is going to devote his life to public health, the details given, though on the whole fairly accurate and up to date, are far too meagre and inadequate to be of much service, but the diagrams of life-cycles of the parasites discussed may serve to impress the facts on the memory. The book seems to be more suited to the requirements of the sanitary or meat inspector or health visitor than of the student of hygiene. R. T. HEWLETT.

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.*]

A Plea for Absolute Motion.

THE title of Prof. Schuster's letter is somewhat wider than its contents. The writer does not discuss whether the term "absolute motion" is significant, but only whether, assuming that the words have a definite meaning, the absolute motion of any body can be determined by physical inquiry. By implication he has himself answered the question in the negative, for at the critical stage of his discussion he introduces arguments which are not physical, but philosophical.

Prof. Schuster asks, "Does it require explanation that all star groups have the same velocity vector imposed upon them?" Certainly; it requires explanation no more and no less than any other distribution of velocities. It is highly desirable that the equations of the proper motions of the stars should be established and their past history traced until the physical circumstance that determined those motions is discovered. But this circumstance need not be a body at absolute rest. In the analogy which Prof. Schuster gives, the inhabitant of a gaseous molecule would be quite wrong if he decided that the rest of the containing vessel was absolute. Accordingly, Prof. Schuster has recourse to philosophical arguments. We have determined, he says, the velocity relative to a material body which does not come within the range of our observations. I should have thought that the mere fact that we had determined a velocity relative to it proved that it had come within the range of our observations; the deduction from the motion of some of the stars of the existence of dark satellites near them seems an analogous case; and since, he continues, this conclusion is absurd, the body must be replaced by something immaterial. Why is it less absurd to determine a velocity relative to an unknown immaterial than to an unknown material substance? Finally, since the something is immaterial, it cannot be in motion, and therefore it must be at absolute rest. The term immaterial may have many meanings; but I should have thought that an immateriality which precluded a substance from being in motion also precluded it from being at rest. A thought, for example, is incapable of motion, but it is equally incapable of rest; any application to it of the terms motion or rest is not true or false, but simply meaningless.

It may also be pointed out that if the "something at rest" is immaterial, the analogy breaks down. The distribution of the velocities of molecules in a gas depends on the collisions with the walls; but a star cannot collide with an immaterial boundary.

Prof. Schuster says that the attempt to make all motion relative to the æther is inconsistent. With all respect, I do not think he sees the point. The reasons for our preference of the Copernican to the Ptolemaic hypothesis are two-fold. The first reason is that the equations of motion of the solar system are simpler on the former theory. The second reason is precisely that which made the theologians object to the Copernican hypothesis; it points out that it is the sun, and not the earth, which holds a unique place in the solar system; this is a question of scientific taste. There are the same reasons for referring all motions to axes fixed in the æther—if we could determine them. Firstly, an attempt is being made to reduce all laws to electrodynamic laws, and these are simplest on the basis of a fixed æther. Secondly, the æther holds such a unique place in the physical universe that it is desirable to direct attention to the fact. The question of the "absolute motion of the æther"—if any—cannot come within the range of physical discussion any more than the "absolute motion of the sun" can come within the range of any discussion based on the properties of the solar system.

I should like to add a few remarks on the subject of "absolute rotation." "Rotation," it seems to me, like

"expansion" or "shear," is not the name of a distinct kind of motion—it is only a term introduced to abbreviate the discussion of a particular and important case of the relative translation of the particles of a body. Direct kinematical statements can only be made concerning particles of infinitesimal volume; such particles can only have translation, they cannot rotate. When bodies of finite volume are considered, they are analysed into particles the motions of which are then investigated. If there is no relative translation between the particles the motion is said to be pure translation; if there is relative translation the motion is said to be partly, or wholly, rotational. It is the characteristic of rotation that two particles situated on a straight line through the "axis of rotation" possess a relative acceleration along that line, and it is by the existence of these accelerations that absolute rotation is detected. If we can find a line such that any two particles situated on a line intersecting it are subject to relative accelerations along the latter, the body is said to rotate. It would be impossible for any observer on a rigid body to detect its rotation, for the relative accelerations of its particles could not be observed. If Foucault's pendulum were rigidly attached to the earth, or if the water in Newton's bucket were frozen, no observers on the earth or the bucket having cognisance of these bodies only could detect the "absolute rotation." In fact, the absolute rotation of bodies of finite volume is only a special case of the relative translation of particles.

NORMAN R. CAMPBELL.

Trinity College, Cambridge, March 18.

Interpretation of Meteorological Records.

THE series of curves given by Messrs. Lander and Smith's instruments, and published in NATURE of March 15, are most interesting, and one cannot help looking for the cause of the close relation between the movements of all the five instruments. It is with the view of offering an explanation of the sympathy between these instruments that the following lines are written. If I might venture to suggest a first cause of these movements, I would say it was the thunderstorm that drew the trigger which started all of them. The thunderstorm gave rise to a heavy fall of rain—a quarter of an inch in a few minutes—and this rainfall appears to have been the cause of the movement of all the instruments, and instead of being placed last in the series should have been put first. The effect of a heavy local fall of rain is to cause a down rush of air, the air being dragged downwards by the falling rain. This downward moving mass of air checks the wind, because its movement is at right-angles to the wind, hence the drop in the wind-velocity curve. The wind not being able to pursue its course gets deflected—in this case the curve shows it was to the north-west. The down rush of air where it meets the surface of the earth has its velocity reduced and direction of movement changed; its pressure is therefore increased, and the barograph shows that the pressure increased by the tenth of an inch. The downward rush of air would bring the air from the upper strata to the surface of the earth, and as this upper air would be in all probability the colder, it would cause a fall in the temperature, which the thermograph shows amounted to twelve degrees.

On one occasion I had an opportunity of seeing this downward movement of air produced by local rain. It was while making some meteorological observations on the top of the Eiffel Tower, in Paris. At first the weather was fine, and the dust-counter showed that the impure city air came to that height in great quantities. After a time a heavy shower came on which reduced the number of particles in the air, and at last the air became as free from dust as any air I have ever tested on the mountain tops of Switzerland. This increase in purity could only be due to the rain dragging down the upper purer air to the level of the top of the tower, as rain cannot wash the air to anything like that purity.

If the time scale of the curves in the instruments had been a good deal wider, and all the clocks going together, one could have found out whether the above explanation was correct or not, as we would expect the rainfall curve to begin first and all the others to follow, but from the closeness of the time scale of the curves no satisfactory information on this point can be obtained.

Ardenlea, Falkirk, N.B. JOHN AITKEN.

Agricultural Education and Colonial Development.

IN your issue of January 11 reference is made to the requirement which has recently arisen for specialists in agriculture and the allied sciences for employment in the British colonies and dependencies. The case, so far as India is concerned, may be stated very briefly. The Government is willing to spend money in the development of agricultural education and research, but the efficient recruitment of the department—or, more properly, departments, for there are eight local governments in India and Burma, each of which will have its own separate agricultural department—is not an easy matter. The educated native of India has not hitherto devoted the interest to the study of agriculture that he has to law and medicine, and men qualified to give instruction or conduct investigations in relation to this national industry are not to be found in the country. It is quite unnecessary to raise the question as to whether they will be obtainable in the future. This is one of the great desires of the Indian Government. In the meantime, however, men qualified to fill the offices above indicated are required, and a search has to be made elsewhere. In this respect, then, India appears to be drawing upon the same market as other countries.

In my view, the description of man that is required is one possessing a thorough knowledge of *principles*. The conditions of tropical agriculture are so very different from those of the British Isles that it is highly desirable for the Britisher to commence work in other continents with as open a mind as possible. I am not thinking so much of the agriculturist as of the botanist, entomologist, or chemist. Just as the chemist who has made himself master of pure chemistry makes eventually the best technical chemist, and finds it, indeed, easier to apply himself to any special technology than the so-called technical chemist, so, likewise, for agriculture in foreign countries, the men who will be most useful in the future will be those who have obtained a thorough knowledge of their particular science at college without any special reference to British agriculture. J. WALTER LEATHER.

Agricultural Research Institute, Pusa, Bengal, February 28.

Peculiar Ice Formation.

IN reply to Mr. James Foulds's inquiry in NATURE (March 15, p. 464) whether the prismatic forms of ice such as he has recently observed in Lancashire have been observed elsewhere, it may suffice to refer him to previous volumes of NATURE, more particularly to vols. xxxi. and xlvii., for letters from Messrs. Woodd-Smyth and McGee, also from myself. In the latter volume is an account by me of a more extended series of observations on these "crystallites" than previous observers appear to have made. Friability of soils is due to interstitial water.

Bishop's Stortford, March 16. A. IRVING.

I OBSERVED the same formation as that described by Mr. Foulds (p. 464) on bare soil, previously soaked with water, near Champéry, in Switzerland, as winter frosts began; and I believe that I have observed it everywhere as a common phenomenon.

I take it that the wet surface is first frozen, and that, as the cold penetrates, the ice exudes from the soil much as lanoline exudes from a lanoline tube, the water expanding as it freezes, and so forcing its way out between the more compact masses of soil, lifting the frozen surface-sheet.

The first touch of sun caused the structure to break up.

It struck me at the time that this was the cause of the injurious effect of frost on the surface of roads considered from the cyclist's point of view. W. LARDEN.

Devonport, March 16.

AMERICAN OBSERVATIONS OF THE TOTAL SOLAR ECLIPSES OF 1900 AND 1901.[1]

IN the year 1900 the moon's shadow swept across the southern portion of the United States of America, travelling from New Orleans, through Georgia, South and North Carolina, and leaving this continent at Cape Henry, in Chesapeake Bay. After traversing the Atlantic Ocean the shadow crossed Spain, and cut the African coast at Algiers.

The large strip of country in America over which the shadow passed drew a great number of American observers to this region, and in a volume which has quite recently been published we have a detailed account of the observations and photographs.

For the main part, this valuable addition to eclipse literature deals with the observations made by the Naval Observatory, which equipped two stations on the central line, one in North Carolina and the other in Georgia, the intention being to duplicate the work in order to minimise the danger of unfavourable weather. Since, however, a large number of other parties with varied equipments was scattered along the line of totality, the reports of several of these have been included in a separate section of this volume.

The stations fixed upon by the Naval Observatory's parties were two in the State of Georgia, namely, Barnesville and Griffin, and one in North Carolina, Pinehurst being the location selected. The reason why two stations were chosen in the former State was because it was desirable to concentrate the spectroscopic attack on the chromosphere near the end of the shadow track, Griffin being the region where the lower strata of the sun's atmosphere during totality were exposed longer to view. Griffin was twenty miles distant from Barnesville. Prof. Updegraff was placed in charge of the Georgia stations, while Prof. Skinner superintended the work at Pinehurst.

Fortunately the weather was very favourable at all the stations, so that the results here brought together are numerous and very complete. First, as regards the instrumental equipment at each of the stations. Space does not permit reference to the instruments in anything like detail, but the reader will find in the volume all the information clearly set out. The general scope of the work undertaken will, nevertheless, be gathered from the following brief summary concerning the chief instruments employed.

Barnesville.—This station was chiefly used for photographing the corona. The largest instrument employed there was an object-glass of 4-inch aperture and 40-feet focal length, the tube being pointed directly at the sun at eclipse time. The image formed was 4·36 inches in diameter.

Another instrument consisted of a battery of cameras mounted on a wooden polar axis 11 feet long and moved by a clepsydra. The cameras erected on this were as follows:—three lenses of 6-inch aperture having focal lengths of 104, 80, and 33 inches; a 4-inch Dallmeyer lens of 17-inch focal length; and a 3·5-inch Dallmeyer of 9·5-inch focal length.

In addition, there were two 5-inch equatorials for visual observations and a prism-spectrograph.

Griffin.—At this station the attack was made from the spectroscopic point of view. Here were located a 10-feet concave Rowland grating worked in conjunction with a 3·5-inch quartz lens and a cœlostat; the plates used were placed in curved backs, and the first-order spectrum was employed. There was also a large Rowland concave grating of 21·5-feet radius, worked also in connection with a quartz lens and cœlostat, but mounted after the method of Rowland. This was employed chiefly for the ultra-violet in the second-order spectrum.

Pinehurst.—Here was erected a 5-inch 40-feet coronagraph pointed directly at the eclipsed sun. Worked in connection with three independent cœlostats were:—a plane grating objective spectrograph with ruled surface 3·5 × 5 inches (15,000 lines to an inch); a concave (10-feet) grating slit spectrograph similar in ruling and size to the plane one; and a 4-inch prismatic camera with one flint glass prism of 60°.

As at Barnesville, a large polar axis was here erected to carry several cameras, and two Dallmeyer lenses of 38-inch focal length and a Voigtländer lens were mounted on it. Three equatorials for visual observations and a transit instrument completed the equipment.

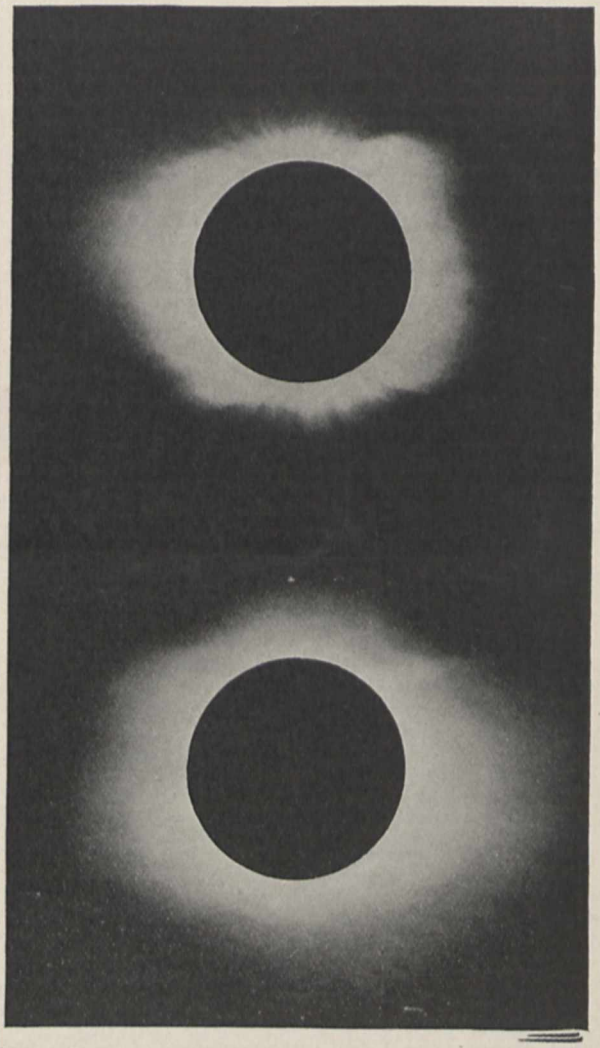

FIG. 1.—The coronas of 1900 (upper) and 1901 (lower) as photographed by the U.S. Naval Observatory parties. (The north-point of the sun is at top of each.)

In the volume before us the results obtained with each of the several instruments are individually discussed, and on the whole they have turned out very satisfactory. Further, the volume is illustrated, not only by a series of excellent reproductions from photographs of the camps and the instruments *in situ*, but of the forms of the corona and the chromospheric

[1] "Publications of the U.S. Naval Observatory." Second Series, vol. vi., appendix i. By Rear-Admiral Colby M. Chester, U.S.N., Superintendent. Washington, 1905.)

spectrum. All these will be of great interest to other observers of the same eclipse, as comparison of results is of great importance in the interest of future eclipse work.

It would lead one too far, and, indeed, it is not necessary, to enter into the very complete treatment here published of the various branches of work so well brought together, but perhaps a word or two may be mentioned with regard to some expectations that were not so successfully realised as was hoped.

In the case of the 10-feet concave grating erected at Griffin, the plates turned out to be very much under-exposed. In explanation of this, Prof. Crew not only summarises the possible causes of failure, but adds some useful suggestions for use on future occasions. In the case of the former he mentions seven possible causes, the first being that the intensity of radiation of the eclipsed sun was underestimated, and consequently only the very brightest lines of the chromospheric spectrum were recorded. The second was that the effect of astigmatism in the curved grating was underestimated.

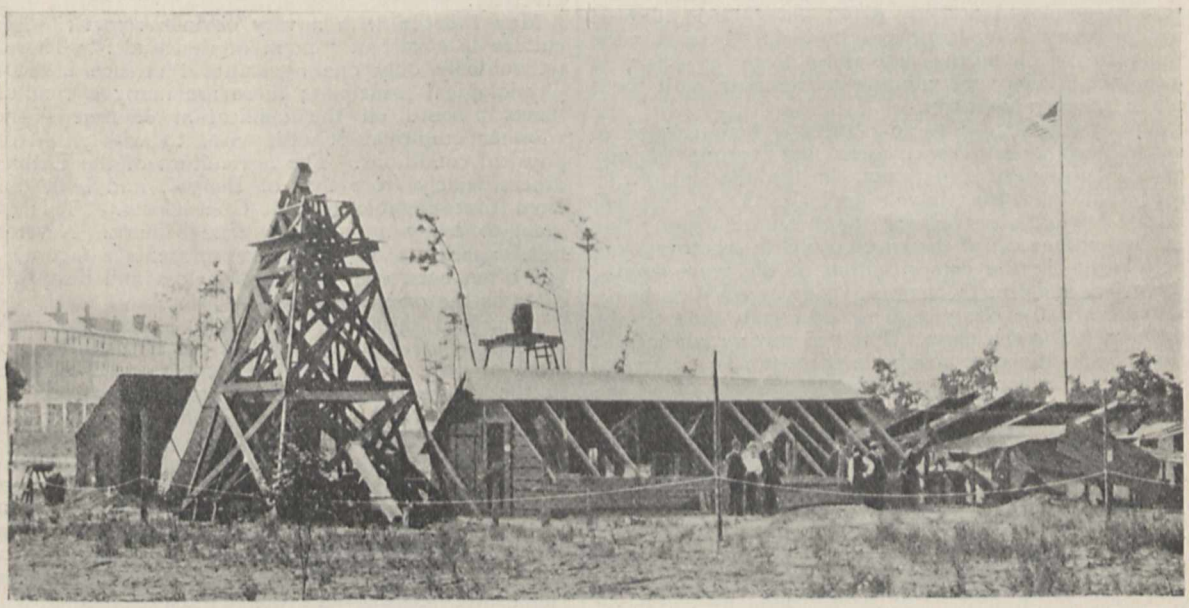

FIG. 2.—The U.S. Naval Observatory Eclipse Station at Pinehurst, North Carolina. The 40-foot Coronagraph is on the left.

A third reason was that an exposure of two plates instead of one during totality was more than was justified by the dispersion and slit width.

In Mr. Humphrey's report relative to the 21.5-feet Rowland grating at Griffin, a very dissatisfied tone is pronounced with regard to the instrument's efficiency. He finally states :—"It does not seem probable, however, that a grating mounted according to the Rowland method and used with a slit can, even under the most favourable circumstances, yield nearly as many flash lines as may be obtained with a prism or a concave grating used *directly without lens or slit*. . . . It would be well in using a spectrograph of this kind to avoid the chromatic aberration of lenses entirely and to form the image on the slit by means of suitable reflectors. It might also be best to use silver reflectors and to avoid that part of the ultra-violet of wave-length shorter than λ 3600. Direct grating or prism spectrographs should be used, if possible without reflectors of any kind, but when a reflector is used it should consist of magnalium for the ultra-violet and of silver for light of longer wave-lengths."

With regard to the plane grating spectrograph used at Pinehurst, Mr. Jewell states that the definition of the lines was good from wave-length 3850 to 4100, and "remarkably fine near the H and K lines." The definition between 3750 and 3850, and from 4100 to 4200, is described as "fair," but "very poor" at wave-lengths less than 3700 and greater than 4200. A complete and long table of wave-lengths of the chromospheric lines measured is given in the report.

The coronal lines observed were six in number, the mean wave-lengths of which were as follows :—3382.4, 3453.3, 3644.0, 3801.8, 3987.5, and 5304.1. The objective prism spectrograph at the same station also secured chromospheric and coronal spectra, and although a long list of the wave-lengths of the lines is published, great weight cannot be given to their accuracy, since the definition on the negative is described as "poor over the whole spectrogram and particularly poor for the violet end."

Although no word has yet been said about other branches of work taken up, the reader must be referred to the volume itself for the numerous reports on them. We reproduce in Fig. 1 (upper part) a picture of the corona as photographed with the 40-feet camera at Barnesville, the exposure of which lasted thirty-five seconds. It will be seen that it illustrates well the "wind-vane" form typical at epochs of sun-spot minimum. The lower part of this illustration shows the corona of 1901, taken also with the 40-feet instrument. Fig. 2 shows a general view of the station selected at Pinehurst, the method of supporting the 40-feet coronagraph, and the houses for the other instruments erected there.

The second portion of this important volume deals with the observations made during the solar eclipse in Sumatra in May, 1901, the stations selected being Solok, Fort de Kock, and Sawah Loento. At the first station clouds reigned supreme during totality, but the chromosphere was photographed at third contact through clouds. At the second station the weather is described as "perfect," while the observers

at the third station only managed to obtain some results at third contact, the weather being very unfavourable.

At Fort de Kock, in addition to some beautiful corona pictures (one of which is here reproduced for comparison in Fig. 1) taken with the 40-feet coronagraph, used horizontally in this eclipse, photographs were secured with the 30-feet concave grating. In the latter, films were used in consequence of the sharp curve in the focal plane of the grating, but, as the report says, "each film showed that, unfortunately, it had not been placed exactly in focus, still the dispersion was so great that many of the lines could be very easily identified." A table is given showing the results obtained from the measures of these negatives, the spectrum covering λ 3118·5 to λ 5204·7; intensities, character, and wave-lengths from Rowland's tables are also included.

At Sawah Loento the plane grating proved a success, parallel rays falling on its surface and being brought to a focus on the photographic plate by means of a lens placed between the grating and the plate. In spite of clouds, the negative taken at third contact is said to have been fully exposed. The large dispersion employed and the definition obtained allowed very accurate wave-lengths to be deduced, so that the table of wave-lengths extending from λ 3835·2 to λ 4957·8 will be very valuable to compare with those made by other observers.

The discussion of these results is here carried to some length, but space does not permit of any extensive reference. It may, in the first place, be said that both Mr. Jewell and Dr. S. A. Mitchell record having observed the magnesium (λ 4481) line in the photograph of the chromospheric spectrum, and both agree in the determination of the wave-length, intensity, and length of arc. It is described as being stronger in the chromospheric spectrum than in the ordinary solar spectrum. The presence or absence of this line in the chromospheric spectrum is a point of such great importance that the observation above described requires to be very carefully corroborated before it can be finally accepted. It is, however, very difficult to understand how the above identification of the magnesium line with the chromospheric line has been obtained, because in the list of wave-lengths here published the evidence seems to point to a titanium origin. Thus we find in this table that the wave-length of the chromospheric line, as measured, is λ 4481·4, while the solar lines nearest this are, according to Rowland, λ 4481·298 (Mg) and λ 4481·438 (Ti). Further, has it been definitely established that the solar line λ 4481·298 is due to magnesium?

It is also stated that it seems probable that the more volatile gases of atmospheric air uncondensed at the temperature of liquid hydrogen, together with hydrogen, helium, neon, and argon, are present in the chromosphere, but with regard to krypton and xenon the evidence is not conclusive. These deductions also do not seem to be supported by sufficient evidence, but will require further discussion before they can be generally accepted.

Enough, perhaps, has been said to indicate to the reader the importance to the study of solar physics of the publication of such a volume as this. Here we have all the data and discussions relative to two eclipses brought together under one cover, rendering a comparison of results a matter of little labour. One blemish we may, however, remark, and that is that the corona reproductions are not oriented in any way.

It may be still in the minds of our readers that, for the observation of the recent eclipse of 1905, Admiral Chester, Commander-in-Chief U.S. Eclipse Squadron, was in command of four men-of-war told off for eclipse work in Algeria and Spain. Their "station bills," showing the staff at each station and the work to be accomplished, gave one a good idea of the thoroughness with which the undertaking was organised. We shall at any rate look forward to another such volume as this, with, we hope, equally successful results. WILLIAM J. S. LOCKYER.

AGRICULTURE AND THE EMPIRE.

NATURE for January 11 contains a short paper on a large subject. Seeing that the cultivation of the soil, or agriculture, is the fundamental condition of human existence with any approach to civilisation, large is a very moderate description.

I take it that the object of the writer was to discuss the part that the Home Country should play in advancing agriculture in the Empire at large. That is a matter which seems to me important enough to receive a little discussion. It is one with which I have been a good deal occupied during the past thirty years. I should like, therefore, to attempt to define the present position of the problem a little more precisely.

May I begin with a very obvious remark? Agriculture is a sort of "noun of multitude." There is undoubtedly only one agricultural science based on physiological principles; there are many agricultural "arts" based on the application of that science, whether empirical or otherwise, to widely different physical conditions. The agriculture of the Lothians differs widely from that of Bengal, and both differ from that possible on the Gold Coast. This will seem to many an absurdly trite remark. Nevertheless, experience shows that it represents a fact which has often been overlooked, with loss and disappointment as the result.

It may, I think, be confidently stated that arable cultivation has been brought in the British Isles to a pitch of perfection which is not surpassed anywhere in the world. It is, however, an "intensive" and highly specialised agriculture. This is readily illustrated by the yield of wheat per acre. On land of prairie value, where the nitrogen removed is balanced by that received from the atmosphere, it has been shown at Rothamsted that the yield is roughly some 10 bushels or less. This actually represents the state of things in the great wheat-growing countries from which we draw our supplies—Argentina, Australia, India and Russia—and the United States with 13 bushels are not much better. The yield of the United Kingdom for the five years preceding 1904 was 31 bushels, and this was only surpassed by that of our antipodal colony New Zealand, 32.

This is largely due to the scientific research in agriculture for which, I think, it may be fairly claimed this country has always been preeminent. I by no means think that it is exhausted. I remember Sir John Lawes saying to me that, having devoted half a century to the study of the soil actually cultivated, he was still absolutely ignorant as to the subsoil and the part played by it. Our knowledge of the action of manures is mainly empirical, and we have still to learn much of its physiological significance. Without this it cannot be said that we possess a rational theory of manuring. Farmers must have wasted enormous sums in the application of nitrogenous manures until Frankland showed that a considerable proportion passed off unused in the drain-water.

I must confess that I am not clear that the arable agriculture of the United Kingdom is in a backward condition, that it does not compare favourably with that of other countries, or that it stands in urgent

need of Government aid in regard to research. Its theoretical principles can be taught in our universities and schools; its practice can only be learnt on the farm. While saying this I must also express my conviction that the agricultural wealth of this country might be increased in many ways. In my evidence before the recent departmental committee on fruit culture I expressed a strong opinion that the condition of that industry was in no way creditable to us.

At the moment, where, so to speak, the shoe pinches is not above but below. There is no dearth of scientific knowledge in the country, but it floats on the surface and does not permeate. The scientific and even practical ignorance of the small cultivator is profound. The Board of Agriculture and Fisheries has tried to grapple with this by the wholesale distribution of carefully prepared leaflets. But such a method of disseminating knowledge is of almost heart-breaking difficulty. I have had prepared at Kew a series of diagrams illustrating the diseases of trees, suitable for schools. The *Daily Graphic* was good enough to say that:—"This publication is equal to the very best of those ever sent out by the United States Department of Agriculture." Yet the sale has been disappointing, and the Board of Agriculture and Fisheries does not see its way in consequence to proceed with the further and still more needed series dealing with the diseases of fruit trees. The crying need, in my judgment, at the moment is the introduction of intelligent cultural instruction into rural elementary schools.

If we turn to India we have to face a difficult problem. The revenue is dependent on the land, and this in turn has to support a constantly increasing population. It has been supposed that this might be met by the use of British methods. But how? Sir James Caird, who was sent out to study the problem on the spot, reported that if the produce of the land could be increased by 1 bushel per acre, all would be well. No doubt; but how is this intensive cultivation to be accomplished? Long cultivation has brought the land down to a condition of nitrogen-equilibrium. Dung is used as fuel, and the cultivator is too poor to import artificial manures.

In 1900 I attended a conference at the India Office on the qualifications of an Inspector-General of Agriculture. The report of the proceedings is printed in the Blue-book of the Botanical Work Committee (pp. 77–78). I stated then, and the statement met with general assent, "It would be the greatest mistake to substitute for Indian agricultural practices western methods, merely because they had succeeded in the west. . . . The problem in India was how best to graft the results of scientific agricultural knowledge on to the stock (the really valuable stock) of Indian agricultural practice and experience."

India has long had experimental farms in plenty. They have not been without their usefulness. But they have lacked permanence and a guiding principle. It now owes in great measure to the munificence of an American gentleman an agricultural research institute at Pusa. It is further, I believe, intended to establish a number of subordinate stations at a cost of 250,000*l*. If these are to be staffed from home *forthwith*, the result will be very much what the Transvaal Director of Agriculture points out. The Government of India should at once make up its mind what appointments it proposes ultimately to make, and inform the universities at home five years in advance. Students at the universities cannot be expected to engage in agricultural or allied studies unless they see clearly what is to come of it at the end.

Let me turn now to the problem presented by the West Indies and other of our tropical possessions. Sir Daniel Morris is quoted as saying in regard to the former:—"Agricultural education is at the root of the successful development of these Colonies." This is perfectly true, only I rather doubt whether the writer of the article quite understood the reason. In temperate countries agriculture is a necessity of existence; in many tropical countries it is not. The wasteful production of a few ground provisions calls for the minimum of effort, and is sufficient to sustain indolence. But with the introduction of orderly government a revenue becomes necessary. Sir Charles Bruce has laid it down that "in the Crown Colonies generally . . . the only taxable fund is the wage fund supplied by the annual proceeds of the cultivation of the land" (Proc. Colonial Institute, vol. xxxvi., p. 248). To induce the negro to engage in profitable cultivation instead of contenting himself with a bare modicum of ground provisions provides a source of revenue, raises his standard of comfort, and makes for his moral progress. But he has to be taught by example how to do it, and this is the agricultural education which Sir Daniel Morris had in his mind. It is widely different from anything of the kind in this country.

In point of fact, tropical agriculture has little relation to that of temperate countries. Its methods are those of horticulture; it is essentially extended gardening. For the supply of men for this purpose our agricultural colleges would be of little or no use. The problem has had to be met in a wholly different way. The machinery for the purpose is compendiously described in the following extract from the Colonial Office List (p. xx.):—"'Botanic Stations' . . . are small and inexpensive gardens, devised in 1885, in order to afford practical instruction in the cultivation of tropical crops, and were intended to develop the agricultural resources at first of the smaller West Indian Islands, and subsequently (1887) of British possessions in Tropical Africa. Each is in charge of a Curator, who is a gardener trained at Kew."

The sort of success that has attended the system may be illustrated by a single example. Cacao was introduced to the Gold Coast from Kew. In 1891 the export was valued at 4*l*. In 1900 I was able to exhibit at the Paris Exhibition from the botanic station the first sample, to the best of my belief, grown on the African continent, when it received a bronze medal. In 1904 the export had risen to a value of more than 200,000*l*. In effect, cacao is exchanged for imported goods; besides thus adding to the comfort of the cultivators, it enables them to pay the taxes necessary to maintain peaceful government.

For work of this kind the Empire has to depend on Kew, which is organised for the purpose as an advanced horticultural school. At the present moment some seventy Kew men are in official employment and carrying on the work I have described in our various tropical colonies and possessions.

But besides native peasant cultures British capital and enterprise are also largely embarked in the tropical regions of the Empire in "planting industries." These meet with difficulties which the local Government can and does supply skilled aid to mitigate. Most of the West Indian colonies have a "Government analyst." Cambridge has secured the traditional right to train and supply these. Incidentally they are able to give important aid in dealing with agricultural problems. The value of the work done by Prof. Harrison in British Guiana and Prof. d'Albuquerque in Barbados can hardly be overestimated.

Ceylon possesses an almost unique staff of trained

experts of every kind at Peradeniya, and a similar organisation is in process of establishment in the Federated Malay States. The rubber industry of the Straits Settlements owes its success to the Director of Public Gardens at Singapore. Besides Pusa, India has experienced botanical experts, all university men, at Calcutta, Madras, and Saharunpore.

Our self-governing colonies know pretty well how to take care of themselves. All possess agricultural departments and produce journals which will compare more than favourably with anything at home. In Canada the Central Experimental Farm at Ottawa is certainly not eclipsed by any institution in the United States. I may be pardoned a little vanity if I remark that when the Transvaal Government applied to Washington for an agrostologist it received a Kew man.

To sum up. What the Home Country can supply to the Empire is:—(1) cultural instructors such as are trained for the purpose at Kew; (2) men with a sound scientific training and a firm grasp of the principles underlying agricultural practice of whatever kind, and for these we must look to the universities. Men who are merely familiar with British agricultural conditions will be mostly of little use unless they possess the flexibility of mind which will apply theory to new and unfamiliar conditions.

W. T. THISELTON-DYER.

NOTES.

THE position of the South Africa medal fund for the endowment of a medal and scholarship or studentship in commemoration of the visit of the British Association to South Africa in 1905 is stated in a circular just issued by Prof. J. Perry, honorary treasurer to the fund. The subscriptions promised or paid amounted to 752*l.*; and to this the council of the British Association has resolved to add the unexpended balance of the special South African fund, amounting to about 800*l.* The following report of the executive committee was adopted at a meeting of subscribers on March 2, and approved by the council of the British Association:—(*a*) That the fund be devoted to the preparation of a die for a medal to be struck in bronze, 2½ inches in diameter, and that the balance be invested and the annual income held in trust; (*b*) that the medal and income of the fund be awarded by the South African Association for the Advancement of Science for achievement and promise in scientific research in South Africa; (*c*) that, so far as circumstances admit, the award be made annually. It is to be hoped that a fund raised for so excellent a project will receive a substantial increase from members of the association who have not already contributed to it, or from subscribers who may wish to add to their subscriptions.

THE terrible mine explosion at Courrières, in the Pas de Calais, on the morning of March 10, involving the loss of about 1200 lives, has naturally led to all sorts of conjectures as to the immediate cause. As usual, atmospheric conditions are said to have played a not unimportant part in bringing about the tragedy. In some mysterious way the very low barometric pressure over the North Sea on March 12, two days later, is supposed to explain the disaster. If, however, attention is concentrated on the atmospheric conditions prevailing at the time of the accident, it will be found that they resembled those which have accompanied the majority of the great disasters of the past fifty years. The *Bulletin météorologique de France* shows that during the night of March 9 a well marked anticyclone extended from Spain in a north-easterly direction across France and the Netherlands, so that at 7 a.m. on March 10, when the calamity occurred, the barometer over the Lens district had risen to 765 mm. (30·1 inches); it had, in fact, mounted nearly a quarter of an inch in the course of the night. Obviously, if atmospheric pressure played any part in bringing about the catastrophe, the latter cannot in any way be associated with a low and falling barometer.

THE death of Mr. William Sowerby, for many years secretary of the Royal Botanic Society, Regent's Park, occurred at his residence in Hertfordshire on March 9. A grandson of James Sowerby, the famous illustrator of "English Botany" and of "British Conchology," and son of James de Carle Sowerby, another gifted naturalist, Mr. W. Sowerby inherited the family taste for natural history. He was responsible for the drawing of some botanical plates, but early in life he became associated with the Royal Botanic Society through his father, who was a founder and the first secretary, and in Regent's Park he worked for half a century. An observation which brought his name prominently before the public was the discovery of a medusa in the Victoria Regia tank, this being the first record of a medusa in fresh water, not to say in a most unexpected locality. He was keenly interested in economic plants, and not only did he bring together a unique collection, but he obtained fruit and fibre, the latter being distributed on several occasions to commercial men for trial. Among his successful experiments was the cultivation of the white mangrove, Avicennia, that flourished and produced aërial roots in artificial brackish water; he also demonstrated that seaweeds could be grown in tanks in the greenhouses.

IT is reported from Tokio that a severe earthquake has occurred at Kagi, in Formosa. Many hundreds of persons have been killed and injured, and a large number of buildings have been destroyed.

A REUTER message from New York states that, according to advices from Honolulu, a volcano in Savaii Island (Samoa) is in eruption on a large scale. Three villages have been completely destroyed, including Maleda. The lava stream is three-quarters of a mile wide, and is flowing into the sea.

DR. H. C. BASTIAN, F.R.S., gave a demonstration, with the aid of lantern slides, "On some Heterogenetic Processes," on March 15 at the rooms of the Medical Society. Various micro-organisms were exhibited with the view of meeting the objections that have been raised to Dr. Bastian's interpretations of the transformations observed. An account of Dr. Bastian's remarks is given in the *Lancet* for March 17.

THE secretary of the Decimal Association informs us that he has within the past few days received fifty-three promises of support from newly elected members of Parliament. In the last parliament there were 330 members pledged to support the adoption of the metric weights and measures in this country, and at the present time 253 votes can be relied upon in the House of Commons. Additional assents are being received day by day, and it is probable that when the canvass now proceeding has been completed there will be as many supporters in the present parliament as there were in the last.

THE report of the late Dr. S. P. Langley, secretary of the Smithsonian Institution, Washington, for the year ending June 30, 1905, shows that much valuable scientific

work is accomplished year by year as a result of the grants made by the institution from the Hodgkins fund administered by it. One such piece of research is that in connection with speech or phonetics, by Dr. E. W. Scripture, who has secured individual gramophone voice records of much historical interest. A voice record of the German Emperor was transmitted by Dr. Scripture in January, 1905, for preservation in the United States National Museum. This record gives, in about 200 words, the Emperor's conception of the aims and beauty of true manhood and of man's duty to his fellow. It is stated that at present only one other record of the Emperor's voice exists, namely, one made at the same time for preservation in the library of Harvard University. Among other important researches aided by the Hodgkins fund may be mentioned the investigations of the upper air currents by means of kites by Dr. A. L. Rotch, of Blue Hill Meteorological Observatory; the experiments conducted by Mr. Alexander Larsen, of Chicago, in connection with the photography of lightning flashes and the fluorescence of minerals; the serial instantaneous photographic study of the flight organs of animals, by Dr. von Lendenfeld; and Prof. W. P. Bradley's experimental investigation of the expansion of air through a nozzle.

THE amphipod crustaceans of Catherine Bay, Murman coast, form the subject of an illustrated paper by Mr. E. van der Brüggen published in the last issue of *Trudui* of the St. Petersburg Academy for 1905.

A PAPER on Californian reptiles, by Dr. S. E. Meek, just issued by the Field Columbian Museum, contains descriptions, with figures, of two species of rattlesnake regarded as new, as well as notes on a number of other snakes and lizards.

WE have received from the Field Columbian Museum at Chicago a copy of a "Check-list of Mammals of the North American Continent, the West Indies, and the Neighbouring Seas," compiled by Dr. D. G. Elliot, and issued by the museum. This bulky volume purports to include the names of all species of mammals inhabiting America as far south as Colombia that have been described up to the date of publication. It is, in fact, supplementary to the author's two previous synopses of American mammals.

"THE Ideal Thoroughbred Stud" forms the subject of No. 8 of Rural Studies Series, this being the title of a lecture by the Rev. E. A. Woodruffe-Peacock, the well known specialist on soils and grass-lands. With a full knowledge of most large English stud-farms, the author expresses his opinion that there is not one which has not at least some deficiency; and after pointing out the lines on which an ideal stud should be formed, he observes that "the birthplace of a long and steady series of race-winners cannot be a matter of mere chance."

THE March number of the *Naturalist* contains an attractive coloured plate representing a pair of bearded tits in their native marsh. The contents include Mr. G. W. Lamplugh's presidential address to the Northern Naturalists' Union at Bradford on January 27, having for its subject the necessity for the amateur spirit in scientific work. Attention is directed not only to the valuable work accomplished by amateurs in the past, but also to the many fields in which their assistance is of the utmost importance at the present day. As an instance, the official geologist cannot possibly devote long periods of time to particular sections or pits, whereas an amateur living in the neighbourhood can easily do so, and thereby is not unfrequently able to solve a problem which has been inexplicable to his professional brother.

THE programme of the July conference of the Museums Association at Bristol is outlined in the February issue of the *Museums Journal*. Among the articles is one by Mr. H. Bolton on the future of museums, being the report of a paper read at last year's conference. The author urges the advisability of a Government grant being paid annually to provincial museums of first-class standing, in return for which such institutions should be severally expected to perform a certain amount of allotted work, and in all instances to maintain a high standard of excellence. Another address at the same meeting, by Mr. S. L. Mosley, had for its subject museums and private collections, the author pointing out how much good a private collector can do by working for a museum, and how much harm when seeking his own ends.

IN the opening article in the February number of the *American Naturalist* Dr. H. Ayers, taking for his text "the unity of the gnathostome type," urges that there is neither anatomical nor embryological ground for removing amphioxus from the vertebrate class, and that we may class this creature as the sole representative of the Acrania, in contrast to the Craniata, which includes all the rest. Not only so, but the discovery by the author of rudimentary jaw-structures in the lampreys renders the division of the Craniata into Cyclostomata and Gnathostomata no longer tenable. The Gnathostomata must comprise, therefore, the Marsipobranchi as well as all the forms previously included, so that all Craniata are Gnathostomes. The origin of the craniofacial apparatus is thus to be sought in the missing links between amphioxus and the Craniata. Old age in brachiopods, by Dr. H. W. Shymer, and the habits of the American spotted salamander, *Necturus maculosus*, by Prof. A. C. Eycleshymer, form the subjects of the other two articles in the same issue.

Science of February 16 contains a report of an address delivered by Dr. C. H. Merriam, as vice-president and chairman of the zoological section, at the New Orleans meeting of the American Association for the Advancement of Science, on the question whether mutation is a factor in the evolution of the higher vertebrates. As the result of a long practical acquaintance with American mammals, Dr. Merriam is of opinion that there is no evidence of origin by mutation (sudden marked variation) in this class, but that everything points to variation by insensible degrees. Here the author takes occasion to mention that among mammals there is abundant evidence of the gradation of one species or race into another, so much so that specific or racial separation of specimens is often difficult. While admitting that in rare instances species of plants may arise by the perpetuation of "sports," Dr. Merriam states his contention to be that "the overwhelming majority of plants, and so far as known, all animals, originate in the generally recognised way, by the gradual development of minute variations."

IT is encouraging to notice the growing appreciation on the part of Government departments and colonial administrators of the benefits to be derived from the application of scientific methods under expert guidance to pearl and other fishery industries. In the proposal to lease the pearl fisheries to a company for a period of twenty years recently laid by the Governor of Ceylon, Sir Henry Blake, before his Legislative Council, it was expressly stipulated "that

a sum of not less than Rs. 50,000 be expended annually on the scientific development of the banks." The Torres Straits pearl-shell fisheries, it seems likely, will also be put under scientific control and cultivation. In a report by Mr. W. Saville-Kent to the Queensland Government (1905) it is shown that the pearling industry to the north of Australia is in a depressed condition due to over-depletion of the natural shell-beds, so that they can no longer be worked at a profit. Mere closure of the beds against fishing is regarded as an inadequate measure, since the remaining molluscs are too few and too scattered to ensure sufficiently rapid propagation to re-populate the ground in a reasonable time. Mr. Saville-Kent recalls what is known of the breeding habits of the animals, and of their suitability for transplantation, and recommends the establishment of at least six "Government pearl-shell breeding reserves" at what seem to be suitable spots in the Torres Straits area. At each reserve about 1000 adult pearl oysters will be kept for breeding purposes enclosed in frames of wire-netting, and Mr. Saville-Kent is of opinion that "within a period of three or four years . . . the adjacent waters within many miles from these breeding centres should be restocked with young shell to such an extent as to permit of profitable fishing." He also recommends the establishment of an experimental cultivation laboratory on the small islet of Wai Weer at Thursday Island, and suggests, further, that a consignment of the Ceylon pearl oyster should be laid down on the Torres Straits ground. It is evident that a good deal in the way of scientific cultivation could also be done by collecting the spat and by cultching the ground, and that regulations may be required in regard to public and private fishing on the beds, and the proper treatment of the stock in the Government reserves. The adoption, before it is too late, of such scientific methods is probably the only way of restoring a depleted pearl-shell industry.

THE progress of Indian agriculture has hitherto been recorded in such publications as the Agricultural Ledger issued by the Reporter on Economic Products, or the bulletins circulated by certain of the provincial Governments; and reports on agricultural experiments have been included in official reports dealing chiefly with land records and administrative questions. The existing methods of publication were not suited to the altered conditions produced by the activity of the new department organised by Mr. James Mollison, first Inspector-General of Agriculture in India, and all interested in Indian agriculture will welcome the news that the Imperial and provincial Departments of Agriculture will henceforth publish a "Journal" and "Memoirs." The first number of the Journal has just been issued from the Agricultural Research Institute at Pusa. It is edited by the Inspector-General with the assistance of the Pusa staff, and will be published quarterly. The present number contains an interesting account of the development of the Indian Departments of Agriculture by Mr. F. G. Sly, officiating Inspector-General, and seven articles on questions connected with the cultivation of sugar-cane, cotton, and other Indian staples. The intention of the Government is that the Journal shall deal with agricultural subjects which are of interest to general readers—crops, insect pests, cattle breeding, irrigation, cooperative credit—while in a second publication, to be entitled "Memoirs of the Department of Agriculture in India," scientific work in agricultural chemistry, botany, &c., will be recorded. The Memoirs will be published as separate articles, and these will be arranged in series. Separate series will be issued for each of the chief divisions of science. Both publications will be freely illustrated.

A VERY valuable report by Dr. A. C. Houston on the bacteriological examination of milk has been issued by the London County Council, with a preface by Sir Shirley Murphy. The report is based on the examination of (*a*) twenty samples of specially selected milk from twenty separate healthy cows; (*b*) twenty samples of milk collected from purveyors' shops; (*c*) twenty samples collected from dairy shops; (*d*) twenty samples collected from churns at railway stations; and (*e*) twenty samples collected from the establishments of well known milk dealers. The samples under (*a*) served as a standard, while those under (*b*) and (*c*) were of milks of indifferent quality, in the main collected from poor neighbourhoods and premises known to be ill-adapted for the sale of milk. The various sources of pollution of milk are enumerated, and an important recommendation is made with regard to a temperature standard, viz. that all milk should be rapidly cooled below 10° C. and maintained at or below this temperature during the whole period of transit and sale in order to prevent the multiplication of bacteria. The following bacteriological standards are suggested:—(1) 1 c.cm. should not give evidence of the presence of *B. enteritidis sporogenes*; (2) 0·001 c.cm. should not give evidence of the presence of *B. coli*. (3) 0·0001 c.cm. should not give evidence of the presence of streptococci; (4) the primary sediments (after twenty-four hours) should not exceed 100 parts per 1,000,000; (5) the secondary sediment (after centrifugalisation) should not exceed 50 parts per 1,000,000. Finally, several reforms which may be considered immediately practicable are suggested for dealing with the milking, the conveyance of the milk, and the vending of the same.

AN editorial article in the *Indian Forester* (January) advocates the formation of forest museums in each forest division or in each province that may contain several divisions. In Europe the inception of such a scheme is found in Saxony, where each forest conservator is provided with a set of mounted specimens of the chief insect pests with instructions for dealing with them. In India the credit of starting collections of timber specimens and other forest produce for a conservator's museum is due to Mr. Gass, of the Coimbatore division, Madras. The collections for this division have been extended to serve for the three circles of the presidency, and a special building has been sanctioned for the purpose.

IN consequence of the drought that was experienced during the season 1904–5, particularly in Antigua, the experiments arranged by Dr. F. Watts on the chemical selection of sugar-canes in the Leeward Islands failed, but the experiments with different varieties of sugar-cane were carried out. In the report published as a separate part by the Imperial Department of Agriculture for the West Indies it is noted that the six canes giving the best results in Antigua were the same as in the previous year, thus confirming the good character of these canes. The experiments in St. Kitts did not agree so closely with those of previous years, this, no doubt, being caused by the irregularity of the rainfall in different districts.

AT a research meeting of the Royal Geographical Society on March 9, a paper was read by Mr. J. L. Myres on the Alpine races in Europe. Rejecting Prof. Keane's theory of a North African origin, Mr. Myres said that the brachycephaly of the Alpine stock might have been de-

veloped locally, or might have immigrated from western Asia, but there was no reason to suppose that the area in which the race occurs in Europe was large enough or secluded enough to account for so considerable a change. The northern or steppe route into Europe was not available until the retreat of the ice-cap and the shrinkage of the Caspian, but south of the Black Sea there was a route, now concealed by submergences subsequent to the period with which he was dealing. In Anatolia the conditions were favourable for the development of a distinct type, and at the same time south-east Europe was partially isolated, and its climate rendered it little suitable for human habitation. *Homo alpinus* was tall in Albania, short in Central France; the dwarf broad-heads developed in south-eastern Europe, where the climate was severe, the giant broad-heads in Anatolia, where conditions were more favourable; and it was natural to find the latter to the east of the former, for they were driven out of Anatolia later, leaving scattered "Dinaric" populations east of the Sea of Azov, and throwing out colonies beyond the "Cevenoles." In favour of this hypothesis were the facts that (1) the fruit-culture of the European lake-dwelling peoples was characteristically Anatolian; (2) physically they were of the right type; and (3) even in classical times Anatolia was noted for this type of dwelling.

At the eighth International Geographical Congress, Mr. R. De C. Ward, of Harvard University, contributed a useful paper on a more rational treatment of climatology. He pointed out that the method of presenting climatic data in the usual tabulated form is unsatisfactory, because it does not bring out the cyclonic variations of different weather conditions experienced from day to day. He does not suggest any change in the recognised order of presentation, but he urges that wherever possible the cyclonic unit should be made the basis of summaries, as well as the diurnal, the monthly, the seasonal, and the annual unit; also that much more attention should be paid to an adequate verbal discussion. Over the greater portion of the equatorial zone, weather and climate are almost synonymous terms, but in the temperate zone, for instance, the regular diurnal changes are very frequently overshadowed by the changes due to the passage of cyclones and anticyclones. The author gives several clear illustrations, *e.g.* in mean monthly and mean annual ranges of temperature we have the sum of both periodic and non-periodic changes which occur during any month, irrespective of the question whether the maxima and minima all occurred under similar conditions, and thus we lose sight of a very important factor in climate; and similarly with regard to rainfall and other elements. More attention should be given to seasonal averages, to departures from the means, and even to the single occurrence of certain phenomena. A tribute is paid to the more rational treatment of climatology as evidenced by the beautiful charts by Dr. Buchan in Bartholomew's "Atlas of Meteorology"; but, valuable as such charts are, the author considers that the various weather elements which, taken together, make up climate should be summarised, not on the basis of the year or month only, but of the cyclone which controls them.

The Journal of the Royal Sanitary Institute (No. 1, 1906) contains an interesting paper by Dr. W. N. Shaw, read before the conference on smoke abatement, and entitled "Is London Fog Inevitable?" The author pointed out that we do not know the actual course of events in the physical processes comprised in the origin and persistence of fog, and referred to two important inquiries made under the superintendence of the Meteorological Council relating to the winters of 1901–2 and 1902–3. In the first report Captain Carpenter came to the conclusion that in winter London was never free from a smoke haze; for some months St. Paul's was invisible from the Victoria Tower at the times of observation, although in the following year conditions were more favourable. The most frequent cause of fog is the cooling of the surface by radiation under a clear sky; there is no limit to the extent of country that may be affected by the formation of fog under this condition. In the second winter, 1902–3, Mr. Lempfert assigned twenty-four cases out of thirty-nine dealt with to the effect of radiation, while eight were considered to consist practically of smoke alone. Thus about 20 per cent. of the London fogs in that year might have been avoided by the abatement of coal smoke, while the remainder depended upon physical processes which are beyond our control. Dr. Shaw remarks that one of the unsolved problems of this interesting subject is why the sun's heat does not dissipate the fog upon which it shines. It was found that the sunshine recorder at Bunhill Row during the month of December lost 83 per cent. of the sun's burning power, that at Westminster 61 per cent., and that at Kew 15 per cent., so that if the sun has any substantial power of dissipating early morning fog, the smoke of the London atmosphere must seriously interfere with its effect. The peculiar manner in which the density varies from place to place, and various other points about London fog, await further investigation.

The Geological Survey of Alabama has issued a revised map of the south-eastern part of the Cahaba coalfield, embodying the results of investigations made since the publication of the original map in 1890. The vertical section shows fifteen seams, mostly of small size, in about 1800 feet of measures.

Statistics of the quantity and value of each of the important minerals raised in India have been published by Mr. T. H. Holland, F.R.S., in the Records of the Geological Survey of India (1906, part i.). Compared with 1903, an increase of nearly 7 per cent. is shown in the total value of mineral production. The production of coal, 8,216,706 tons, exceeded all previous records. There were also produced 3596 tons of chromite, 286 carats of diamonds, 618,746 oz. of gold, 3256 tons of graphite, 3778 cwt. of jadeite, 1315 tons of magnesite, 150,297 tons of manganese ore, 19,575 cwt. of mica, 118,491,382 gallons of petroleum, 265,901 carats of rubies, 1,170,205 tons of salt, 315,558 cwt. of refined saltpetre, and 1388 cwt. of tin ore. Statistics of the production of alum, amber, asbestos, borax, building stone, clay, gypsum, limestone, marble, ochre, and slate are incomplete.

In the Records of the Geological Survey of India (vol. xxxiii., part i.) Mr. E. Vredenburg deals with Pleistocene movement as indicated by irregularities of gradient of the Narbada and other rivers in the Indian peninsula. He gives a very striking photograph of the falls of the Narbada at Dhári. Recent changes in the course of the Nam-tu River, in the northern Shan States, are described by Mr. T. D. La Touche, and the same author gives a note on the natural bridge in the Gokteik Gorge, advantage of which was taken in selecting a site for the railway bridge on the Mandalay-Lashio line. Lastly, Mr. P. N. Bose gives an account of the geology and mineral resources of the Narnaul district, in the Patiala State. The minerals

of economic value met with include iron ores, mica, copper ores, manganese, rutile, as well as limestone and other building stones.

IT has always been a difficult matter to obtain pure lithium by the electrolysis of fused lithium chloride, which has been the method employed up to the present, and was originally used by Bunsen. In the *Zeitschrift für Elektrochemie* of March 9, Messrs. O. Ruff and O. Johannsen describe a process which they have satisfactorily worked out for its preparation by the electrolysis of lithium bromide. They prepare the lithium bromide by the action of hydrobromic acid on the carbonate. The electrolysing vessel is of copper, and is partially water-jacketed in order that the walls may be kept cool and thus protected by a coating of solid lithium bromide. The anode is of retort carbon, and the two kathodes of iron wire 4 mm. in diameter. The electrolyte consists of lithium bromide containing 15 per cent. of lithium chloride. A current of 100 amperes at 10 volts is employed, and the yield of metallic lithium is about 80 per cent. of the theory. From time to time the metal as it collects on the iron kathode is removed with a flat iron spoon, and at once placed on a cold stone surface, where it rapidly solidifies. Determinations of the melting point showed it to be 180°, which agrees with that found by Bunsen in the middle of the last century.

A SIMPLE arrangement for purifying mercury which is likely to prove of considerable service is described by Messrs. G. A. Hulett and H. D. Minchin in the *Physical Review* (vol. xxi., No. 6). The method consists in distilling the mercury in a Wurtz flask under diminished pressure, allowing bubbles of air to pass through the mercury during distillation so as to prevent bumping. The air also serves the very useful purpose of oxidising any metallic impurity, such as zinc, cadmium, or lead, which otherwise would contaminate the distillate. Ordinary distillation *in vacuo* of mercury containing one of these metals does not suffice to remove the impurity, but by using the method described an amalgam of zinc can be made to yield pure mercury in a single distillation. An electrical method of ascertaining the presence of one part of zinc in ten billion parts of mercury is described incidentally.

THE March number of the *Geographical Journal* contains an interesting table by Miss Nora E. MacMunn, compiled from planimetric measurements made on an orographical map at the School of Geography, Oxford, showing the areas of the orographical regions of England and Wales. As a rule, the plains have been measured to the 250-feet contour line, and the hills have not been considered to begin below that level. The average height of England and Wales, calculated from these measurements, is 385 feet. Of the total 58,324·3 square miles constituting the area of England and Wales, 26,481·6, or 45·4 per cent., are under 250 feet in elevation; 16,364·5, or 28 per cent., are between 250 feet and 500 feet; 10,476·3, or 18 per cent., are between 500 feet and 1000 feet; 4698·3, or 8 per cent., are between 1000 feet and 2000 feet; 300·0, or 0·5 per cent., are between 2000 feet and 3000 feet; and 3·6 are more than 3000 feet above sea-level.

MR. FROWDE is about to publish for the Radcliffe trustees a "Catalogue of 1772 Stars, chiefly comprised within the Zone 85°–90° N.P.D., for the Epoch 1900," deduced from observations made at the Radcliffe Observatory, Oxford, during the years 1894–1903, under the direction of Dr. A. A. Rambaut, F.R.S.

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A NEW COMET (1906*c*).—A telegram from Kiel announces the discovery of a new comet by Mr. Ross, of Melbourne, on March 18.

Its position at 7h. 36·1m. (Melbourne M.T.) was

R.A. = 2h. 3m. 52s., dec. = −7° 41′,

which is about half-way between ζ and *o* Ceti.

A second telegram from Kiel states that Mr. Morgan observed the comet at Glasgow (U.S.A.) on March 19. Its position at 7h. 40·9m. (Glasgow M.T.) was

R.A. = 2h. 9m. 31·4s., dec. = −5° 47′ 25″.

The comet is stated to be of about the eighth magnitude.

COMET 1906*b*.—Numerous observations of comet 1906*b* are reported in No. 4078 of the *Astronomische Nachrichten*.

Observing at Bamberg on March 4, the day after its discovery, Prof. Hartwig found that the comet had a diameter of about 10″ and a central condensation of about magnitude 11·0. The same magnitude was recorded by Dr. Wirtz at Strassburg on March 6.

Prof. Max Wolf reports that the comet is easily seen on his plates, and shows a tail of about half a degree in length; with the 10-inch refractor a sharp nucleus was observed on March 4, and it was seen that the tail extended to the north-west.

COMET 1906*a* (BROOKS).—In No. 4078 of the *Astronomische Nachrichten* Herr M. Ebell gives a further daily ephemeris for comet 1906*a*, extending from March 16 to May 3. The following is an extract therefrom:—

Ephemeris 12h. M.T. Berlin.

1906	α (true) h. m. s.	δ (true) ° ′	log *r*	log Δ	Brightness
Mar. 20	5 41 5	+46 31	0·2618	0·1986	0·25
24	5 42 18	+43 47	0·2710	0 2284	0·21
28	5 43 58	+41 23	0·2801	0·2567	0·18
April 1	5 45 57	+39 18	0·2891	0·2835	0·15
5	5 48 10	+37 27	0·2981	0·3088	0·13
9	5 50 34	+35 48	0·3069	0·3325	0·11

Brightness on January 27 = 1·0 = about 10·0 m.

Observing at Arcetri on January 31, Dr. Abetti found that the comet had a central nucleus of about the tenth magnitude or a little greater, and that the surrounding nebulosity extended for about 2′, chiefly towards the direction of lesser right ascension.

On March 22 this comet will pass near to β Aurigæ, about 11m. (R.A.) to the west, whilst on April 5 it will be only about 5m. west of θ Aurigæ.

A PROGRAMME OF SOLAR RESEARCH.—Now that the Mount Wilson Solar Observatory has fairly settled down to work, Prof. Hale has revised his "Programme of Solar Research," published several years ago, and gives an outline of the revised programme in No. 1, vol. xxiii., of the *Astrophysical Journal*.

Two principal studies are to be prosecuted. First, a study of the sun as a typical star, with reference to stellar evolution; secondly, the relationship between solar and terrestrial phenomena.

These studies are divided into five groups, each of which contains a number of subdivisions. The five main groups are:—(1) direct photography; (2) spectroheliograph researches; (3) spectroscopic investigations; (4) studies of the total solar radiation; and (5) allied laboratory investigations.

Most of these are now being prosecuted at Mount Wilson, and Prof. Hale points out that there are many other solar investigations which call for attention, and of which many may be carried out by amateur observers with modest equipments.

HARVARD COLLEGE OBSERVATORY.—Prof. Pickering's report of the work done at Harvard College Observatory during the year ending September 30, 1905, is the sixtieth of the series, and contains the record of an immense amount of work, too much even to summarise here.

One or two special features may, however, be mentioned. Eighteen eclipses of Jupiter's satellites and eight occultations of stars by the moon were observed with the 11-inch Draper telescope. Three of the occultations were photo-

graphed continuously on a revolving plate, so that the nature of the disappearance, whether instantaneous or gradual, could be recorded.

Numerous valuable observations of peculiar stellar spectra were made during the year, including the discovery of Nova Aquilæ No. 2 by Mrs. Fleming. This is the eighth Nova discovered by that observer from the Draper memorial spectrograms.

With the Bruce telescope 523 plates were obtained, making 7504 in all, from which Miss Leavitt has discovered 1129 new variable stars during the year.

The bibliography of variable stars compiled by Miss Cannon was nearly ready for publication when the Astronomische Gesellschaft appointed a committee to undertake a similar work. Prof. Pickering therefore proposes to publish the Harvard work in an abridged form.

CATALOGUE OF 3799 BRIGHT STARS.—A useful catalogue of 3799 bright stars has just been published by M. J. Bossert, of the Paris Observatory.

This catalogue gives the magnitude and mean coordinates (1900·0) of each star, and, in addition, the precession, secular variation, and proper movement, together with instructions and examples for finding the star's position at any given epoch.

The stars are arranged in zones of 1° of N.P.D., and in each zone they are given in order of R.A., this classification being considered the most convenient for meridian observers.

Stars down to the seventh magnitude are included, the magnitude of Aldebaran being taken as 1·0.

ECLIPSE OBSERVATIONS AT CATANIA.—On the occasion of the total solar eclipse of August 30, 1905, observations of prominences, by the Lockyer-Janssen method, and of the variations in the terrestrial electric field were carried out, during the whole day, at the Catania Observatory.

The results are published in No. 1, vol. xxxv., of the *Memorie della Società degli Spettroscopisti Italiani*, and show, among other things, that the maximum effect of the solar radiation corresponds to the minimum potential of the atmospheric electricity.

MICROMETER MEASURES OF STRUVE DOUBLE STARS.—No. 4078 of the *Astronomische Nachrichten* contains the results of a series of measures of eighty-one "Struve" double stars made by Dr. H. E. Lau, of the Copenhagen University Observatory.

The position for 1900·0, the position-angle, the distance, and the data and hour of each observation are given for each star, and are followed by brief notes by the observer.

SOME APPLICATIONS OF THE THEORY OF ELECTRIC DISCHARGE THROUGH GASES TO SPECTROSCOPY.[1]

THE luminosity produced by an electric current passing through a gas at low pressure varies greatly in character, not only when we alter the nature of the discharge, as, for example, when we pass from the arc to the spark, but also in many cases at different points of the same discharge. The luminosity may be of one colour at one place and of a very different colour at another, and spectroscopic examination shows that the spectrum of the same gas often varies considerably as we proceed along the line of discharge. As recent experiments have thrown a considerable amount of light on the processes going on in the different kinds of electrical discharge and at different parts of the same discharge, the study of the connection between the changes in the electrical effects and the changes in the spectra might be expected to throw some light on the very interesting question of the genesis of spectra. Many important points can very conveniently be studied by the aid of Wehnelt's method of producing the current. In this method the kathode is a strip of platinum or a piece of platinum wire on which either a little lime or barium oxide has been deposited. This when heated to redness emits large supplies of corpuscles, and by altering the temperature of the platinum very large variations in the current passing through the tube and in the potential difference between the electrodes can be obtained. In our experiments the current varied from a small fraction of a milliampere to several amperes, and the potential difference from a few volts to several hundred.

The apparatus used is shown in Fig. 1. AB is the platinum strip with the lime on it; a thermocouple—a platinum and platinum-rhodium junction—was fused to this strip, and served to determine its temperature; the strip was connected with the earth, and was heated by a current passing through the leads LM; a rheostat was placed in series with the heating current, and by means of this the temperature could be altered gradually. The anode was a platinum disc; this was connected with the positive pole of a battery of storage cells, the negative pole of which was earthed; to allow of gradual variations in the potential difference between the electrodes a potential divider of 100 resistances of 10 ohms each was used. The current through the tube was measured by a d'Arsonval galvanometer, and the potential difference between the terminals by a Weston's voltmeter.

Some of the most interesting features of the discharge are very prominent when the temperature of the platinum is high, say 1400° C., and the pressure of the gas low, less than 0·01 mm. of mercury. The discharge is light

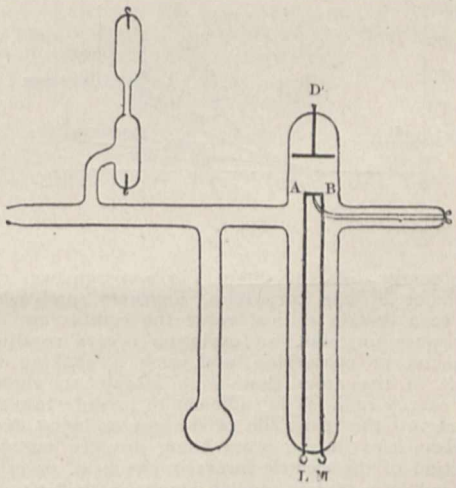

FIG. 1.

blue, and its spectrum shows the mercury lines and the band spectrum of nitrogen. In this case the relation between the current and the potential difference is represented by a curve like Fig. 2, the ordinates representing the current and the abscissæ the potential difference. In the case we are considering, when the wire is very hot and the pressure low, the change from the dark to the luminous discharge takes place very abruptly, an increase of the potential difference by 1/100 of a volt being often sufficient to convert a discharge where no light could be detected even in a darkened room into one where the light was quite bright. When luminosity appears there is a very rapid increase in the current; in some of the experiments an increase in the potential difference of 1/100 of a volt increased the current forty-fold. At this stage the thermo-junction showed that there was no increase in the temperature of the platinum where the luminosity appeared; we shall see later on that it is possible by using large potential differences to get such large currents through the tube that the platinum becomes appreciably warmer by the passage of the current.

One point which I think very suggestive is the abruptness with which the luminosity round the kathode appears. We see that by a very small increase in the potential difference the discharge passes from a state in which no luminosity can be detected, even in a dark room, to one where the luminosity can plainly be seen in a bright light; thus the molecules of the gas in the tube, just when the luminous discharge is on the point of appearing, are in a state in which a very small change in the electrical

[1] Discourse delivered at the Royal Institution on Friday, January 19, by Prof. J. J. Thomson, F.R.S.

conditions of the tube makes the molecules pass from a condition in which they are not giving out an appreciable amount of light to one where they are brightly luminous, and, as the great increase of the current when the luminosity appears shows, this change in state is accompanied by an emission of corpuscles. From this and other considerations I have come to the conclusion that what takes place when the gas becomes luminous is that the

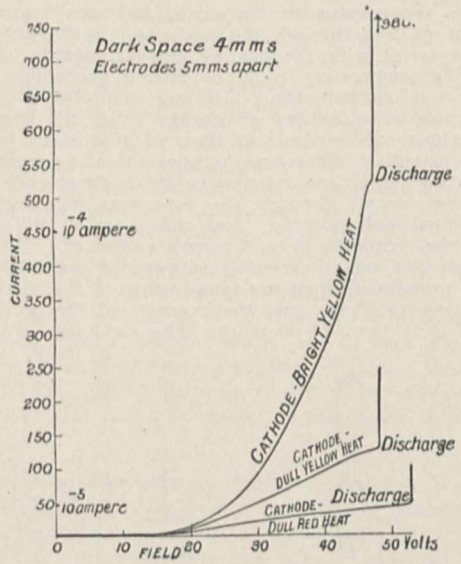

FIG. 2.

internal energy in the atom, in consequence of its bombardment by the corpuscles, increases, and when it gets up to a certain critical value the equilibrium of the atom becomes unstable, an explosion occurs resulting in an expulsion of corpuscles, and such a shaking up of those left in the atom that these vibrate so vigorously that the energy radiated is sufficient to produce luminosity. Thus I regard the ionisation of the gas as being due, not to the corpuscles in the atom being dragged out by the direct action of the electric forces in the field, or as being knocked out by a rapidly moving corpuscle striking against them, but to an explosion due to the atom having absorbed so much internal energy that its equilibrium becomes unstable. Other phenomena point to this as the method by which ionisation is effected. If the corpuscles are dragged out of the atoms by the electric field, the velocity with which they are projected should depend upon the strength of the field; while if they are projected by an explosion their velocity would depend only upon the nature of the atom, and not upon the strength of the field. Now when Röntgen rays fall upon a substance the atoms of the substance are ionised, and corpuscles are emitted forming a stream of kathodic rays. Barkla has lately shown, however, that the penetrating power of the kathodic rays produced in this way is independent of the intensity of the Röntgen rays. Now the electric force in the Röntgen rays depends upon their intensity, and the penetrating power of the kathodic rays depends upon their velocity, so that this result shows that the velocity of the corpuscles does not depend upon the intensity of the force acting upon them. Again, Lenard has shown that the velocity of the corpuscles ejected when ultra-violet light falls upon a metal is independent of the intensity of the light. Lenard also investigated the secondary kathode rays produced when kathode rays fall upon matter, and found that, in addition to rays the velocity of which was of the same order as that of the primary rays, and which may be regarded as deflected primary rays, there were other very slow rays, and the measurements he gives indicate that the velocity of these varies but little from that of the primary rays.

A point of great importance which can easily be shown by this apparatus is that the stage at which luminosity sets in depends upon the current density through the tube, and not merely upon the potential difference. One way of showing this is to lower the temperature of the platinum, keeping all the other conditions the same, and again determine the relation between the current and the potential difference. The effect of lowering the temperature is to reduce the number of corpuscles starting from the kathode, so that with the same potential difference the current density is smaller. If the relation between the current and potential difference is represented by a curve such as Fig. 3, it will be seen at once that the lower curve cannot be deduced from the upper curve by reducing all the ordinates in the same proportion. The critical points on the curves, *i.e.* the place where ionisation by collision begins and where the luminous discharge appears, are at very different potentials: the greater the current density the smaller the potential difference corresponding to these critical points. Thus, to take a case actually observed. When the wire was very hot the discharge was brightly luminous with a potential of 24 volts; on lowering the temperature no luminosity could be detected with a potential difference of 110 volts.

We can also show the effect of current density without altering the temperature of the kathode by placing near the tube an electromagnet so arranged that its lines of magnetic force in the discharge tube are along the line joining the kathode and the anode; the effect of the magnetic field is to make the corpuscles move along the lines of force, and thus without altering the number of corpuscles emitted by the kathode it concentrates their paths and so increases the maximum current density in the tube. When the magnet is on, ionisation by collision and luminosity both occur at a much lower potential difference than when it is off, and it is easy to arrange matters so that, keeping the potential difference constant, the discharge is luminous when the magnet is on and dark when it is off. When the potential difference is too small to produce a bright discharge even when the magnet is on, the current through the tube is often greater when the magnet is on than when it is off. By placing the magnet so that the lines of magnetic force are across the line joining the kathode to the anode we can render the paths of the

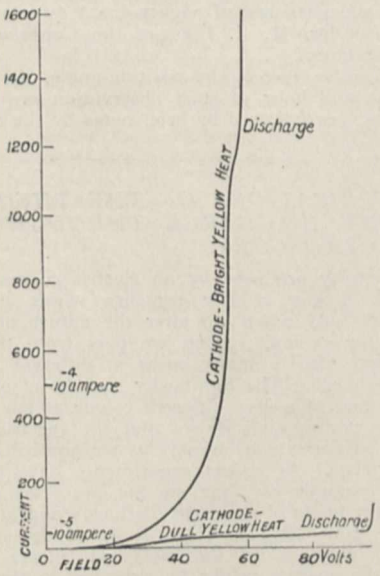

FIG. 3.

corpuscles more diffuse than they would be without the field, so that the maximum current density is less when the magnet is on than when it is off; in this case it requires a larger potential difference to produce a luminous discharge with the magnet on than with it off. Similar effects produced by a magnet on another kind of discharge are described in my "Recent Researches," p. 105.

The potential difference P just where the glow commences, when the pressure is low, sometimes varies so rapidly with the current i as to be roughly inversely proportional to it. The following are some values of i and P for a gas at a constant low pressure as the temperature of the platinum strip was increased; the numbers are in the order of increasing temperature :—

(in scale divisions)	P (volts)	Pi
6	60	360
8·7	40	348
11·2	30	336
14	25	350

Such a simple relation between P and i is, however, exceptional.

The fact that the potential differences at which ionisation by collision or luminosity begins depend upon the current density, shows that the ionisation or luminosity of an atom need not, and, indeed, cannot entirely, be the result of a *single* collision between a corpuscle and the atom. For if that were the case, then since the energy of the corpuscle depends only upon the electric field, and not upon the current density, the effect of increasing the current density would merely be to increase in the same proportion the number of luminous atoms, while, as a matter of fact, if the potential difference is kept constant and the current increased by raising the temperature of the platinum strip the increase in the luminosity is greater out of all proportion than the increase in the strength of the current.

The result, however, is easily explained if we look at the question from the following point of view. Suppose that for ionisation or luminosity to take place the internal energy of the atom must increase by certain amounts, say E_1, E_2 respectively. Then, if the energy possessed by the corpuscle were very great, the result of one collision with an atom might be to give to the atom enough energy to ionise it or make it luminous, or both. But even if the corpuscle were less energetic, and did not in one collision give enough internal energy to the atom to ionise it, it would communicate some energy to it, and if the atom had any power of storing up energy this would form a contribution towards the critical amount of energy required by the atom before it is ionised. The atom, after having had this energy communicated to it, would, so long as it retained any of it, not require so much energy to ionise it as before. The atom, too, might acquire energy, not merely by corpuscles striking against itself, but also by the collision of corpuscles with neighbouring atoms; such collisions generate soft Röntgen rays, the energy of which might be absorbed by the atom under consideration and help to raise its energy to the critical point; the energy in the Röntgen rays might by itself raise the internal energy of the atom to this value, or else raise it so nearly to this value that the collision with a corpuscle would give it enough energy to carry it past the critical stage. The rate at which the energy, due to collisions of corpuscles with itself or with neighbouring atoms, comes to an atom will be proportional to the rate at which energy is being communicated to the gas, *i.e.* to Fi, where F is the electric force and i the current density, and thus for a constant electric force would be proportional to the current density. The atom will radiate away some of its internal energy; if the rate of this radiation is proportional to the amount of energy, E, possessed by the atom, say equal to βE, then if q is the rate at which energy is being communicated to the atom, we have

$$dE/dt = q - \beta E,$$

so if E vanishes with t,

$$E = q/\beta\,(1 - e^{-\beta t}).$$

Thus q/β is the limit to the energy acquired by the atom, and this is proportional to q, while q is proportional to Fi, so that the atom will acquire the critical amount of energy or not according as Fi is greater or less than a certain value.

Application of these Results to Spectroscopy.—We have seen that the passage from the dark to the luminous discharge occurs with great abruptness, an increase of the potential difference by 1/100 of a volt being sufficient in certain circumstances to convert a discharge in which no luminosity at all could be detected to one where it was quite bright. This suggests that the luminosity sets in when the internal energy of the atom, or rather of that part of it which gives rise to the particular kind of light present in the luminous discharge, attains a perfectly definite value. This way of regarding the origin of the luminosity affords a very simple explanation of the variation of the spectrum with the kind of discharge and of the effect of introducing capacity or self-induction into the circuit containing the discharge tube. Let us consider the rise in energy of a vibrating system inside the atom; let E be the energy at the time t, α the rate at which it is absorbing the work done in the discharge tube; the energy may be supplied to it from the Röntgen radiation in the tube or from the corpuscles which come into collision with the atom, α will be proportional to the rate at which the electric field producing the discharge is doing work in the neighbourhood of the atom we are considering; it will thus be proportional to the product of the electric force and the flux of corpuscles in this neighbourhood. Let us suppose that the system radiates energy at a rate proportional to E, say equal to βE, then we have

$$dE/dt = \alpha - \beta E,$$

or

$$E = \alpha/\beta\,(1 - e^{-\beta t})$$

if $E = 0$ when $t = 0$.

Consider two different systems, A and B, in the same atom; let E_1, α_1, β_1; E_2 α_2, β_2 be the values of E, α, β for the systems A and B respectively.

$$E_1 = \alpha_1/\beta_1\,(1 - e^{-\beta_1 t}),$$
$$E_2 = \alpha_2/\beta_2\,(1 - e^{-\beta_2 t}).$$

Now suppose that the system A is one that does not absorb much, but also does not radiate much, while B absorbs a great deal more than A, but radiates still more in proportion, so that $\alpha_2 > \alpha_1$ but $\alpha_1/\beta_1 > \alpha_2/\beta_2$, then ultimately E_1 is greater than E_2, but at first E_2 is greater than E_1. The curves A and B, Fig. 4, represent the variations of E_1 and E_2 with the time.

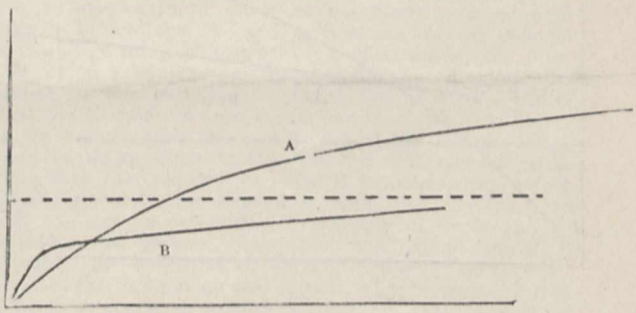

FIG. 4.

Suppose, now, that systems A and B become luminous when the internal energy is equal to W. It is not necessary to assume that the critical amount of energy is the same for the two systems; the assumption is only made to simplify the diagram; it will be seen that the argument will apply if the critical amounts of energy are different in the two cases.

Now consider, first, the case when the rate at which work is being done in the tube is so small that though α_1/β_1 is greater than W, α_2/β_2 is less than W, the case represented in Fig. 4; here system A acquires the amount of energy necessary to make it luminous, while system B does not; thus in this case the spectrum of the gas would show the lines corresponding to A, but not those of B. Suppose, now, we increase the rate at which work is done in the tube, so that both α_2/β_2 and α_1/β_1 are greater than W, the case represented in Fig. 5.

Here the system B attains the critical amount of energy, and it reaches this value before A does so, so that in this case the lines of B will be visible. Let us now consider the lines in the spectrum corresponding to the system A; these will be visible if the energy in the system reaches the critical value. The conditions in this case are in some respects more unfavourable for the supply of energy to

this system than they were in the previous one. For in the first case the system B got into the condition in which it radiated as much energy as it received, and thus did not absorb any of the energy; in the second case, however, B became luminous before its radiation was equal to the absorption; it is thus taking in more energy than it gives out, and this may result in a diminution in the rate of supply of energy to A. It would be so, for example, to a marked extent if the conditions were such that A received a considerable portion of its supply of energy from B; this diminution in the supply might be great enough to prevent the internal energy in B reaching the critical value. Thus the effect of the increase on the rate of supply of the electrical energy might be to weaken, or even obliterate, the lines of A, and while with the smaller rate we had the lines of A and not those of B, with the larger rate we might have the lines of B and not those of A; thus an increase in the rate at which the electric field is doing work such as would be produced by increasing the current through the discharge tube might result in an entire change of the spectrum. We should expect that it would only be in exceptional cases that the lines of A would be obliterated under the conditions holding in case 2, but in all cases the increase in the brilliancy of the lines of B would be large compared with the increase of those in A.

We see from the equations giving E_1 and E_2 that until the supply of energy has lasted for a time comparable with $1/\beta_2$, E_2 is large compared with E_1; thus for electrical discharges which last for an exceedingly short time we

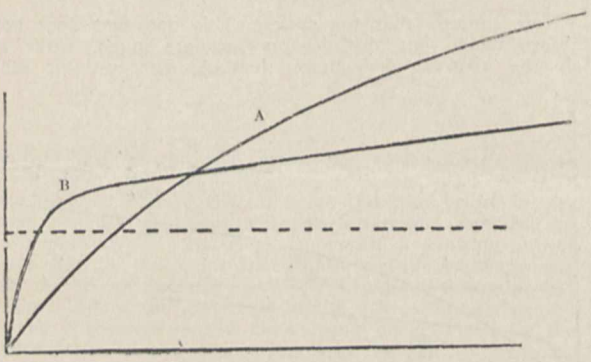

FIG. 5

might easily have the lines of B visible and not those of A.

In a discharge tube conveying an electrical current the amount of work per unit volume of the gas done by the electrical forces per unit time varies very largely from one point of the tube to another; if the cross section of the discharge is the same at all parts of the tube, so that the current density is uniform, the rate at which the electrical forces do work will be proportional to the electric force; as this is much greater near the kathode than at other parts of the tube, we should expect the lines of systems of the type B to preponderate near the kathode, and to be absent or much feebler in other parts of the tube. If the tube were of the type frequently used for spectroscopic purposes with a capillary portion in the middle, then since the current density is much greater in this portion than in any other, the rate of work per unit volume of the gas will be much greater in the capillary portions than in the wide parts of the tube, and we should therefore expect the lines of systems of the type B to be much more prominent in the capillary part than in the wide part.

Effect of Self-induction and Capacity.—Suppose that we have a tube of uniform bore arranged as in Fig. 6, the terminal of the tube being connected with the plates of a condenser of capacity C, and that there is a coil the coefficient of self-induction of which is L placed in series with the tube; then if the discharge through the coil begins when the potential difference between the plates of the condenser is V_0, the potential difference between the plates after a time t will be

$$V_0 \cos pt,$$

and the current through the tube

$$CV_0 p \sin pt,$$

where $p = 1/\sqrt{LC}$.

Thus the maximum value of the product of the current and the potential difference, *i.e.* rate at which the electric forces are doing work in the tube, is $CV_0^2 p$ or $V_0^2\sqrt{C/L}$, and is thus proportional to the square root of the capacity and inversely proportional to the square root of the self-induction. Thus increasing the capacity increases the maximum rate of work, and therefore increases the brilliancy of the lines corresponding to systems of the type B relatively to those of type A, while inserting self-induction in the circuit increases the brilliancy of those of type A as compared with those of type B. If we suppose that the "blue" spectrum of argon corresponds to a system of type B, the red to a system of type A, we have an explanation of the changes in the spectrum of this gas, for by inserting capacity in the circuit we can change from the red to the blue spectrum, while having got the blue we can get back to the red by inserting self-induction. I have here a little model which is intended to illustrate the way in which the red and blue spectra of argon originate. It is based on the fact that when we send a current of electricity through a circuit the current

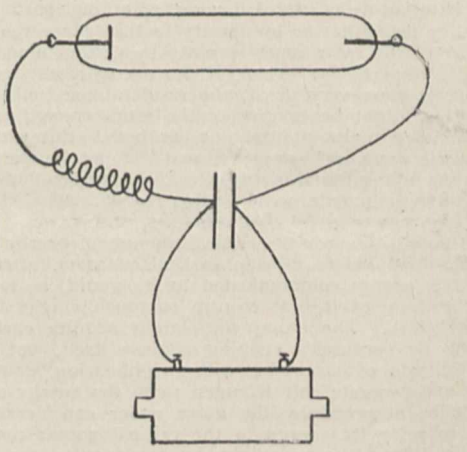

FIG. 6.

does not rise to its steady value instantaneously, but, starting from zero, increases with the time in exactly the same way as we have supposed the intrinsic energy in the atom, *i.e.* the way represented by the curve in Fig. 4. The quantity in the electrical case corresponding to the radiation β is the resistance of the circuit divided by the self-induction, while the quantity α is inversely proportional to the self-induction. Thus a circuit with large self-induction and small resistance is analogous to the system A, while one with small self-induction and large resistance is analogous to a system of type B. Now my model of the argon atom consists of two circuits, C and D, placed in parallel. C has large self-induction and small resistance, D has little self-induction but large resistance. An electric lamp is placed in each circuit. If I supply energy in one way, *i.e.* by continuous current, to the system, the red lamp in C lights up, the blue lamp in D is dark, while if fed by an alternating current the blue lamp shines and the red is dark. It would be interesting to see whether as we gradually diminish the self-induction we get the whole of the lines in the blue spectrum at once, or whether the lines of this spectrum enter in groups one after the other. I have tried somewhat similar experiments with the hot lime kathode to see in a mixture of gases, mercury vapour and air, which spectrum first appeared as the rate of doing work in the gas was gradually increased. The great difficulty in this determination is that when once

the luminosity begins there is such a rapid increase in the ionisation that the current through the gas and the rate of doing work increase in an exceedingly short time through a wide range of values, and thus a gradual increase in the rate of work is exceedingly difficult to obtain. On several occasions, however, I was convinced that on gradually increasing the rate of work the mercury lines were the first to appear, and were the last to disappear when the rate of work was reduced from a high value, at which both the nitrogen and mercury spectra were bright, down to a point where the discharge ceased to be luminous.

The preceding considerations have also an important application to the difference between the arc and spark spectra. In the continuous arc discharge, although the average rate of work is much higher than in the spark, the maximum rate is very much less; in the spark discharge we have an exceedingly intense current density lasting for a very short time, and while the spark is passing we have a very much greater rate of work than in the arc. Hence the state of things in the spark will be analogous to that represented in Fig. 5, and the lines corresponding to systems of the type B will be enhanced relatively to those of type A; we conclude, then, that the arc lines correspond to systems of the type A, the spark lines to those of type B.

The work done in the discharge tube is probably ultimately converted for the most part into heat, so that the rate at which work is being done at any part of the tube is approximately proportional to the rate at which heat is being produced in the tube. I do not, however, regard temperature, *i.e.* the energy due to the translation of the atoms as a whole, as having any direct connection with the production of spectra. The work done by the electric field on the corpuscles is, since the corpuscles can easily penetrate the atoms of the gas, first converted into internal atomic energy; this energy may ultimately be for the most part transformed into the energy of translation of the molecules of the gas, and so appear as temperature, but it by no means follows that if we heat the molecules of the gas by non-electrical means to the temperature to which even a few of its molecules are raised by the electric discharge we shall get a luminous spectrum. The production of the spectrum depends upon the internal energy of the atom; when we use the electric discharge all the work done by the corpuscles goes at first into the form of internal atomic energy, while if we supply the same amount of energy to the gas by thermal, as distinguished from electrical, means, the energy will go first into increasing the energy of translation of the atom, and very little of it will ever get inside the atom. It is probable, however, that some of the energy of translation will get converted into internal energy, and that temperature is one way of giving internal energy to the atom, and so producing luminosity; from our point of view, however, it is a very extravagant method, as the fraction of the energy spent in heating the gas which goes to produce luminosity is small.

The coefficient of absorption α of the systems will depend upon the way in which the internal energy is given to the atom as well as upon the rate at which the electric field is doing work in the neighbourhood of the atom. Thus, for example, if the internal work is given by means of rapidly moving corpuscles, the coefficient of absorption will depend upon the velocity of the corpuscle, for we can easily show that when a corpuscle passes at a fixed distance from a system of corpuscles having a definite period of vibration there is one velocity of the corpuscle, depending on this period, fast if the period is short, slow if it is long, for which the energy given by the corpuscle to the system is a maximum. Thus the relation between the amounts of energy absorbed by two systems from the corpuscles depends upon the velocity of the corpuscles. The velocity of the corpuscles in a discharge tube depends upon the pressure of the gas, so that even though the rate at which the electrical forces are doing work may be the same at two different pressures, the relative intensities of the lines of two systems A and B may be different.

Again, we might expect that the coefficient of the rate of absorption of energy would be different according as the energy is given to the atom by means of the large systems which form the positive ions or by means of small corpuscles, and that the relative brightness of lines might be different in the two cases. In the Kanal-strahlen we have positive ions moving through a gas and producing luminosity, and the spectrum of this luminosity possesses interesting peculiarities differentiating it from the spectrum of other parts of the tube. Perhaps the most striking difference, however, is when the positive ions strike against a salt like lithium chloride; they make the red lithium line appear with great brilliancy, while if corpuscles strike against the chloride the red line is not visible. It is remarkable that the spectrum of the metal is produced much more readily by the positive ions when they strike against a salt of the metal than when they strike against the metal itself; this is shown in a striking way if we take the liquid alloy of sodium and potassium and direct a stream of Kanal-strahlen upon it; the clean parts of the alloy appear quite dark, but the specks of oxide scattered over its surface shine with a bright yellow light, giving the sodium spectrum.

When the internal energy of the atom is increased by means of light, as in Prof. Wood's beautiful experiments on the fluorescence of sodium vapour, the coefficient of absorption of a system will depend upon the relations between the periods of that system and the period of the incident light vibrations; thus, as Prof. Wood found to be the case, the numerous lines in the spectrum given out by the vapour alter greatly in character and wave-length when the period of the incident light is changed.

The same principles which explain the variation in the intensities of the spectra given out by two different systems in the same atom can be applied to explain the variations in the intensities of the spectra of two gases, A and B, when these are mixed together. We know that under some conditions the lines of only one constituent of the mixture appear, while under others we get the lines of both the gases. Let us suppose that the lines of A appear with a lower rate of work of the electric forces than those of B, and that we send a constant current through the discharge tube, we can calculate what the electric force must be to produce from the molecules of A alone the number of ions required to carry this current; having found the electric force on this supposition, we can, knowing the current, find the rate at which the electric forces would be doing work in the tube; if this rate of work is less than that required to make B luminous, the current will be carried by the ions of A alone, and the spectrum of B will not be developed; if the rate of work on this supposition is greater than that required to make B luminous, the spectrum of B will appear, and it must take a share in carrying the current. Let us suppose that we have so much of A present that the rate of work is not sufficient to develop the spectrum of B, and consider what will happen as the proportion of A is diminished. In order to supply the number of ions required to carry the given current from the smaller number of molecules of A, the electric force, and therefore the rate of work in the tube, must, on the supposition that the current is wholly carried by A, increase, and if we continually diminish the amount of A present the rate of work will at last reach a value sufficient to make B luminous with the given current. This stage will give the smallest quantity of A which can for the given current wholly swamp the spectrum of B. The rate of work done in the tube will depend on the current going through it and also on the pressure of the gases, so that both these quantities will influence the proportion of the gas B required to make its spectrum visible.

MICROSCOPIC AQUATIC PLANTS AND THEIR PLACE IN NATURE.[1]

EVERY piece of water, besides containing large plants and animals which are readily visible to the naked eye, harbours a more or less considerable number of minute forms, which pervade all the layers of the water in varying amount, and collectively constitute the plankton or pelagic life. The most important difference between the

[1] Abstract of a lecture on "The Microscopic Plants of our Waters," delivered before the London Institution on February 1 by Dr. F. E. Fritsch.

plankton and the remaining flora and fauna of our waters lies in the fact that all the organisms which compose it are free-floating during the greater part of their life. Practically all the pelagic plants belong to the group of the algæ, and their minute size, of course, suits them well to a floating existence. A certain number of them are motile (*e.g.* Volvox, Gonium, Pandorina, &c.), and these are able actively to maintain themselves in their position in the water; but the large majority are non-motile, and all these forms are slightly heavier than water, and consequently tend to sink; they develop diverse mechanisms, by means of which their power of flotation is increased. The most important of these are:—assumption of a flat plate-like shape (Pediastrum, Merismopedia, many Desmids); development of numerous delicate processes from the body of the plant (Stephanodiscus, Richteriella); arrangement of the individuals of a colony in a more or less stellate manner (Asterionella, some Tabellarias); assumption of a delicate acicular shape (Synedra); formation of fat in the cell (many Diatoms and Cyanophyceæ), and so on.

In spite of these adaptations, however, most of the non-motile organisms of the plankton sink to the bottom of the containing vessel in the space of a few minutes after they have been collected. How is it that this does not happen in nature? It has been suggested that the continuous currents in the water, due to the wind and other causes, help to buoy up the organisms of the plankton; but it is of course also possible that in collecting such delicate forms they are damaged in some way or other so as to deprive them of that power of floating which suits them so well to their natural habitat. An interesting point connected with the development of the diverse floating mechanisms is that in some plants they have been found to be far more strongly developed in the summer than in the winter forms; this is, undoubtedly, in some way connected with the lower specific gravity of the water in summer, although the exact relation is not yet quite evident.

If the plankton of any piece of water is examined from week to week or month to month, we find not only astonishing variations in the quantity of organisms present, but also very marked differences in the specific constitution of the pelagic life. The quantity of the plankton is generally very much less in the winter than in the summer months, and the organisms composing it are quite different in the two seasons. Thus in the Thames there are four well marked annual phases, each characterised by its own peculiar plankton. This periodicity exhibited by the pelagic life stands in close relation to the external seasonal changes; some of the forms prefer cold, others warm water, and consequently they flourish in those seasons which are most to their liking. Some plants are particularly sensitive, and consequently only put in an appearance for a very short space of time each year. During their period of absence from the plankton these organisms persist as resting spores in the mud at the bottom of the piece of water; when favourable conditions return the spores germinate, giving rise to a new generation of pelagic organisms, which by their prolific division are able to dominate completely a piece of water in a few days' time.

The pelagic plants form the food of the animal plankton; these, again, are devoured by their larger brethren, which are the main source of nutrition for the smaller fishes. The larger fish are mostly carnivorous, feeding on smaller individuals of their kind. The organic matter of the pelagic plants thus gradually travels from one organism to another until it comes to form part of the body of the large aquatic animals; it passes through a series of incarnations before being returned to the water in the form of excrements or products of decay of dead animal and vegetable bodies. This organic matter is built up by the pelagic plants from simple inorganic salts and from carbon dioxide dissolved in the water, and these latter substances are thus changed into a form which makes them available to the aquatic fauna. All the organisms of the latter, as, indeed, all the animals of the world, are ultimately herbivorous. Without some kind of plant growth a piece of water must remain a lifeless, dead mass, unpopulated, and a thing apart from the living world around it. The presence of vegetation immediately transforms it into a throbbing universe, full of energetic life, exhibiting complex inter-relationships, and connects it with the remaining parts of our universe. The most important element of the vegetation from this point of view, however, is the phyto-plankton, and a piece of water with plenty of pelagic plants is sure to form a good breeding-place for fish and other aquatic animals.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The report of the committee of the school of geography for 1905 shows that the school now holds a strong position in the University, and is doing valuable work in encouraging the study of geography and surveying, and in providing special courses of geographical lectures suited to the requirements of the different final honour schools. Both the lectures and practical instruction were well attended throughout the year, although there were only a few candidates for the diploma. This year, in addition to the ordinary work during term, a special course lasting three weeks, specially suited to those who are engaged in teaching, is being arranged for August. The instruction will be both practical and theoretical, and there ought to be no lack of support for so useful an innovation.

CAMBRIDGE.—The forestry committee having been commissioned to submit a scheme of study and examination for the diploma in forestry, recommends that the Senate approve the following:—Candidates, before receiving the diploma in forestry, shall be required to produce evidence that they have (1) passed (or obtained exemption from) the Previous examination, together with the additional subjects; (2) satisfied the examiners in physics, chemistry, geology, and botany, either in part i. of the examination for the diploma in agriculture, or in that examination in combination with the Natural Sciences Tripos, part i., or in some other examination or examinations approved by the committee; (3) diligently attended courses of instruction in forest botany, in entomology, in forestry, in forest mensuration, surveying, and engineering, and such other courses in related subjects as may from time to time be approved by the committee; (4) attended for a time equivalent to one academical year courses of instruction in practical forestry approved by the committee; (5) obtained a certificate of proficiency in practical forestry approved by the committee; (6) passed the examination for the diploma; (7) been admitted to a degree in the University.

The general board of studies has approved for the degree of Doctor in Science Mr. G. H. F. Nuttall, Christ's College.

The general board of studies also recommends that it be authorised to appoint, subject to confirmation by the special board for medicine, Mr. G. H. F. Nuttall to be reader in hygiene in connection with the special board for medicine; that the university lectureship in bacteriology and preventive medicine terminate on his appointment as reader; and that the readership terminate with the tenure of office of Mr. Nuttall.

DR. W. A. THORNTON has been appointed to the newly-created professorship of electrical engineering at Armstrong College, Newcastle.

ACCORDING to a message from Wolfville, Nova Scotia, Mr. Carnegie has promised to the Acadia University 6000*l.* for a new science building as soon as 20,000*l.* has been raised for a forward movement now in progress. Of this sum nearly half is already in hand, and the rest is definitely promised.

THE council and principal of the Bedford College for Women will hold the usual reception at the college on Commemoration Day, May 9, after the presentations for degrees at the University of London. The Pfeiffer entrance scholarship in science, tenable for three years, and of the annual value of 48*l.*, will be offered for competition in June next.

AT the annual dinner of the students of the Camborne Mining School, held in Camborne on March 10, the prin-

cipal, Mr. J. J. Beringer, in reviewing the growth of the school for the past ten years, made some remarks upon the recent report of the departmental committee on the Royal College of Science. He pointed out that while the fellows of the faculty of mining and metallurgy may be only capable of being produced and fully nourished to maturity in the new institution, yet the general practitioners would still find their way to Camborne for their training. The chairman of the school committee, Mr. C. V. Thomas, remarked that though encouragement was given by the Government and the County Council, sufficient material assistance had always been wanting, and plans for extensions were crippled for want of funds.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 7, 1905.—"A Biometrical Study of Conjugation in Paramæcium." By Dr. Raymond **Pearl.** Communicated by Prof. Karl Pearson, F.R.S.

The purpose of this investigation was to determine whether any sensible differentiation exists between the conjugating and non-conjugating members of a population of the common ciliate infusorian *Paramaecium caudatum*, and to what degree structurally similar individuals tend to pair together in conjugation. The characters principally studied were length and greatest breadth of the body, and the shape of the organism as measured by the length-breadth index. The material used covered a considerable range of cultural conditions. It was found that there is a very considerable differentiation between conjugant and non-conjugant individuals. In respect to the absolute size characters (length and breadth of body), the differences between the means for the two groups of individuals amounted to from 10 per cent. to 20 per cent. of the mean size of the larger (non-conjugant) individuals. Not only are conjugants absolutely smaller than non-conjugants, but they are also sensibly differentiated in shape. Further, they are much less variable, and less highly correlated. There is a strongly marked tendency for like to pair with like in the conjugation of Paramæcium. The coefficients of correlation measuring homogamy in conjugation, are relatively very high, both for direct and cross assortative pairing, in all the characters examined. By an experimental study of random pairings it was shown that this homogamy in conjugation is due to a real assorting and pairing of like with like, and not a spurious effect of local differentiation in the culture. Further, by comparing records obtained from recently united pairs of conjugants with similar records from pairs about to separate, it was shown that the results cannot be due to any process of equalisation in size during the process of conjugation itself. The probable manner in which the homogamic pairing is brought about is discussed, and it is shown that the results are easily explicable on the basis of known facts regarding the behaviour of the organism. It is pointed out that the demonstration of the existence of a relatively fixed "conjugant type" has a direct bearing on current views as to the theoretical significance of protozoan methods of reproduction. The importance of getting positive evidence that a sensible degree of homogamy actually exists among organisms living under natural conditions has been many times emphasised by writers on evolution. The present work brings forward such evidence for a single organism standing low in the scale of organisation.

January 18.—"A Case of Regeneration in Polychæte Worms." By Arnold T. **Watson.** Communicated by Prof. C. S. Sherrington, F.R.S.

January 25.—"On the Overstraining of Iron by Tension and Compression." By Dr. James **Muir.** Communicated by Prof. A. Gray, F.R.S.

The behaviour of mild steel under compression is investigated. Compression stress-strain curves are usually shown very much rounded at the yield-point. In this paper a specimen of steel is shown to have obeyed Hooke's law until abrupt permanent shortening occurred at the stress of 21½ tons per square inch. At this stress the reading on a Ewing "compression extensometer" altered from 241 to 2900 without increase of load. This permanent shortening at the compression yield-point was found to be practically equal to the extension at the tension yield-point of the same material. A second compression test made on the same specimen, after recovery from the compressional overstrain, showed that the compression yield-point had been raised by a step of 4 tons per square inch. This was approximately the step by which the tension yield-point of the material could be raised by tensile overstrain.

Experiments were further made to investigate the behaviour under compression of steel which had previously been subjected to tensile overstrain. The experiments seem to indicate that there are two distinct causes contributing to the phenomenon of hardening by tensile overstrain:—(1) the overstraining itself—the actual stretching of the material—seems to harden the material equally as regards both resistance to tension and to compression; while (2) the process of recovery from tensile overstrain, which seems to bring into existence an internal stress, raises the tension yield-point by a definite step above the overstraining stress, but seems to lower the compression yield-point by approximately an equal amount below the overstraining stress. For example, a specimen subjected to a series of tension tests in which the loading is carried just beyond the yield-point (recovery from overstrain being effected between each test) might exhibit yield-points at 20, 25, 30, 35, and 40 tons per square inch. The corresponding compression yield-points should probably occur at about 20, 15, 20, 25, and 30 tons per square inch. This conjecture can scarcely be said to have been fully established, further research being necessary; but it is shown that steel may be hardened by tensile overstrain to resist higher stresses both in tension and in compression, although material so hardened always withstands a greater stress in tension than in compression.

February 8.—"Polarisation in Secondary Röntgen Radiation." By Dr. C. G. **Barkla.** Communicated by Prof. J. J. Thomson, F.R.S.

In a previous paper the author gave an account of experiments which demonstrated the partial polarisation of a beam of X-rays proceeding from the anti-kathode of an X-ray focus tube. The secondary radiation from substances of low atomic weight placed in the primary beam, however, varied in intensity in the two principal directions by not more than about 20 per cent.

The experiments described in this paper were made on the secondary radiation proceeding from a substance of low atomic weight, for, according to the theory given, the radiation proceeding in a direction perpendicular to that of propagation of the primary should be almost completely polarised.

The method was similar to that used in previous experiments, the intensity of tertiary radiation from a light substance placed in the secondary beam being studied by means of electroscopes, shielded from the direct primary and secondary radiations.

The principal experimental difficulties were due to the weakness of the tertiary beams.

Carbon was chosen as the radiating substance because the energy of secondary radiation from substances of low atomic weight had been found to be proportional merely to the quantity of matter passed through by a primary of given intensity, and as absorption diminishes with the atomic weight, the lower the atomic weight the greater is the energy of secondary radiation proceeding from thick plates exposed to a given primary.

A large mass of carbon was placed in the primary beam, and the horizontal secondary beam proceeding from this in a direction perpendicular to that of propagation of the primary was studied. In it was placed a second mass of carbon, and two electroscopes were situated to receive tertiary rays proceeding in horizontal and vertical directions. As the X-ray tube was turned round the axis of the secondary beam, the intensities of tertiary radiation in the two directions changed, one increasing to a maximum while the other decreased to a minimum.

It was found that the horizontal tertiary reached a maximum and the vertical a minimum when the primary beam was horizontal, and that the conditions were reversed when the primary was turned through a right-angle.

This result was anticipated by the theory previously given, and may be explained by considering the electrons in the radiating substance to be accelerated in the direction of electric displacement in the pulses passing over them.

The intensities in the two principal directions were approximately in the ratio 3 : 1. Considering the obliquity of primary, secondary, and tertiary rays in the beams experimented upon, this result indicates fairly complete polarisation in a narrow pencil of secondary radiation proceeding from the substance in a direction perpendicular to that of propagation of the primary.

When iron was used as the radiator in the secondary beam, though the rates of deflection of the electroscopes were of the same order of magnitude as before, there was no appreciable variation as the direction of the primary beam was changed.

This result was what previous experiments on iron led one to expect, and was the most conclusive proof of the interpretation of the results obtained with carbon. The independence of motion of the electrons disappears in the heavier atoms, and each is subject to considerable forces not directly due to the primary pulse (in this case the secondary pulse) and not in the direction of electric displacement in this pulse. Hence the variation in intensity of the tertiary in different directions becomes inappreciable, while the pulse thickness in the tertiary beam becomes greater than in the secondary, and is consequently more readily absorbed.

Geological Society, February 16.—Annual General meeting.—Dr. J. E. Marr, F.R.S., president, in the chair.—Influence of the geological structure of English Lakeland upon its present features. Anniversary address: **President.** After an account of the light thrown upon the structure of Lakeland by the writings of other geologists, the president considered his subject under the following heads:—Events prior to the uplift which produced the dome; production of the dome; initiation of the drainage-lines; effects of the three types of rocks upon the scenery; modification of old drainage-lines; depression of the outskirts; effects of meteorological conditions, (1) general, (2) the Glacial period. Of the events prior to the dome-shaped uplift, he laid greatest stress upon the movements of Devonian times, which had caused the Lower Palæozoic rocks to be affected by fractures forming a roughly rhomboidal network, the fissures being marked by belts of broken rock along their courses. He accepted Hopkins's view of the formation of a dome comparable in shape to a "caddy-spoon" with the short handle to the east. He gave further reasons in support of the view that the uplift of the dome and the final movements of the Pennine Chain were of Tertiary date. After commenting on the theory that rocks of New Red Sandstone age extended over the district, he discussed the nature of the radial drainage impressed upon these newer rocks during the uplift of the dome, and the removal of these rocks in the district itself by denudation, producing a superimposed drainage on the Lower Palæozoic rocks. The changes which took place in the valleys as the result of the imposition of the rivers upon the ancient rocks were then discussed, and it was maintained that diversion of the river-courses had largely taken place owing to the easier erosion along the shatter-belts. When discussing the effects of meteorological conditions he commented on hill-outlines, where the upper parts of hill-slopes presented a convex outline towards west and south, and a concave curve towards east and north. This he attempted to explain as due to the more profuse growth of vegetation on the slopes facing west and south.

February 21.—Sir Archibald Geikie, Sec.R.S., president, in the chair.—The constitution of the interior of the earth, as revealed by earthquakes: R. D. **Oldham.** This paper sets forth the information to be obtained from the records of distant earthquakes. The record of a great earthquake exhibits three phases, of which the third represents wave-motion travelling along the surface of the earth, and can give no information regarding the interior. The other two phases form the preliminary tremors, and represent the emergence of two forms of wave-motion propagated through the earth. Up to a distance of 120° of arc from the origin, these waves are propagated at a rate which increases with the depth of the wave-path, and reaches an average of more than 10 km. sec. for the first-phase, and more than 6 km. sec. for the second-phase waves. The increase may be attributed to the effect of increased pressure and temperature. Beyond this limit the first-phase waves show a reduction in the mean rate of transmission, while the second-phase waves are found, not where they would be expected, but at about 11′ later. Two interpretations are given. Either alternative leads to the conclusion that, after the outermost crust of the earth is passed, there is no indication of any rapid change of physical and chemical properties until a depth of about six-tenths of the radius is reached.—The Tarannon series of Tarannon: Dr. Ethel M. R. **Wood.** The Tarannon strata are well developed in the Llanbrynmair-Tarannon district, and the present paper gives the results of a detailed survey of the entire Tarannon series as there exhibited. Lists of the contained graptolites are given, and the species are paralleled with those from the corresponding beds of the south of Scotland, the Lake District, North Wales, central Wales, and Sweden, demonstrating the similarity of the graptolitic succession in all these districts. The Tarannon series in this district has a maximum thickness of 3500 feet, but thins somewhat as it is traced north-westward. It rests conformably on Llandovery rocks below, and passes up without a break into Wenlock beds above. This rock-series is stratigraphically continuous from base to summit. The strata of the overlying Wenlock series present all the characters of the Denbigh Grits and Flags of North Wales. The Llandovery series, which underlies the Tarannon series, has, at present, been recognised only in the western part of the district, namely, in the valley of the Twymyn, and its rocks are brought to the surface by an anticlinal fold. A comparison of the graptolitic lists shows that the Tarannon series, as here defined, corresponds almost exactly with the Gala or Queensberry group of the south of Scotland, includes all the palæontological zones hitherto assigned to the Tarannon, and fills up the whole period intervening between the Llandovery below and the Wenlock above.

Physical Society, February 23.—Prof. J. Perry, F.R.S., president, in the chair.—A note on Talbot's lines: J. **Walker.** The diffraction-pattern of a line of monochromatic light seen in focus, due to a rectangular aperture with its sides parallel to the line, is characterised by dark bands arranged at equal intervals on either side of the geometrical image of the line. The effect of covering half the aperture with a retarding plate is to displace the bands of an odd order towards the covered side by an amount proportional to the retardation introduced, those of an even order remaining fixed. Suppose that the light is white and that its monochromatic constituents have been made by spectral analysis to occupy different angular positions in the field. Owing to the dispersion, the bands of an even order are obliterated; but in the case of those of an odd order the dispersing power of the plate itself produces a dispersion of the bands, and consequently these bands will be seen, provided the plate have a suitable thickness and be so placed that the dispersion of the bands produced by it acts in opposition to the primitive dispersion of the light.—Secondary Röntgen radiation: Dr. C. G. **Barkla.** In previous papers the author has shown that the secondary X-rays from certain gases and light solids subject to Röntgen radiation may be fully explained by considering the corpuscles or electrons constituting the atoms to be accelerated in the direction of electric displacement in each primary Röntgen pulse as it passes through such substances, and that the interaction between the electrons affects only to a slight extent the character of the secondary radiation. Experiments on the absorption of rays proceeding from thick plates of a large number of elements showed that beyond the region of atomic weights in which the character of the secondary radiation is almost independent of the nature of the radiation, the absorbability is a periodic function of the atomic weight of the radiator, and that, so far as these experiments have gone, different periods are represented by curves of similar form. The theory which has been found to explain all the pheno-

mena of secondary radiation from light atoms may be extended to explain these results, if the independence of motion of the electrons is conceived to disappear with an increase in the number of electrons in the atom.—Records of the difference of potential between railway lines when a train passes and at other times, and a suggested method for the observation of earth currents and magnetic variations: C. W. S. **Crawley** and F. B. O. **Hawes.** The experiments described in the paper were made on the London and South-Western main line, between Walton and Weybridge stations. To each rail of the up line a wire was permanently attached, and the other ends of the wires were connected to the terminals of a reflecting galvanometer. The deflections of the galvanometer were recorded on a moving sheet of paper, and curves obtained showing the variation in the current through the galvanometer. The curves showed a concordance in the results from successive trains. The normal current through the galvanometer began to be disturbed about one minute before the passage of a train, and the disturbance lasted about two minutes.

Royal Microscopical Society, February 21.—Dr. Dukinfield H. Scott, F.R.S., president, in the chair.—A method of producing stereo-photomicrographs: W. P. **Dollman.** A number of good stereoscopic prints were exhibited in the room in illustration of the paper.—A simple method of taking stereo-photomicrographs and of mounting the prints without cutting: Mr. **Taverner.** Though this paper was upon the same subject as the previous one, the methods of the authors were different, and Mr. Dollman limits his operations to very low powers, giving amplifications of 9 to 20 diameters only. He uses a stop in front of the objective, and exposes first one side of the lens and then the other as he takes his two stereoscopic pictures. Mr. Taverner uses higher powers, and a peculiar stop at the back of the objective. The authors adopt a similar arrangement for obviating the necessity of cutting the prints.—A second list of rotifers of Natal: Hon. T. **Kirkman.** The author described a remarkable new species, *Copeus triangulatus*.

Anthropological Institute, February 27.—Prof. W. Gowland, president, in the chair.—Ancestor worship in Japan: W. G. **Aston.** It was shown that the so-called ancestor worship of the Japanese is in reality a cult of the sun and other nature deities, but as the sun or sun-goddess, by a genealogy which covers a period of about 2,000,000 years and contains many miraculous incidents, is feigned to be the ancestor of the Mikados, the Japanese naturally speak of this cult as ancestor worship. We should not follow their example. The descent of the Japanese nobility from the sun-goddess and other deities of the old Pantheon is to be regarded in the same light. There is a worship of true ancestors in Japan, but it is due to Chinese influence, and is of later origin.—Anthropological notes from Lake Tanganyika: W. A. **Cunnington.** The author dealt with the manners, customs, and arts, &c., of the natives living by the lake. Among the slides exhibited was a series showing the different stages of the manufacture of a pot, the peculiar point being that the bottom of the pot is put in last. Other slides showed examples of weapons, dress, houses, and costumes of the natives.

March 13.—Prof. W. Gowland in the chair.—A collection of Palæolithic implements from the neighbourhood of Southampton: W. **Dale.** The author divided the implements into the following groups:—flakes, plain and trimmed; implements with the butt end purposely left smooth, used for chopping; oval- and almond-shaped implements with a cutting edge all round; pointed implements with both edges equal, and tapering gradually; pointed implements with one curved and one straight edge, adapted for making long cutting strokes; pointed implements in which one side has been left as flat as possible—these occur very sparingly in the Hants gravels.—Materials for a study of tatu in Borneo: R. **Shelford** and Dr. C. **Hose.** The paper contained the observations made by the writers amongst the Kayans, Kenyahs, Bakatans, Kalabits, and Sea-Dayaks of Sarawak. All the information on the subject by previous writers had been analysed and compared, special use being made of Dr. A. Nieuwenhuis's books on Borneo. Kayan tatu, which is still a flourishing art, was described in considerable detail, not only with reference to the tatu designs employed, but also to the elaborate ceremonial accompanying the practice. The Kenyahs and Sea-Dayaks also appear to have borrowed the practice of tatu very largely from the Kayans; but most of the Indonesian tribes have all had at one time or another a distinctive tatu. It is most unfortunate that the practice is rapidly dying out amongst these people. It was not found possible to classify the tatued peoples of Borneo in three main divisions as had been done by Dr. Nieuwenhuis for those of a less extended area.

Linnean Society, March 1.—Prof. W. A. Herdman, F.R.S., president, in the chair.—A new type of stem from the Coal-measures: Dr. D. H. **Scott.** The stem is one of the many interesting fossils obtained from the pit at Shore-Littleborough, in Lancashire, opened up for scientific purposes by the generosity of the owner, Mr. W. H. Sutcliffe. The sections were cut by Mr. J. Lomax. The specimen was derived from one of the roof-nodules, which generally represent a peculiar flora, distinct from that of the seam-nodules immediately below. Specimens of the great petioles of the same plant had been discovered a year or two before the stem itself came to light. The fragment was about 15 cm. long, and belonged to a stem of considerable size, the diameter being about 12×6·5 cm. The new stem is referred to the family Medulloseæ, of which it constitutes a unique type. It is placed in a new genus, named Sutcliffia, in honour of Mr. Sutcliffe, of Shore-Littleborough, and the specific name *S. insignis* is proposed for it.—Notes on some species of Nereis in the district of the Thames estuary: Dr. H. C. **Sorby.** In the course of yachting expeditions during successive summers for more than twenty years, Dr. Sorby has observed some remarkable facts connected with the Heteronereis form in two species of Nereis. The rarity of the occurrences should make the record of them acceptable. Notes are given in the paper on five species of Nereis found in the Thames district.

Sociological Society, March 14.—Prof. E. Ray Lankester, F.R.S., in the chair.—Notes on the sociological appeal to biology for suggestion: Prof. J. A. **Thomson.** The sociologist is beginning to recognise the usefulness of analysing out the organic processes which contribute to the result which we call social activity. The same is true of the sociologist's appeal to biology. If the recognition of biological factors operative in social activity is very partial the result is sure to be fallacious. By recognising the operation of biological factors in the life of a societary group the sociologist brings what is distinctively social into greater prominence. There is some danger of an inaccurate "materialism" if we pretend that sociology is merely a higher department of biology. The chief value of the appeal to biology by sociological students is threefold:—(*a*) aiding in analysis; (*b*) showing that various modes of social activity have a biological aspect; (*c*) suggesting from biological experience the discovery of sociological laws.

PARIS.

Academy of Sciences, March 12.—M. H. Poincaré in the chair.—The propagation of a movement round a centre in an elastic, homogeneous, and isotropic medium: J. **Boussinesq.**—The effects of the absorption of tuberculin by the digestive tube in healthy and tuberculous animals: A. **Calmette** and M. **Breton.** The experiments described show that tuberculin, when absorbed by the alimentary canal, is toxic for non-tuberculous animals, the effect being especially marked for young animals. The tuberculin is no better tolerated when the dosage starts from a minimum and is progressively increased. For tuberculous animals a very much smaller dose of tuberculin is poisonous.—The evolution of the Tertiary mammals: the importance of migrations: Charles **Depéret.**—The seventh scientific voyage of the *Princess Alice*: **Prince Albert of Monaco.** General description of the work done in oceanography, zoology, microbiology, and meteorology of the Sargasso Sea, in mid-Atlantic.—Observations of the comet 1906*b*

made with the large equatorial of the Observatory of Bordeaux: E. **Esclangon.** The observations were made on March 6 and 7. The comet had the appearance of a star of 10·5 magnitude, surrounded by a very feeble luminosity.—The electromotive forces of contact between metals and liquids, and an improvement in the ionograph: Charles **Nordmann.** Diagrams are given of the apparatus and of a record of the recording instrument for a period of twelve hours.—The sympathetic vibration of a string giving a low note under the influence of one giving a higher note, and the possible consequences arising from this: Edmond **Bailly.** It has been held up to now that a note cannot produce a sympathetic vibration in a string of lower pitch than itself. The author describes an experiment leading to a contrary conclusion.—The action of hot sulphuric acid on salts of platinum and iridium in the presence of sulphate of ammonium: Marcel **Delépine.** Both these metals are dissolved by boiling sulphuric acid in very appreciable quantities. Complex acids appear to be formed in which the sulphuric acid is not precipitable by barium chloride.—The action of peroxide of nitrogen on ammonia and some ammoniacal salts: MM. **Besson** and **Rosset.** When liquid ammonia at −90° C. is added to solid nitrogen peroxide at the same temperature there is a violent explosion. The reaction can be moderated by working with ammonia gas at −20° C.; the products are nitrogen, nitric oxide, and ammonium nitrate.—The action of silicon chloride upon cobalt: Ém. **Vigouroux.** At a high temperature silicon chloride is reduced by cobalt, a volatile metallic chloride being formed and a cobaltosilicon remaining behind. The amount of silicon in this latter compound tends to the silicide Co_2Si as a limit.—The dilactide of lævorotatory lactic acid: E. **Jungfleisch** and M. **Godchot.**—A method of determination of the foreign materials contained in cocoa and chocolate: F. **Bordas** and M. **Touplain.** The substance is treated with carbon tetrachloride mixed with varying proportions of benzene, so as to get a range of density between 1·6 and 1·346. A separation of the materials of different densities is readily effected.—Polyvalent antioxydase serum: C. **Gessar.**—Contribution to the systematic anatomy of some kinds of ferns: Ferdinand **Pelourde.**—Nuclear fertilisation in the Mucorineæ: M. **Dangeard.**—*Hylochoerus Meinertzhageni*: Maurice **de Rothschild** and Henri **Neuville.**—The structure of the cæcum or filiform appendices of the middle intestine of *Phyllium crurifolium*: L. **Bordas.**—The comparative anatomy of the Sipunculidæ: Marcel A. **Hérubel.**—The evolution of the supposed coccidia of cephalopods: Th. **Moroff.**—A new disease of the trout: L. **Léger.**—The analysis of tubercle bacilli: G. **Baudran.** Separate analyses were made of dead and living bacilli. The former gave lecithin, cholesterin, and fat, cellulose, nuclein, and albumenoid materials. The living bacilli gave, in addition, an anaëroxydase and an alkaloid.—The reaction of the blood a function of nutrition: Jean **Gautrelet.** There is an absolute parallelism between the apparent alkalinity of the blood and the activity of the organic exchanges as measured by the amount of hæmoglobin.—The Pleistocene glaciers in the valleys of Andorre: Marcel **Chevalier.**—The volcanoes of the Livradois and Comté, Puy-de-Dôme: Ph. **Glangeaud.**—The tectonic of the Ivrée and Strona zones: Émile **Argand.**—The diatom-bearing sediments of the region of Lake Tchad: Paul **Petit** and H. **Courtet.**

DIARY OF SOCIETIES.

THURSDAY, MARCH 22.

ROYAL SOCIETY, at 4.30.—*Bakerian Lecture*: Recent Advances in Seismology; Prof. J. Milne, F.R.S.—On Methods whereby the Radiation of Electric Waves may be mainly confined to Certain Directions, and whereby the Receptivity of a Receiver may be restricted to Electric Waves emanating from Certain Directions: Chevalier G. Marconi.—A Note on the Theory of Directive Antennæ or Unsymmetrical Hertzian Oscillators: Prof. J. A. Fleming, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electrical Equipment of the Aberdare Collieries of the Powell Duffryn Co.: C. P. Sparks.—Electric Winding considered Practically and Commercially: W. C. Mountain.

ROYAL INSTITUTION, at 5.—Internal Combustion Engines: Prof. B. Hopkinson.

FRIDAY, MARCH 23.

ROYAL INSTITUTION, at 9.—Imperial Defence: Lord Roberts.

PHYSICAL SOCIETY (University College), at 5.—On Unilateral Electric Conductivity over Damp Surfaces: Prof. F. T. Trouton, F.R.S.—The Construction and Use of Oscillation Valves for Rectifying High Frequency Electric Currents: Prof. J. A. Fleming, F.R.S.—On the Use of the Cymometer for the Determination of Resonance Curves: G. B. Dyke.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Waves: F. K. Stevens.

SATURDAY, MARCH 24.

ROYAL INSTITUTION, at 3.—The Corpuscular Theory of Matter: Prof. J. J. Thomson, F.R.S.

MONDAY, MARCH 26.

SOCIETY OF ARTS, at 8.—Fire, Fire Risks, and Fire Extinction: Prof. Vivian B. Lewes.

INSTITUTE OF ACTUARIES, at 5.—Some Aspects of Registration of Title to Land: J. R. Hart.

TUESDAY, MARCH 27.

ROYAL INSTITUTION, at 5.—The Influence of Geology on Scenery: Dr. J. E. Marr, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Continued Discussion*: The Outer Barrier, Hodbarrow Iron Mines: H. Shelford Bidwell.—The Harbours of South Africa: C. W. Methven.

WEDNESDAY, MARCH 28.

SOCIETY OF ARTS, at 8.—Coal Conservation, Power Transmission and Smoke Prevention: A. J. Martin.

THURSDAY, MARCH 29.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On the Dilatational Stability of the Earth: Lord Rayleigh, O.M., P.R.S. On the Observations of Stars made in some British Stone Circles. Second Note: Sir J. Norman Lockyer, K.C.B., F.R.S.

ROYAL INSTITUTION, at 5.—Internal Combustion Engines: Prof. B. Hopkinson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—*Adjourned Discussion*: Electrical Equipment of the Aberdare Collieries of the Powell Duffryn Company: C. P. Sparks.—Electric Winding, considered Practically and Commercially: W. C. Mountain.

FRIDAY, MARCH 30.

ROYAL INSTITUTION, at 9.—Recent Progress in Magneto-optics: Prof. P. Zeeman.

SATURDAY, MARCH 31.

ROYAL INSTITUTION, at 3.—The Corpuscular Theory of Matter: Prof. J. J. Thomson, F.R.S.

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