NATURE

SATURDAY, MAY 5, 1928.

CONTENTS.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 3053, Vol. 121]

Forestry and Agriculture in Great Britain.

A RECENTLY published part of the *Scottish Forestry Journal* (vol. 41, pt. 2) contains several articles of interest for those who have some acquaintance with forestry practice in Great Britain. Perhaps the paper of chief importance at the present time is that by Dr. John D. Sutherland on the "Economic Balance between Forestry and Agriculture." Dr. Sutherland's main theme revolves round the contention of the Forestry Commissioners that in view of the good work already accomplished, a larger grant should be made to them for the next ten years' work, allusions to which have already appeared in our columns. Dr. Sutherland in his opening remarks states that "there is the certain prospect of a world shortage of coniferous timber within the period of one forest rotation." Opinions differ, as can be readily understood, as to the exact significance to be attributed to the phrase "the threatened timber famine."

Some time ago, reference was made in some short paragraphs under the heading "Log Rolling," in the *Timber News*, to Lord Clinton's remark in a recent address on "Imperial Forestry" read at the Royal Colonial Institute. Lord Clinton stated that it was estimated that the quantity of timber used and destroyed amounted to eight times the annual growth. On this the writer remarks, with particular reference to the subject of timber famine in Europe :

"This cannot go on for ever . . . we have no great faith—like the masters in the timber trade—in the belief of approaching timber famine . . . we are inclined to the impression that prices of timber will gradually rise after post-war stabilisation, and that in course of time there will be a shortage compared with the preponderating supplies of to-day, and it seems that in hardwoods, as with softwoods, those who warn us of a timber famine are nearer the truth than those who ignore the idea."

In his article Dr. Sutherland contrasts the Government expenditure in connexion with agriculture with that on forestry :

"It is a fact," he says, "that both food and timber are essential to our existence, that our consumption of the former represents a value of £722,000,000, and the value of the timber used is £63,000,000 (figures for 1925) . . . is it too much to expect that when the subsidies and assistance to agriculture are £16,000,000 the amount presently devoted to the making of timber through the creation of forests might not in the same proportion be £1,300,000 annually instead of about £350,000 ? If further support of this suggestion

be necessary, it may be represented that the expenditure by the nation on forestry, whatever the amount, is for creative purposes and might be described as a national endowment, and one which will be productive of material absolutely essential, and in this process of production yield a return to the State."

Dr. Sutherland produces many sound arguments in favour of afforestation in his paper, but the one above quoted appears open to question. Both as individuals and as a nation we are greatly impoverished. However desirous individuals might be to form an endowment for the future of their children, let alone grandchildren (as is the case with forestry), their present circumstances preclude the idea. Much of the State expenditure on agriculture is at least profitable to the existing generation, and therefore the taxation imposed for this cause results in some direct return. Few at present alive can hope to share in any future benefits which may accrue from the afforestation work undertaken at the present day. In the opinion of many who have studied this question, the decision which faces the Government, in view of the fact that no very apparent alleviation to the taxpayer is in sight, is on what scale the afforestation work, with due regard to the interests of the taxpayer, should be carried on during the next ten-year period and whether some of the heavy overhead charges could not be curtailed.

Science and Policy in India.

The Development of Indian Agriculture. By Albert Howard and Gabrielle L. C. Howard. (India of To-day, Vol. 8.) Pp. vi + 98 + 6 plates. (London: Oxford University Press, 1927.) 3*s*. 6*d*. net.

THE Oxford University Press is to be congratulated on the foresight it displayed in 1924 in inviting Mr. and Mrs. Albert Howard to prepare a short account of the present position of agriculture in India, and Mr. and Mrs. Howard deserve the warmest thanks of all those interested in agricultural development and research, the education of the farming community, and the social institutions and economic life of the coloured cultivators of Great Britain's tropical and subtropical possessions, not only for the skill with which they have dealt with their subject matter, but also for its timely publication. Their hundred-page volume on "The Development of Indian Agriculture" is a model of compression, not merely a masterly summary, of the salient facts and current opinions regarding the past, present, and future of the industry upon which nine-tenths of the population of India is directly or indirectly dependent. It should prove invaluable as a guide to the labours of the Royal Commission on Indian Agriculture which at present, under Lord Linlithgow, is pursuing its investigations in India; it can also be warmly commended to the members of the Simon Royal Commission for their careful study, not because it deals with the constitutional issues which are their immediate concern, but because constitutional reform without economic and educational reform will do nothing to ameliorate the condition of life of the mass of the population of India, and this is what matters most.

Mr. and Mrs. Howard are concerned mainly with the problem of raising the standard of living of the rural communities of India. They write with an authority based upon twenty years' successful work in the country. They possess the cardinal virtues of faith, hope, and charity: faith in the scientific method, hope for the dawning of the day when the peoples of India possess the knowledge and determination to apply the discoveries of science to the soil which sustains them, and that charity born of sympathy and a ripe understanding of the peasants for whom they labour. They combine a *flair* for research with unusual gifts for administration, the enthusiasm to discover, coupled with the will, capacity, and determination to have their results applied. They are of a type with those public servants of Canada recently described by Prof. McLennan as working for meagre rewards and little recognition to confer incalculable benefits upon mankind. The very nature of their work makes them the architects of a new order, missionaries of an enlightened imperialism, statesmen of the world, not the instruments of parties, factions, or nations. Their function is so to direct the energies of man that he will no longer spend all his days in ceaseless toil for mere existence.

Nothing could illustrate the struggle for existence better than the statistics given in this volume. Out of the 316,000,000 people in India, about 225,000,000 are directly dependent on agriculture. The total area under food and fodder crops, for supplying the cultivator and his cattle with food, is only 220,000,000 acres, that under money crops —out of the proceeds of which the cultivator pays his land revenue and purchases a few necessaries other than food—is less than 40,000,000 acres. The average holding is thus extremely small, in some districts less than five acres in area, and the position is made worse because they are frequently cultivated by methods which are suitable only for

large areas. Abject poverty is the result. The majority of the people of rural India live in houses built of mud, thatched with grass, and possess practically no furniture. Small wonder that people living under such conditions are unprogressive.

They are "for the most part uneducated, illiterate, and almost incapable of thinking for themselves. The majority are born in debt, live in debt, and die in debt. Money-lending has become one of India's greatest industries. . . . Even the best cultivators have little or no capital for developing their fields. Everywhere agricultural land is regarded as a convenient means of investing money so that the rents can provide a certain income. Only in rare cases is money devoted to land improvement. In many parts of the country the pressure of population, both human and bovine, is intense, and but for the high infant mortality and periodical waves of pestilence the position would become desperate."

Keatinge estimates there are nearly 1,000,000 useless cattle in the Bombay Deccan alone—and these have to be fed: as the cow is a sacred animal, and the people mostly vegetarian, they cannot be used for food.

One fact is omitted in this volume which is of the greatest importance. Due largely to the application of the discoveries in medical and sanitary science, and the improvement in means of communication which enable food to be distributed in the event of the failure of the monsoon, the population of India has risen in the last fifty years from about 200,000,000 to its present total of 320,000,000. Now it cannot be pretended that the agricultural and allied services, in spite of their recorded triumphs, touch the fringe of the problem presented by this increase, or that the growth of manufacturing industries in India has done much to improve the general condition of the peoples. There is obviously an urgent demand for the acceleration of the work having for its objects the improvement of methods of agriculture, so that each unit shall yield "either more produce, more valuable produce, or an increased yield of a better quality than the average," and the increase of the area under cultivation. That this can be done is exemplified by some of the results obtained in the past fifteen years. 'Pusa wheats' now spread over an area of more than two and a quarter million acres in the United Provinces, representing a yearly increase of profit to the growers of £2,500,000: heavy yielding varieties of rice now cover 0·8 per cent. of the total area under this crop; 12 per cent. of the area under cotton, and nearly 10 per cent. of that under jute, is now raising improved types; improved varieties of sugar-cane, fodder-crops, ground-nut, and tobacco have also been introduced with successful results. At a conservative estimate, made in 1925–26, improved varieties covered no less than 7½ million acres, representing an enhanced yearly value of more than £5,500,000. Compared with the cost of the services which produced them, the results are a magnificent achievement, but

"much greater progress could have been made," say our authors, "but for one great obstacle, namely, the fact that the Indian cultivator is uneducated and cannot be reached by the printed word. How greatly the illiteracy of the peasant has hampered the work of rural uplift [my only complaint against the authors is the frequent use of this word 'uplift'] in India will be realised if the spread of the new varieties of Pusa wheats is compared with that of Marquis varieties in Canada and the Northern States of the Union. . . . In 15 years the Pusa wheats have covered a little over 2 million acres. In about the same period the area under Marquis has exceeded 20 million acres."

Mass education of the Indian country-side is the obvious need. By no other means will a desire for progress be kindled among the inhabitants of the villages of India. Unless the educational level is raised it is impossible to achieve lasting results by mere demonstration, except at ruinous expense.

Two aspects of the problem of educating hundreds of millions of people have to be considered, the education of the adult and the education of the child. Grundtvig in Denmark, Plunkett in Ireland, and the General Education Board—the unofficial body which investigated conditions in the southern States of the United States of America—have dealt with the first aspect with such success that prosperity has been brought to peoples which were formerly distressingly poor and unprogressive. The experiments they tried were successful because official effort was deliberately limited to propaganda aimed at creating a demand on the part of the cultivators themselves for the education of their children and for better villages, rather than foisting upon them a programme of education and rural improvement from the outside, and as a first practical step to assist them by the inauguration of co-operative farm demonstration to make the soil yield a higher dividend. Above all, the problem of "rural development was surveyed as a whole, studied as a whole, and dealt with as a whole."

The efforts made in India for the past twenty years, which at first sight resemble closely those adopted elsewhere with success, have been ineffective because of the lamentable fragmentation

of effort. "Moreover, the horde of minor officials (mostly townsmen) who now deal piecemeal with the problems of the villager is more likely to exasperate than to awaken him from his present attitude of indifference to all forms of progress." Consequently, just as Mr. and Mrs. Howard advocate a reform of the agricultural research services whereby the plant, for example, cotton, will be regarded as the centre upon which a knowledge of several sciences, of practical agriculture, and of the requirements of the trade will be brought to bear, its activities controlled by an unofficial organisation representing all interested parties, in place of the present officially controlled system based on the separate science, so they recommend the removal of the various agencies which deal with the problems of rural India from official to unofficial control and their consolidation under a Development Board of Rural Reconstruction, upon which the legislature, the executive, the local notables, and the most able of the workers could be represented.

For dealing with the problem of the education of the child in rural areas Mr. and Mrs. Howard suggest that full use be made of American experience. In America the inefficiently staffed, inadequately equipped and poorly built schools were abolished and replaced by a lesser number of central schools, well-staffed and equipped and well-built, the children being conveyed to them at the public expense. This system, it is suggested, could be adopted with great advantage in India. What is wanted is not

"one poor little school in each of the 7,000,000 villages of India," but from "1,000,000 to 2,000,000 well-constructed central schools, each with suitable equipment, a number of well-trained teachers, and sufficient pupils to feed the classes. Each of these schools, under the guidance of a schoolmaster who should be drawn from a village—with adequate pay and a recognised position of honour in the community—could be the centre of progress of a group of villages. By its means such movements as Co-operative Credit, the Co-operative sale of produce, the establishment of better markets, the demonstration of simple improvements in cultivation, the distribution of improved seed, improved rural sanitation, better housing and better communications will be provided with a suitable meeting place. . . . The people generally will come in contact with the Government in other ways than through the policeman and the tax-gatherer."

In short, Mr. and Mrs. Howard believe that by the reorganisation of research, the concentration of the various departments at work for rural development into a single agency for each province, mass education for adults and children on lines similar to those followed in America,

"the people [of India] could be taught how to help themselves and how to appreciate and make proper use of funds contributed by the State for the support of local movements. The gradual growth of the rural electorate, capable of intelligent co-operation with Government in the future development of India, would follow."

This volume should not only be eagerly read by the members of the two Royal Commissions dealing with Indian problems; it should also be in the hands of every statesman and politician in India, every student of rural education the world over, and of all those who wish to understand the problems with which administrators and other public servants in the various parts of the British Empire are faced. The problems facing India have been intensively studied for some years. They do not differ essentially from those facing our local governments in Africa. It has been said: "It is one of the defects of our system of State departments that the invaluable lessons of our Indian administration and economic progress—the result of much costly experience and research—and the history of its successes and failures, are not more readily accessible to other tropical dependencies, which are emerging from the state in which India was many years ago." Mr. and Mrs. Howard have done much to remedy this defect.

A. G. CHURCH.

Stellar Thermodynamics.

Thermodynamik der Himmelskörper. Von R. Emden. (Sonderausgabe aus der Encyklopädie der mathematischen Wissenschaften.) Pp. iii + 373-532. (Leipzig und Berlin: B. G. Teubner, 1926.) 6·40 gold marks.

R. EMDEN is well known among students of theoretical astrophysics from his book "Gaskugeln," which summarised and extended the work done prior to 1906 on the problem of the internal constitution of the stars. The present book has many points in common with "Gaskugeln," but it covers a wider field, inasmuch as the recent development of the subject is also considered.

In its scope and arrangement of subjects the book appears essentially as a historic account of our ideas concerning the internal structure of celestial bodies since the foundation of modern astrophysics. The introduction is naturally concerned with the fundamental laws of thermo-

dynamics and their applicability to stellar problems. Next comes a short review of earlier ideas concerning the origin of the energy radiated from the stars: the meteoric hypothesis of Mayer, and the gravitational contraction theory of Helmholtz; and the insufficiency of both, in accounting for the apparently long life cycle of a star, is pointed out. An interesting excursion on meteors in the terrestrial atmosphere closes this first section of the book.

The second section is concerned with the structure of gaseous stars in which the effect of transmission of energy by radiation is ignored. This was the point of view commonly adopted by the pioneer workers in this field in the past century, which led to the conception of stars in convective equilibrium. Most of Emden's work fell within this category, and was ably covered in his "Gaskugeln." By a rare caprice of Nature, it happened that much of this work retained some interest also in the theory of radiative equilibrium of the stars, such that an inclusion of this section in a modern work is justifiable. Besides, this section is concerned with a variety of allied problems in which it is essential to adopt the microscopic point of view of kinetic gas theory. An important problem of this type is, for example, the calculation of the loss of mass from the surface of a star due to random motion of the molecules.

In the third section a step further is taken, so as to include the effect of transmission of energy by radiation inside a star. We are here led through the different stages of development in this phase of the theory, as they are marked down by the names of Schwartzschild, Eddington, Milne, and Jeans. This section is written with sober judgment and becoming reticence with regard to doubtful points, which is much to be commended, considering the delicate nature of the questions involved. The fourth section is concerned with the application of atomic physics to stellar problems. Here is given, for example, a short exposition of the theory of thermal ionisation, which was initiated by Eggert and Saha, and has proved to be of great value in the interpretation of astrophysical facts.

The book thus covers a wide field and bears witness of being written by a broad-minded and intelligent observer. However, in view of the difficult aspects of most questions concerned with stellar constitution, we cannot help thinking that this book would have gained considerably in value if it had been written from an entirely different point of view. In fact, so much space has been spent on the historical side of the questions, that modern aspects of the stellar problems have received too scanty consideration. The author himself admits that the vital questions of stellar theory are really problems in atomic physics. If he had drawn the logical consequence of this recognition he would have devoted the bulk of the book to a thorough discussion of just these basic atomic problems, leaving earlier ideas, which we admit to be inadequate or unessential, to the care of the historian. S. ROSSELAND.

The Streptococci.

Annals of the Pickett-Thomson Research Laboratory. Vol. 3 (containing a Historical Survey of Researches on the Streptococci). Published for the Pickett-Thomson Research Laboratory, St.Paul's Hospital, 24 Endell Street, London, W.C.2. Pp. vi + 316 + 57 plates. (London: Baillière, Tindall and Cox; Baltimore, Md.: Williams and Wilkins Co., 1927.) 42*s.* net.

ALL pathologists will agree that our present knowledge of the streptococci, the round-celled bacteria which form chains by successive division, is in great confusion, and that the reason for this is the lack of proper means of identification of the numerous streptococcal species. Yet the importance of the streptococci in both human and veterinary pathology is known to be very great and suspected to be still greater than has been actually established. Scarlet fever, puerperal fever, erysipelas, and the gravest forms of wound infection are accepted examples of streptococcal invasion, while acute and chronic rheumatism, in its many manifestations, heart disease, the enlarged tonsils and adenoids of youth, and the premature decay of teeth, are all diseases of possible streptococcal origin which, for elucidation of their cause, wait upon the identification of the infecting streptococcus by the bacteriologist.

Our authors, Drs. David and Robert Thomson, have attempted to bring some order out of the present chaos. They have assembled the widely scattered literature on the appearance, behaviour, and classification of streptococci, the more important papers being reviewed in great detail and illuminated by comments based on the authors' own observations. This review, which occupies 250 of the 300 pages of letterpress, would alone justify the very great labour and expense involved in the production of the book. Nothing comparable in extent has ever been published on the streptococci, and it may be taken as certain that bacteriologists who have been deterred from research on the streptococci by the thought of the arduous

preliminary reading involved will now take up the problems thus prepared and set before them.

The review is followed by an article of 19 pages by Dr. Warren Crowe, giving an account of his methods of differentiation (with 5 full-page colour plates of colonies) and by the authors' list of the streptococci which they think can be identified and classified as separate varieties. They divide the streptococci into five main groups, distinguished from each other by the colour changes produced by the constituent varieties on agar containing boiled blood. Group A produces no colour, group B produces a faint green tinge, group C shows a narrow green or yellow zone, group D bleaches powerfully, producing a wide yellow zone, while group E blackens the medium. Each main group has 4 to 6 sub-groups, based on hæmolysin production, the appearance of the colony and the character of the streptococcal chains; the sub-groups comprise each from 2 to 16 individual varieties differing from each other in their power to produce acid from a set of 10 different sugars. Each of the varieties—there are above 100—is given, finally, 7 photographs (made up in 52 full-page half-tone plates) illustrating the appearance of its colonies under different conditions of culture and illumination and the microscopical characters of the constituent cocci.

Photographs have not hitherto proved of much value as an aid to the working bacteriologist, and it is doubtful whether those in the volume, despite the care and skill which have obviously been devoted to them, will be more successful.

It is perhaps regrettable, since, at least, it is an honest attempt at orderly arrangement, that the general body of bacteriologists are not at all likely to accept the classification proposed, and this for the reason that the characters on which it depends have not the validity required for the creation of bacterial types. The authors discuss this question and appear to conclude that, since cultivation and examination were in each instance performed by them under uniform and optimal conditions, the distinguishing features are stable and will reproduce themselves with all strains of the same type. They admit that strains which have been long in artificial culture may be found greatly altered, but that has not deterred them from classifying and figuring such altered strains on the basis of the latter findings. The consequence is that the hæmolytic streptococci which most probably do belong, for the most part, to one species, find themselves in all three of the main groups A, B, and C.

Bacteriologists are tending rather to admit a wider and wider range of possible variations in the cultural characters of even well-established bacterial species and to choose, as the nucleus of specific definition, the chemical reactions of the bacterial protein displayed in serological tests. It is true that variation is possible even in these, and it may turn out that there is a limbo of less differentiated bacteria from which emerge, and to which return, the definable species as met with in disease and other forms of special bacterial activity. But the serological basis of species differentiation has, at least, the virtue of depending on a single reaction instead of on a complex of characters which so easily leads to the simulation of innumerable varieties.

The volume includes a bibliography referring to more than a thousand original papers, a testimony, if further such were needed, to the industry and devotion of the authors.

In the preface the promise is made that volume 4 of these *Annals* will deal with the pathogenic streptococci, and bacteriologists in general may hope that it will furnish them with an equally useful tool for research on this highly important group. W. M. SCOTT.

Descartes' Geometry.

La géométrie de René Descartes. Pp. iii+91. (Paris: J. Hermann, 1927.) 21 francs.

THIS is a reprint—"nouvelle édition" it calls itself—of the great work of Descartes, giving the first exposition (such as it is) of the system of co-ordinate geometry since known as "Cartesian." The reprint comes only two years after another, edited by David Eugene Smith and Marcia L. Latham for the Open Court Publishing Company, and naturally provokes comparison with it. The Open Court edition has the text in the form of a facsimile of the first edition of 1637. The present reprint is not a facsimile, but a reprint in modern type, and it is made more modern by the substitution, *e.g.*, of a^2 for *aa*, and of = for Descartes' sign for equality (a symbol like that used in modern algebras for 'varies as,' but turned the opposite way); it has no historical or explanatory notes, no preface and no index; and it does not give even the date of the edition from which it is reproduced. The Smith-Latham edition, on the other hand, has an English translation facing the facsimile text, and a large number of useful notes, historical and other.

No doubt the present reprint is meant for the French reader, but the question arises, who

nowadays is likely to read the "Géométrie" in the original, unless he is studying or writing on the history of mathematics, and wants to understand the exact stage of development represented by that work?—for no one would think of going to it for the technique of modern analytical geometry. As Prof. Loria has remarked, there is a greater gulf between Descartes' work and a modern treatise on analytical geometry than there is between an ancient (*i.e.* Greek) and a modern treatise on any other mathematical subject.

If the book is read from the historical point of view, the reader will certainly want much help in the way of notes showing the relation between Descartes' methods and those of other writers, ancient and modern. Such aids are all the more necessary with a book which is in any case difficult to read, because the author himself purposely left many things obscure or only half explained. There was a reason for this in the general attitude of the mathematicians of the time to one another. Every one wanted to get personal credit for discoveries, and to avoid giving anything away which another could use and then claim as a discovery of his own. So far does Descartes betray this anxiety that he even hints at things which he has not set down but could 'an if he would.' "I hope," he says, "that posterity will give me credit, not only for those things which I have explained, but also for those which I have voluntarily omitted in order to leave them the pleasure of discovering them," as if he wished 'to have it both ways'!

On the whole, the reprint before us seems rather to fall between two stools, unless indeed it is merely intended as a handy book of reference for those who, studying an account of Descartes' work in an ordinary history, wish to look up some particular point in the original. T. L. H.

Our Bookshelf.

Rasa-Jala-Nidhi: or Ocean of Indian Chemistry and Alchemy. Compiled in Sanskrit by Rasacharya Kaviraj Bhudeb Mookerji. With English translation by the Author. Vol. 1. Pp. v+xv+viii+350+v. Vol. 2. Pp. ii+5+8+10+296+23. (Calcutta: The Author, 41A Grey Street, n.d.) 10 rupees.

THE author says that he has been a devout student of early Indian chemistry from his boyhood. By accident, he came into contact with a Yogi from whom he learnt much more than could be found in the existing books on Indian chemistry, which he considers to be incomplete, incoherent, incorrect, and in many cases misleading. The Yogi's teaching, however, enabled him to arrange methodically the materials found in the existing books on early chemistry, which were mostly in a chaotic state, and had been neglected for several centuries past. Unfortunately, the author gives no list of authorities for his facts and recipes, though he promises one for the concluding volume (the tenth); it is therefore impossible to assess the work properly from a historical viewpoint. Since, however, he maintains that Rasavidya, or chemistry, was cultivated by the early Aryas some 1950 million years ago, and states that fragments of two or three books written about 898,000 B.C. are still in existence, his claims to be treated as a serious historian are perhaps not very weighty. Mr. Mookerji dismisses Sir P. C. Ray's work on Hindu chemistry as that of an amateur critic, and says that it contains many misinterpretations of important principles, due to a hasty and superficial study of the subject.

It appears that the author is the principal of a college of medical chemistry, as testimonials of cures are given at the end of the first volume. Whether the remedies described in the book are those employed in practice by Mr. Mookerji does not seem clear, but if so, the Indian constitution must be remarkably resilient. Among other bizarre recipes we read that "essence of earth-worms is cool, and cures all sorts of carbuncles and leprosy," besides imparting to mercury the property of withstanding the heat of fire.

The 'chemistry' is equally startling—"mercury is in a state of swoon, when it succeeds in curing diseases without producing any after-effect. The processes of causing swoon of mercury, as known to the expert chemists, are many; of all these, heating with six times its weight of sulphur is the best of all."

It is not improbable that much of the material which the book contains may be of some antiquity, and it is to be hoped that the author will fulfil his promise of adducing his authorities. Until he does so, his book must serve merely to throw into relief the unscientific nature of a queer folk-pharmacology. E. J. H.

Mushrooms and Toadstools: an Account of the more common Edible and Poisonous Fungi of Canada. By H. T. Güssow and W. S. Odell. Pp. 274 (128 plates). (Ottawa: Division of Botany, Dominion Experimental Farms, 1927.) 1 dollar.

THE outstanding feature of this book is its price—one dollar! For a large, well-bound volume of 274 thick leaded pages, with 128 plates containing hundreds of unusually good photographs of fungi, two of these plates being in most delicate colouring, a price of one dollar is literally startling. The book is published by direction of the Minister of Agriculture, Ottawa, and if this is a sample of his direction, one can only fervently wish 'more power to his elbow.' The volume is really an extended bulletin of the Division of Botany of the Dominion Experimental Farms, the senior author being the Dominion botanist. It contains simple but adequate descriptions of the common edible and poisonous fungi of Canada, and although it is far from complete, few if any of what may be

regarded as the commonest fungi have been omitted. It is in no sense a 'learned treatise,' and the arrangement adopted might cause a strict systematist to wilt. For its avowed purpose, however, which is "to appeal to students as well as nature lovers, who wish to know the many odd or beautiful forms of fungous growth they may happen upon in their country rambles," it is quite admirable. Four introductory chapters deal with the general structure of the fungi and useful practical hints to collectors. Following these are the illustrated descriptions of 160 species, and then brief but adequate accounts of the preparation and value of fungi as food, of poisoning by fungi, and of mushroom culture. A useful glossary and a good index complete the volume.

To criticise such a work is in very truth to look a gift horse in the mouth, and one can only admire and envy the skill of Mr. Clarke, chief of the Photographic Division of the Geological Survey of Canada, who took nearly all the photographs, and the energy and opportunities of Mr. Odell, who, "in his frequent jaunts through woods and meadows," collected the specimens.

Altogether, a book for every botanist to become possessed of with all possible speed, so that the Minister of Agriculture may be encouraged to direct the publication of others. W. B. B.

Die Tierwelt der Nord- und Ostsee. Herausgegeben von G. Grimpe und E. Wagler. Lieferung 9. Teil 6 c_1: *Oligochæta*, von W. Michaelsen; Teil 12 a_2: *Thaliacea*, von J. E. W. Ihle; Teil 12 f_1: *Chondrostei*, von E. Ehrenbaum; Teil 12 f_2: *Teleostei Physostomi*, von H. M. Kyle und E. Ehrenbaum. Pp. 44+28+86. 13·60 gold marks. Lieferung 10. Teil 7 d_1: *Gastrotricha*, von A. Remane; Teil 11 c: *Halacaridæ*, von K. Viets; Teil 12 h_2: *Teleostei Physoclisti*, 11-15, von E. W. Mohr und G. Duncker. Pp. 56+72+61-140. 16·80 gold marks. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1927.)

THAT section of the present work dealing with the oligochætes contains a unique account of the marine and brackish worms belonging to that order and occurring in the North and Baltic Seas. All oligochætes living in, or at intervals submerged by, water, the salinity of which is greater than five parts per thousand, are regarded as coming within the scope of the present paper. Habitat receives especial attention. The section dealing with the Gastrotricha is very well illustrated and deserves no less praise than the last section.

The portions dealing with the systematics of fishes are, in our opinion, not up to the standard of the remainder of the work. Most of the figures are from familiar books. Nevertheless, the advanced students and amateurs to whom the work is mainly addressed could not be blamed if they failed to recognise some of their fish captures from the figures given. In accordance with the original plan of the book, those fishes of economic importance receive fuller treatment than the others, yet there is a good deal of recent and important work upon the herring which receives no recognition, and although there are references in the text to names apparently to be given in the bibliography, they are not to be found there. In a review of an earlier part of the publication, mention was made of the great usefulness of the table given for the identification of pelagic fish eggs. If this could be included, it seems a pity that there is not more information given upon the larval and post-larval stages of fishes.

Christ the Word. By P. E. More. (*The Greek Tradition: from the Death of Socrates to the Council of Chalcedon, 399 B.C. to A.D. 451*, vol. 4.) Pp. viii+343. (Princeton: Princeton University Press; London: Oxford University Press, 1927.) 18*s.* net.

MODERN theologians who attempt the most necessary task of devising a scheme of Christian thought at once retaining all the traditional content and yet not incongruous in the light of scientific knowledge, tend more and more to utilise the Greek conception of the *Logos*. It seems evident that the Greek tradition in theology is the right one to follow. Hence the value of Dr. More's book for those students of natural science who take an interest in the problems of theology. It is a short history of the development of Christian theology from the Fourth Gospel to the Council of Chalcedon.

In reading these pages, students of science will find themselves in a world where much seems unfamiliar, but they will recognise the fundamental idea that the reason of man finds its counterpart in the essential rationality of existence. We cannot avoid the conviction that if men of science occupied some of their leisure moments in the study of the origin and development of Christian ideas, they would discover an unexpected source of intellectual interest, and perhaps find an atmosphere less alien than they had imagined, since both science and theology have their origins in Greek thought.

J. C. H.

Lectures on the Religion of the Semites: the Fundamental Institutions. By the late Prof. William Robertson Smith. Third edition, with an Introduction and Additional Notes by Dr. Stanley A. Cook. Pp. lxiv+718. (London: A. and C. Black, Ltd., 1927.) 12*s.* 6*d.* net.

A NEW edition of Prof. Robertson Smith's lectures was badly needed, for although they were first published in 1889, and the second edition edited by Sutherland Black appeared in 1894, they still hold first place as a classic study of the subject. But a vast amount of material dealing with the Semitic and other religions of the world has accumulated during the last thirty years, and cognisance of this must now be taken. In the new edition, Dr. Stanley Cook has provided a carefully considered introduction, in which he examines Robertson Smith's main conceptions in the light of later developments in the comparative study of religion, and in some two hundred pages of notes has added facts and bibliographical references to further information, which will serve to illustrate and define the position of the beliefs of the Semites in their relation to other systems, especially in the ancient world.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Coals as Colloid Systems.

IN a memoir on the geology and coal resources of Korea State, Central Provinces, published in 1914 (*Memoirs, Geological Survey of India*, **41**, p. 180), I suggested that the bright coal of the Barakar series "judging from its brilliant conchoidal fracture is of the nature of a colloidal substance." I find that H. Potonié had noted the colloidal nature of humus in 1911, whilst Drs. Stopes and Wheeler, in their paper on the "Constitution of Coal," mention H. Winter as believing in the colloidal nature of coal in 1913, the reference quoted (*Glückauf*) not being, however, accessible to me. Later authors have referred to the same point, but I have not noticed accounts of any research specifically directed towards the study of coals as colloid systems. It may be useful, therefore, to refer briefly to data derived from a study of certain Indian coals that appear to provide definite evidence on this question.

For some years I have been interested in the relationship between the specific gravity and ash contents of Indian coals, and I have in particular collected data for the Bokaro (Bihar and Orissa) and Kurasia (Korea) coalfields. These data are discussed in a paper now in the press for the *Records of the Geological Survey of India* (vol. 60, pt. 4).

The most important fact that has been elicited by this research is that the coals from the Bokaro coalfield can be divided into two series according to their macroscopic aspect in hand specimens, and that the series so made are found to yield different types of density–ash curves.

The economically more important series is the *vitrain–durain series* ranging from *bright coal* with about 1 per cent. of ash through various types of *banded silky coals* to *dull coal* with ash contents up to about 40 per cent. For these coals the density–ash relationship is linear. If g be the specific gravity of any piece of coal in this series, k the specific gravity of ash-free vitrain, and a the ash contents, then it is found empirically that the following relationship holds :

$$a = 100(g - k).$$

For Bokaro $k = 1{\cdot}26$. Hence, if in the jungle a piece of coal is found to have a specific gravity of 1·50 (by means, for example, of Walker's balance), one can predict that the ash contents will be found to be $100 \times (1{\cdot}50 - 1{\cdot}26) = 24$ per cent. Actual analysis yields results often within 1 per cent. of, and rarely so much as 3 per cent. different from, the predicted value. Larger deviations than this can be attributed to special causes ; for example, ash of unusually high specific gravity due to a high proportion of ferric oxide.

The second series contains types ranging from *shaly coals* through *coaly shales* to *carbonaceous shales*, in which layers of vitrain and carbonaceous shale are interlaminated in various proportions. The relationship between specific gravity and ash contents for this series is not linear, but is expressed by a curve of the same shape as would be obtained by mixing mechanically two substances of different specific gravities.

Searching for an explanation for the different types of relationship between specific gravity and ash contents in these two series, I find that an appeal to colloid chemistry appears to provide the answer, and that my empirical data are explicable if we regard the vitrain–durain series as a series of suspensoid colloid solutions, and the shaly coals, coaly shales, and carbonaceous shale as a series of coarse suspensions, often with layers of vitrain.

Reverting now to the vitrain–durain series, I may mention another curious fact. On comparing the proximate analyses and specific gravity of vitrain from various coalfields, I find that the specific gravity *increases* with the moisture contents, but not according to a linear rule as for the ash contents, the few data so far collected yielding a curve convex towards the density ordinate. These data find a simple interpretation if we regard the moisture as present in a colloidal state, as in a gel or in an emulsoid, in moisture-free vitrain.

Durain has been shown by various observers to contain both vegetable detritus and vitrain, as well as a variable quantity of 'ash.' Recalling this, it appears that on the basis of the data referred to above we can describe (1) *vitrain* as a colloid system (either gel or emulsoid) containing moisture ; (2) *durain* as a disperse system in which vitrain is the dispersion medium, whilst the ash contents (suspensoid) and the vegetable detritus (coarse suspension) are present as disperse phases.

If these suggestions are well founded, then light may be thrown on certain practical aspects of coal (1) prospecting, (2) beneficiation, (3) coking, and (4) conversion to liquid fuel. The points are noticed in the paper mentioned and need not be discussed further here, except that, with reference to the coking coal, I may mention that my data indicate that high moisture contents are much more harmful to the coking properties than high ash contents. (These conclusions concerning coking coals are in harmony with results obtained by Mr. Balaram Sen, of the Tata Iron and Steel Company, as described by him at the recent meeting of the Indian Science Congress in Calcutta.)

The suggestions contained in this paper are really based on the consideration of coals as specimens representing points on density–concentration diagrams of various types of disperse systems. It appears that much valuable information would result from an exact study of the specific gravity of selected specimens of coal in conjunction with various properties both physical or chemical. In this letter, for example, vitrain has been treated as a homogeneous substance acting as the dispersion medium for the ash contents and vegetable detritus. That it is really extremely complex is of course well known ; and various methods of attack have been devised in the attempt to solve its constitution. Little success, however, seems hitherto to have been attained. Perhaps a study of vitrain, and of coal in general, from the physico-chemical point of view might help. Thus, since the paper referred to above was sent to the press, I have been comparing analyses of similar coals from different fields. This comparison reveals curious relationships between 'volatile matter,' 'fixed carbon,' and specific gravity. Taking matched pieces of coals with almost identical ash contents, and not very dissimilar moisture, these comparisons indicate that for each pair higher specific gravity almost invariably means higher 'volatile matter' and lower 'fixed carbon.' We do not know the condition in which the 'volatile matter' and 'fixed carbon' is present in coals, but the facts exposed by these comparisons suggest several questions. Is the moisture-free vitrain itself a colloid system ? Has the component of this

system that yields 'fixed carbon' a lower density than that which yields the 'volatile matter'? Is there actually free carbon in colloid solution in the hydrocarbon complex, or are we dealing with a colloidal association of two series of compounds, one of which series yields the major portion of the 'fixed carbon' on the application of heat, whilst the other series yields the major portion of the 'volatile matter'?

In conclusion, one may say that the data to which reference is made in this letter seem to indicate that much valuable information might be obtained from a systematic study of coals as colloid systems; not being myself a student of colloid chemistry, but a geologist with no opportunity for physico-chemical research, I have, therefore, ventured to direct attention to these data and to make some apparently rash suggestions in the hope that they may attract attention to the subject and cause others more competent to undertake the careful research that the preliminary data seem to warrant. L. L. FERMOR.

Geological Survey of India, Feb. 16.

Light and Sight.

ALL the facts point to the conclusion that vision takes place by stimulation of the cones of the retina through photo-chemical decomposition of the liquid surrounding them which is sensitised by the visual purple. The rods are not percipient elements, but control the visual purple. Helmholtz stated that there was no evidence that the rods were percipient elements. This theory explains numerous facts which are otherwise inexplicable, such, for example, as the change in position in the field of vision of after-images on movement of the eye. Two after-images may combine into one, or a red after-image may go right through a green one. This proves conclusively that the stimulus is liquid.

Apart from the numerous facts against the duplicity theory, which supposes that the rods are percipient elements for perception in a dim light, it will be found that it is supported almost entirely by misstatements, namely, (1) that certain animals have only cones, and others have only rods; (2) that the periphery of the retina is colour-blind; (3) that the eye is totally colour-blind in dark adaptation; (4) that the Purkinje phenomenon and the recurrent image are not found with the fovea. With regard to these I offer the following criticisms:

(1) Though I have examined numerous collections I have never been able to find any animal with only rods or only cones, neither have I found anyone who has seen such a retina. The tortoise is the most quoted; it is stated to have only cones. The rods and cones in the retina of the tortoise are as clearly defined and distinct as in the human retina.

(2) The periphery of the retina is not colour-blind when colours of sufficient intensity are used. The reader can test this for himself with a doctor's red lamp. He will find he can see it as red to the extreme periphery.

(3) In dark adaptation the eye is not totally colour-blind. Further, there is no scotoma or blind area corresponding to the rod-free portion of the macula which is equal to a visual angle of about three degrees.

(4) The Purkinje phenomenon and recurrent image are found with the fovea.

Hess showed not only that the recurrent image was found with the fovea, but also that it was bent outwards at this region as it would be if the visual purple had to flow into the fovea.

F. W. EDRIDGE-GREEN.

London, April 21.

PROF. HARTRIDGE'S letter in NATURE of April 21 is of interest if only for the reason that it exposes our ignorance of the history of human vision. Apparently those who have studied this problem have not yet established any conclusion which limits the field of speculation. It would scarcely be possible to find suggestions more diverse in character than the three already made in this discussion, and it is doubtless much easier to add to the variety than to demonstrate the impossibility of those already put forward. I do not claim to have shown that Sir John Parsons' suggestion is impossible; having pointed out that an additional link is needed to complete the chain of his argument, I merely venture the opinion that this link is very unlikely to be found.

In his third and fourth paragraphs, Prof. Hartridge attempts to provide this missing link, but since he prefers another theory he is perhaps conscious that something is still wanting. Unfortunately, I find his third paragraph unintelligible, and part of the fourth is so ambiguously worded that it would not be profitable to discuss it. It may, however, be as well to say at once that similarity of the two curves Sir John mentioned is not a factor in the problem; the only point under consideration is the occurrence in the same neighbourhood of the peaks of both curves. Since the distribution of solar energy is known, nothing can be gained by introducing into the discussion such foreign considerations as experimental apparatus.

Many readers of NATURE may like to see reproductions of Prof. Wood's photographs, and read his own explanation of these effects, before deciding whether Prof. Hartridge's assumption that they are faulty and misleading photographs is well founded. They will be found in the *British Journal of Photography* for Aug. 12 and Oct. 28, 1910. If, after reading and inspecting them, Prof. Hartridge has any lingering doubts about the reality of these effects, I suggest that he should himself take corresponding photographs through filters of the types used by Prof. Wood, utilising, of course, the much more convenient plates that are now available.

The explanation of our limited visual sensibility proposed by Prof. Hartridge scarcely seems to me compatible with an evolutionary outlook. The words 'difficulty' and 'absence,' suggesting as they do such questions as 'who found it difficult?' almost carry the discussion into the domain of theology. In any event, it is not a view of which my opinion is likely to interest others.

An inappropriate choice has been made in selecting the visibility of a thin dark line as an illustration of the finer powers of the eye; there is no mystery about the explanation. The phenomenon is independent of resolution, and, despite his penultimate paragraph, I can scarcely think that Prof. Hartridge commits such an error as making the line width a function of the resolving power. What is yet uncertain is how it comes about that the eye can detect want of alinement of two parallel lines when the displacement corresponds to an angle of about one second at the eye, and can discriminate between an outline formed by two perpendicular straight lines meeting in a point and another formed by two perpendicular straight lines joined by a circular arc of a radius so small that the separation of the pointed and rounded contours, if the straight lines were superposed, would be much less than the projection, on the plane containing the lines, of the diameter of a single retinal cone. Does Prof. Hartridge's theory give an adequate explanation of these facts?

Is the eye capable of making these refined judgments without moving in its socket, and can the

unattached ends of the cones move? Is there any evidence which supports some of the theories offered to reconcile the appreciation of these small differences of position with the comparative coarseness of the unit retinal receiver, and tends to discredit the others? When we have obtained answers to such questions we may begin to feel more secure in our theories.

The distinction between the "Optical Paradox" and the problem of measurement has been discussed in my reply to Dr. Campbell. The word optical is of some significance, for the special conditions of this experiment enable us to disregard factors such as memory and fatigue, which introduce uncertainty into many other experiments on sensations.

T. SMITH.

National Physical Laboratory,
Teddington, Middlesex.

The Polarisation and Fading of Short Wireless Waves.

THE effect of the earth's magnetic field in altering the plane of polarisation and producing circular polarisation in a transmitted wireless ray has been fairly fully discussed recently by Nicholls and Shelling [1] and by Appleton.

Examples of this effect have been observed at night time when the ray from a vertically symmetrical aerial gives a received ray either partially or wholly horizontally polarised, and consequently an erroneous bearing. Further, rather more definite indications of these polarisation effects have been observed on very short waves in two sets of experiments originally started early last year. In these a receiver consisting of a vertical aerial coupled to a closed loop rotating about a vertical axis was used. Such a receiver has unidirectional receiving characteristics. The E.M.F. in the vertical aerial can be made to balance that induced in the loop when the plane of this is in the plane of the incoming ray, but maximum signals will be obtained if the loop is rotated 180°. The position of the loop when zero signals are obtained is an indication of the direction of the station. This arrangement can also be used to indicate the existence of a circularly or elliptically polarised ray to show the direction of rotation of this ray. In using this receiver in April of last year, on the short wave band between 14 and 50 metres, it was found that on certain occasions the received ray was circularly or elliptically polarised.

The results were not numerous, but quite definite, the conditions under which circular polarisation occurs being relatively rare. The effect has not been observed on long-distance stations, and it appears to be most marked on stations just outside the skip distance. The stations observed giving the effect were:

		Wave.	Direction.
(1) PCMM	Kootwick, Holland	27 m.	East.
(2) PCJJ	Eindhoven, Holland	30 m.	Slight S. of E.
(3) Unknown	Station probably Belgian		S.E.
(4) GBK	Bodmin [2]	26 m.	W.S.W.
(5) GLQ	Ongar	24 m.	W. nearly.

The first three stations to the east and south of us always showed circular polarisation in a clockwise or right-handed direction; the latter two in a counter-clockwise or left-handed direction. The observations were all made in the daytime; unfortunately, there were no stations to the north on which to test, so that the information is rather incomplete. The explanation is obviously connected with the double refraction suffered by two circularly polarised components of the plane polarised wave emitted; one of the components being more bent than the other, the two will be separated near the edge of the skip distance where the effect is observed.

It has not been possible yet to trace the two rays which must pass through a medium of variable electronic density, partly along and partly across the earth's magnetic field, in sufficient detail to account for the difference in direction of rotation of the rays according as they travel eastward or westward. But it might be surmised that at greater distances, that is, well outside the skip distance, both the rays into which the original plane polarised wave is split will reach the receiver, where they will combine to produce a plane polarised ray, the direction of which will depend on the distance traversed by the ray through the medium and the strength of the magnetic field. This resultant direction will vary momentarily with slight changes in the path and the earth's magnetic field,[3] with the result that the vertical field will vary from time to time and produce fading. But fading from this cause, which is due to a bodily rotation of the electric vector, will produce opposite effects on a vertical and horizontal aerial perpendicular to the ray. In fact, the fading on one will be the inverse of the fading on the other, for when the vertical electric force is a maximum the horizontal force is zero and vice versa. Experiments made recently confirm this view, at least in certain cases. In Fig. 1, simultaneous fading records taken on a horizontal and vertical aerial are shown, and it is clear at a glance that these are opposite in phase.

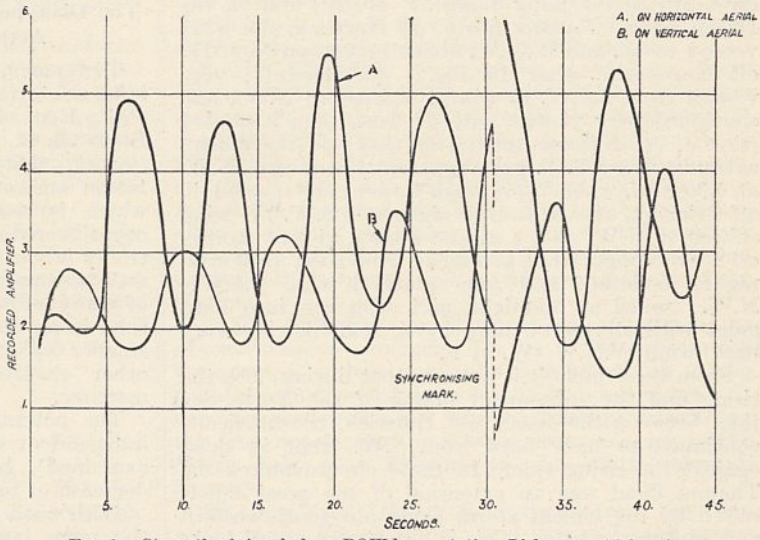

FIG. 1.—Strength of signals from PQW beam station, Lisbon, $\lambda = 15{\cdot}6$ metres, sending high-speed dots.

The observations were made on PQW, a beam station at Lisbon, and many more records showing the same characteristics have been taken. Apart from the theoretical interest, these results have great practical value in devising systems which will eliminate, or at least reduce, fading.

Whether all short wave fading is of this type remains to be seen, but further experiments seem to show that this is not the only type of fading.

T. L. ECKERSLEY.

Marconi's Wireless Telegraph Co., Ltd.,
Research Department, Chelmsford.

[1] *Bell System Technical Journal*, April 1925.

[2] On the rare occasions when it was outside the skip distance.

[3] As suggested by Breit. *Proc. Inst. Radio Eng.*, August 1927.

Thames Floods.

THE Thames flood of Jan. 6–7 last has served to direct attention to the conditions under which these visitations are developed. From the concluding paragraph of the review of Messrs. Loughton and Heddon's volume on "Great Storms" (NATURE, Mar. 31), the natural inference is that northerly gales are necessary to drive the North Sea tide into the Thames. The authors, however, do not limit themselves to northerly gales. At page 70 they again mention northerly gale floods, but they also bring in the Thames flood under the great storm of November 1703, in which the wind "did not veer to the north-west in time to produce the effect to its full extent."

Of meteorological information contained in the log books of more than a hundred ships of the navy of that period I made a special collection for an article on this great storm, which appeared in the *Cornhill Magazine* for November 1897. The records enable me to state definitely that throughout the night of November 26–27 the storm maintained its south-westerly direction, at no time veering beyond W.S.W., between Rye, the Downs, the Thames Estuary as far north as the Long Sand, 51° 50′ N., and on the Dutch coast. Farther north, off Harwich, the wind veered to W. and W.N.W. about 11 A.M. on Nov. 27; off Yarmouth, after 10 A.M.; off Haisbro', very violent from S.S.W. at 6 A.M., shifted to N.W., and continued very violent until 11 A.M., then it abated (time of the shift not stated); off Claypole (the Wash), extremely hard S.W. gale, apparently veered to N.W. at 6.30 A.M., when "our small bower cable parted"; off Grimsby, after a stormy night at S.S.W. the wind shifted to N.W. at 5 A.M. and blew a violent storm; off Scarborough, while at anchor, from noon until midnight, moderate and fair weather, wind S.S.W.–N.W.; sailed at midnight, and soon ran into hard gales with storms of rain, by 4 A.M. blowing very hard, wind W.N.W.–W. by S.

From these facts it is obvious that during both the rising and the subsequent falling of the North Sea tide, between the Wash and Harwich, the hurricane continued to blow hard from S.W., that is, dead against the rising tide. In these circumstances the Thames flood was an extension of the great floods raised by the violent storm along our south-western and southern coasts. This is practically on all fours with our experience in January last, when the country was swept by a violent south-westerly storm, with wind velocities ranging upwards to 85 miles an hour, and the veering to W. or N.W. on the North Sea being too late and not far enough north to affect materially the east-coast tide. As was stated in the *Times* of January 9, the heavy south-westerly wind "is thought to have been the determining factor, for it piled up the southward flow of the tide in the Straits, and so diverted an unusual quantity of water into the Thames Estuary."

As the coast from about Lowestoft into the Thames runs due south-west, gales from between N. and E. or S.E. are necessary to raise the river above the normal level. So long as our gales maintain a direction between S. and W., they keep in check the North Sea tide, and according to circumstances, as recently, flood the river from the Channel.

In the *Meteorological Magazine* for March 1927, p. 35, discussing the great storm of 1703, occurs the following: "Over England the storm was succeeded by an intense anticyclone, for on the 28th [of November] there was a north wind of unusual violence in the North Sea, which caused a very high tide in the Thames." The particulars in the ships' logs show that the south-westerly type of disturbed weather was maintained until the close of the month; the *Deal Castle*, which left Scarborough at midnight of Nov. 26, took 80 hours to beat down against the head wind, casting her anchor off Yarmouth at 9 A.M. on Nov. 30. Daniel Defoe, in his collection of information, prints in full communications he had received from three ships cast adrift early in the morning of Nov. 27 in the southern part of the North Sea, all helpless and carried away northward, one as far as Scarborough; another driven "at a great rate" before the storm to the Norwegian coast by Tuesday, Nov. 30; and H.M.S. *Association* drifting so far as Gothenburg by Dec. 11, the only northing in the wind during the fortnight being a brief interval of N.W. wind on Dec. 4, off the Elbe. These northward driftings would have been impossible against "a north wind of unusual violence," which itself would have been a very striking occurrence in an intense anticyclone, where naturally we should expect to find a dead calm and very light variable breezes.

HY. HARRIES.

April 12.

The Disappearance of Gases into Glass under the Action of the Electric Discharge.

THE passage of sodium through glass under the influence of the electric discharge is well known (Burt, *Phil. Mag.*, **49**, 1168; 1925. Taylor, *Jour. Scient. Instrs.*, **3**, 12, 400; 1926). The present writer showed (*loc. cit.*) that with neon lamps or discharge tubes the action was reversible. If the molten sodium nitrate, which is used as electrolyte, was maintained at negative potential with respect to the internal electrodes (about 300 volts negative), then the inside glass wall became covered with negative glow. A current of many milliamperes flowed initially, but fell off with time in an almost exponential manner to a constant smaller value. Similar results were obtained with other electrolytes and with conductors such as mercury.

The potential required to strike a discharge was independent of the temperature (60° C. to 400° C. examined), but the current fell off rapidly with decrease of temperature.

With such a discharge the hydrogen contained in the neon lamps—indicated spectrographically—disappeared rapidly and only a trace remained after a run of five minutes. On continuing the discharge the carbon monoxide bands appeared. The carbon monoxide arose largely from an electrical action, not from thermal decomposition.

Experiments were carried out in a specially constructed apparatus (soda glass) in which positive ions obtained in various gases at low pressures by means of a seven-metre wave electrodeless discharge were pulled out by an electric field to the walls of a thin-walled glass bulb immersed in molten sodium nitrate. The glass apparatus was thoroughly 'baked out' at high temperature and subjected to the action of the electrodeless discharge before results were taken.

The currents flowing through the glass walls of the bulb and the gas disappearance were measured concurrently. Experiments were made on hydrogen, oxygen, nitrogen, helium (mercury vapour frozen out in all cases by liquid air trap), and the results showed:

1. For hydrogen, oxygen, nitrogen, the quantity of gas disappearing is directly proportional, within the limits of experimental error, to the quantity of electricity transferred through the glass walls.

2. For hydrogen, every electron charge passed involves the disappearance of one hydrogen molecule.

3. For oxygen and nitrogen, every two electron

charges passed involves the disappearance of one atom of oxygen or nitrogen respectively.

4. For helium (continually purified by carbon in liquid air), a current flowed but no disappearance of gas took place.

Thus with hydrogen at an initial pressure of 2·5 mm., in 21 min. the pressure fell to 0·03 mm. The current through the glass (at 480 volts) was variable (6 to 16 m.a.) Assuming H^+ as carrier, then, from the electrical quantity, 1·16 c.c. at N.T.P. should have disappeared. Actually 2·05 c.c. disappeared. With initial pressure 0·057 mm. the current was 0·5 to 0·1 m.a. (500 volts), and the estimated disappearance was $22{\cdot}7 \times 10^{-3}$ c.c. at N.T.P. The actual disappearance was 41×10^{-3} c.c.

Experiments carried out on the conduction of glass and quartz at temperatures such as those used in the above experiments showed that the conductivity was considerable and the mechanism largely electrolytic. Only a relatively small quantity of the gas that had disappeared was recovered on heating, and the electrical action was not reversible (sodium was introduced on reversing). Experiments carried out to test whether the gas passed through the glass walls and could be collected have, up to the present, given negative or inconclusive results.

The non-disappearance of helium shows that the action is not an accelerated diffusion through the glass pores, for, in that case, helium should pass through about twenty times as quickly as hydrogen.

The action appears to arise from an electrolytic decomposition of the glass which probably results, in the case of hydrogen, in the formation of water which penetrates deep into the glass structure.

With mercury discharges gas is usually brought out of the walls.

The above actions are probably of fundamental significance in most phenomena of 'clean up' or gas disappearance into glass walls.

JAMES TAYLOR.

Trinity College,
Cambridge, April 11.

Rare Fishes in the North Sea.

THERE are a good many North Sea fishes which never pass their whole lives in that sea, but only enter it for limited periods, in quest of spawning-grounds or of food. Amongst these are several important species, such as the hake and the halibut, the mackerel and the tunny; and others also of less importance, such as the gurnards, the anchovy, the horse-mackerel, and the monk or angler (Lophius). While all of these arrive in sufficient quantity to be more or less important to the fisherman, there are others which come in small shoals or as individual stragglers, and so come to be considered as rare and unusual occurrences. It happens that within the last couple of years or so some of these casual visitors have been unusually plentiful, and have attracted the attention of the fishermen.[1]

Among these recent visitors has been a number of sharks, of more or less uncommon species. The Thresher shark (Alopias) is one of these; another, and a greater stranger, is the great Basking Shark of Atlantic waters (*Selache maxima*). Another stranger to the North Sea is the Six-gilled Shark (*Hexanchus* or *Notidanus griseus*, L.), which has its home in the Mediterranean and neighbouring parts of the Atlantic, but has of late occurred in our home waters in quite unusual abundance. It has been caught especially on the Viking Bank, to the westward of the deep Norwegian Channel, and in such numbers as to become of almost regular occurrence in the fish-markets of Germany, where these and other sharks are in demand for food and fetch very good prices.

Even more remarkable perhaps than these is a long succession of captures of Ray's Bream, a fish of remarkable and striking appearance, which up to very lately had been but seldom recorded from the North Sea. Of late it has been taken in the English Channel and on the Viking Bank; and specimens have been caught or cast ashore in a large number of places all along the east coast of Great Britain from Cromer to the Dornoch Firth. One was lately caught in a flounder net on the Swedish coast of the Öre Sound; and there is an earlier record so far east as the Pomeranian coast of the Baltic.

In the past few months there have also been caught on the Viking Bank by German steam-trawlers certain other very rare species:

1. The so-called 'Devil-fish' (*Epigonus telescopus*, Risso; formerly wrongly named Pomatomus). This is a perch-like fish never before recorded from the North Sea; its true home is in the southern Atlantic, for example, near St. Helena. It is a dark-coloured fish, with enormous shining or luminous eyes. Our North Sea specimen was 57 cm. long, and was trawled at the very considerable depth of 230 metres.

2. The Blackfish (*Centrolophus pompilus*, Risso) belongs to the family Stromateidæ, and has a certain outward resemblance to some of the flatfishes. A specimen (53 cm. long) was caught recently in 59° 20′ N., 3° E.; and another a couple of years ago, on the Danish side of the Cattegat. It has been recorded before from the North Sea, but by no means often; it is an Atlantic fish, going as far south as Madeira. An allied species (*C. britannicus*) has occasionally been captured in the western part of the Channel.

3. The Snipefish, or Trumpet-fish (*Centriscus* or *Macrorhamphus scolopax*, L.), is a fish of curious appearance, with a small toothless mouth on a long tubular snout, well known in the Mediterranean. It has been observed a few times on the Cornish and on the Irish coasts, and on one previous occasion in the North Sea, near Arendal on the south coast of Norway.

All these rare Atlantic fishes come from the deep water of the Viking Bank; and it would seem necessary to suppose, in order to account for their presence there, that they had been transported by a submarine current from the Atlantic rounding the plateau of the northern North Sea and making its way into the Norwegian Channel. But while Ray's Bream, the Devil-fish, and the Blackfish may all be considered deep-water forms, and might well have come by such a deep-water under-current, it is somewhat remarkable that the Snipefish is known to prefer soft ground near to the coast in waters of only moderate depth—at least in its home in the Mediterranean.

E. EHRENBAUM.

Hamburg.

[1] Cf. *Der Fischerbote* (Hamburg), p. 487, 1927; p. 126, 1928.

Stark Effect and Series Limits.

THE treatments of the Stark effect found in the literature concern themselves chiefly with the behaviour of atoms in the lower quantum states, a problem to which the theory of perturbations can be applied. Consideration of the effect of the external electric field on highly excited atoms necessitates the discussion of the complete equations, in particular with regard to the existence of conditionally periodic orbits. The investigation which we have carried out gives a negative upper limit for the energy of quantised

orbits in a hydrogen-like atom, and shows that there exist various types of unquantised orbits which have negative energies.

The energy of a periodic orbit must be less than

$$-\frac{3}{2}\left(\frac{eFp_\phi}{\sqrt{m_2}}\right)^{2/3} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where F is the magnitude of the applied field. This necessary condition is sufficient only for small values of F and of the angular momentum p_ϕ. There can, however, exist aperiodic orbits of less, as well as of greater, energy than this value, and in one class of these orbits the electron may approach the nucleus within distances comparable with the dimensions of the periodic orbits. The lower limit of the energy of these latter orbits is approximately

$$-2e\sqrt{eF} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

As a result, the line spectrum will not be continued to the normal spectral limit, but will end to the long wave-length side at a point which depends on the field in the gas; the continuous spectrum associated with ionisation or recombination will also extend to the red of the limit.

Since any atom becomes hydrogen-like as one of its electrons is removed to higher quantum states, expression (2) can be used to calculate the apparent limit of any continuous atomic spectrum. The following table gives the observed maximum and calculated limit of the continuous spectrum for the available data for which an estimate of the mean field strength can be made.

Element.	Limit.	Field. (e.s.u.)	Maximum (cm^{-1} from Limit).	
			Observed.	Calculated.
H	Balmer	6	330	270
He	$2s$	3	175	190
Cs	$2P$	8	250	310
Cs	$2D$	8	300	310

The data for hydrogen are taken from the measurements of Yü (*Lick Obs. Bull.*, **12**, p. 104; 1926) on stars of class A and B. Russell's estimate (*Astrophys. Jour.*, **59**, p. 197; 1924) of the field in the sun is used for these stars, since the ion concentrations may be considered the same in the two cases. The data for helium are from the work of Paschen (*Berl. Sitzungsberichte*, p. 135; 1926), and those for cæsium from the recent measurements of Mohler (*Phys. Rev.*, **31**, p. 187; 1928). The field in this last case was estimated from Mohler's measurements of ion concentration in a tube similar to the one in which the spectrum was observed (as reported at the meeting of the American Physical Society, New York, Feb. 25, 1928), using the formula of Holtsmark (*Ann. d. Phys.*, **58**, p. 577; 1919). Considering the rough methods of estimating the field and the fact that we have applied a theory of homogeneous fields to the stray fields arising in an ionised gas, the agreement is satisfactory.

A paper discussing this subject in more detail is being submitted to the *Physical Review*.

JANE M. DEWEY.
H. P. ROBERTSON.
(National Research Fellows.)
Palmer Physical Laboratory,
Princeton University,
Feb. 29.

The Buoyancy of Whales.

THE hydrostatic equipment of the whale would be incomplete without some means of enabling it to alter its buoyancy at will: these means are doubtless the lungs and chest.

The lungs and chest of whales are known to be very elastic and capable of great expansion and contraction. When the whale wishes to sink, it compresses its lungs, and allows them to expand when it wishes to rise or float. In whales that die at the surface and float, these organs are doubtless in a state of expansion, and in those that die at a depth in a contracted and airless one. In the latter, that is, in those that die at a depth, the chest and lungs are compressed; the blow-hole valves yield to the pressure from within (but not to that from without); the imprisoned air escapes; the chest contracts; and the body sinks. In the former, however, that is, in those that die at the surface, the chest and lungs remain expanded and the body floats.

In whales, in the intervals between the respirations, the air in the chest, for hydrostatic reasons, may be in a more or less compressed state. Consequently, when the whale dies at the surface, its chest may expand somewhat, but it is difficult to see why, and bearing in mind the mechanical nature of the valves, even to see how more air can enter it, as Mr. Taylor suggests.

Except in death from asphyxia, in which the animal's body doubtless sinks, no matter at what depth death takes place, the answer to the question at issue, namely, why do whales recently dead in some instances float, in others sink, appears to depend on the depth at which death takes place; for a certain degree of compression of the chest is necessary to overcome the blow-hole valves and cause the air imprisoned in the chest to escape. Given the necessary pressure, that is, if death takes place at a sufficient depth, the body sinks, but failing this, that is, if death takes place at or near the surface, the body floats.

Granted that the tendency of the whale's body to float or sink depends entirely on the state of its chest and lungs, and given the weight of a dead one that sinks, the lungs and chest of which are presumably in the fully contracted state, or the weight of the parts that in the living one appear above the surface when the animal is motionless and its chest and lungs are presumably in the opposite condition, it follows that the whale's 'vital capacity,' or the volume of the air it inhales and exhales when breathing deeply, is ascertainable. Making use of certain imperfect data, a large Greenland whale, estimated to weigh 70 tons, had a vital capacity amounting to about 250 cubic feet.

Whales struck with the hand harpoon probably never die at once, and when the simple gun harpoon was substituted against them, did so very rarely; but when they died under water, presumably from asphyxia, they did so irrespective of which weapon was used.

Of 203 Bottlenose whales captured in 1882, only one was shot dead and only one died under water; the former floated, the latter had to be hauled up (see Log of *Eclipse, Land and Water*, Dec. 1882). Of about the same number of Greenland whales captured by Scoresby senior in a number of years, a larger number died under water and had to be hauled up; but his catches largely consisted of young whales, and, as his son states, "it is not unusual for small whales to run downward until they exhaust themselves so completely that they are not able to return to the surface, but are suffocated in the water."

In conclusion, whales killed with the hand harpoon

or with the simple gun harpoon usually die at the surface and float, while those killed with the bomb harpoon, as is well known, usually do so under water and sink. The latter appear to do so because death is seldom instantaneous enough to prevent them leaving the surface, yet the injury done them is usually so serious that they are unable to regain it and consequently die under water from asphyxia.

ROBERT W. GRAY.

33 The Strand, Exmouth.

The Optical Analogue of the Compton Effect.

THE presence in the light scattered by fluids, of wave-lengths different from those present in the incident light, is shown very clearly by the accompanying photographs (Fig. 1). In the illustration (1)

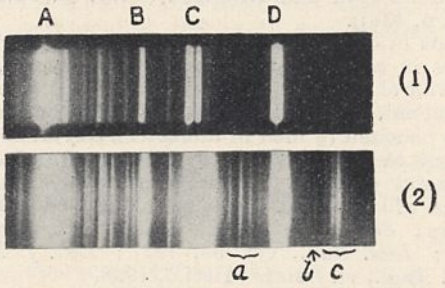

FIG. 1.—(1) Spectrum of incident light; (2) spectrum of scattered light.

represents the spectrum of the light from a quartz mercury vapour lamp, from which all wave-lengths greater than that of the indigo line have been filtered out. This line (4358 A.) is marked D in the spectrogram, and C is the group of lines 4047, 4078, and 4109 A. Spectrogram (2) shows the spectrum of the scattered light, the fluid used being toluene in this case. It will be seen that besides the lines present in the incident spectrum, there are several other lines present in the scattered spectrum. These are marked *a*, *b*, *c* in the figure, and in addition there is seen visually another group of lines which is of still greater wave-length and lies in a region outside that photographed. When a suitable filter was put in the incident light to cut off the 4358 line, this latter group also disappeared, showing that it derived its origin from the 4358 line in the incident radiation. Similarly, the group marked *c* in spectrogram (2) disappeared when the group of lines 4047, 4078 and 4109 was filtered out from the incident radiation by quinine solution, while the group due to 4358 A. continued to be seen. Thus the analogy with the Compton effect becomes clear, except that we are dealing with shifts of wave-length far larger than those met with in the X-ray region.

As a tentative explanation of the new spectral lines thus produced by light-scattering, it may be assumed that an incident quantum of radiation may be scattered by the molecules of a fluid either as a whole or in part, in the former case giving the original wave-length, and in the latter case an increased wave-length. This explanation is supported by the fact that the diminution in frequency is of the same order of magnitude as the frequency of the molecular infra-red absorption line. Further, it is found that the shift of wave-length is not quite the same for different molecules, and this supports the explanation suggested.

Careful measurements of wave-length now being made should settle this point definitely at an early date.

C. V. RAMAN.
K. S. KRISHNAN.

210 Bowbazar Street,
Calcutta, Mar. 22.

Excitation of the Auroral Green Line in Active Nitrogen.

THE auroral green line, which is now thought to be an arc line of oxygen, has been excited with considerable intensity in active nitrogen that was produced by a condensed discharge in a mixture of nitrogen and about 4 per cent. oxygen. Under the most favourable conditions for its excitation, the line was as intense as the afterglow band at 5442 A. Eastman astronomical plates were used because of their great sensitivity in the green. The spectrum was photographed on a small Hilger visible spectrograph. Because of the small dispersion of the instrument, the wave-length of the line could be measured only to within 0·1 A. Using helium standards the wave-length was found to be 5577·5 A. The measurements of Babcock and of others give this wave-length as 5577·35 A. It was shown definitely that with decreasing amounts of oxygen the line gradually disappeared. This and the fact that the wave-lengths agree fairly well, give sufficient proof that the line in question is the auroral green line.

Besides the green line, a red line having a wave-length of 6654·8 A. was observed in the afterglow under the same conditions as the green line. There is an unclassified line of oxygen at 6654·8 A. and it is thought that these two lines are identical. Amounts of oxygen too small to bring out the green line were found to be sufficient to bring out the red line. This observation is based on the fact that the red line was as intense as one of the afterglow bands in the red (6185 A.), the intensity of which was given by Lord Rayleigh as the same as the band 5442 A. mentioned in connexion with the green line.

Too little is known about the energy levels of the oxygen atom and about the spectroscopic origin of the green line for any hypothesis as to the process of excitation in this experiment to be of any value. The excitation of the line with an intensity comparable with that of one of the afterglow bands does, however, seem to indicate that the dissociation of the oxygen molecule and the excitation of the atom occur in a single act. Since no green line afterglow has ever been observed in oxygen discharge tubes, it is certain that the excitation in this experiment is due to the active nitrogen. It is interesting that the green line has been excited without the simultaneous excitation of the other strong arc lines of oxygen, a phenomenon that occurs in the night sky, where the green line alone has been observed.

JOSEPH KAPLAN.
(National Research Fellow in Physics.)
Palmer Physical Laboratory,
Princeton University, U.S.A.
April 13.

Stellar Radiation and the Nature of the Universe.

REFERRING very briefly to NATURE of April 28, p. 674, the reason Dr. Jeans and I agree to differ in our estimate of the possibilities of the universe is because he is dependent on matter for all energy, the rest being empty space; whereas I postulate a vast store of energy in a rotational ether, which only or mainly manifests itself in localised portions apprehended by us as particles or waves.

Similarly, a cyclically permanent universe would seem to him dull or dead; whereas to me it furnishes the mechanism apparently needed for the continued evolution of an entity known to us as life or mind, which, unlike its inorganic counterpart, is progressive.

OLIVER LODGE.

Correlation Coefficients in Meteorology.

IN NATURE for Mar. 17, Mr. E. V. Newnham, in an interesting letter on "Correlation Coefficients in Meteorology," points out that if we wish to test if an observed value could reasonably have occurred in a sample from uncorrelated material, ρ should be put equal to zero in the formula

$$\frac{1-\rho^2}{\sqrt{n}},$$

and not equated to the observed value, r. So far as it goes, this advice is correct, but without other warning, and especially in conjunction with the example chosen, it is not a little misleading. The correction may be considerably greater, or less, than that required to give a reliable value.

Using $(1-r^2)/\sqrt{n}$, the probability that a correlation derived from 16 pairs of observations should exceed 0·70, would appear to be 0·000,000,02, or only one in 50 million trials; this, as Mr. Newnham indicates, would make the odds in favour of a genuine connexion "overwhelmingly great"; using the corrected formula, $1/\sqrt{n}$, it would appear to be 0·00256. However, if the odds are calculated by an exact method, it is found that the probability is actually a little more than 0·00127; the real odds happen in this case to be nearly double those which Mr. Newnham advocates.

The fact is that the distribution of the correlation coefficient from small samples is so far from normal that the use of any formula for the standard error is misleading. This is not to be regretted, since the exact test of significance is no more difficult to apply than the use of the standard error; indeed, special tables have been available for some time from which the level of significance of an observed correlation can be read off at a glance, and similar tables for the multiple correlation have already been prepared for publication by Dr. Wishart in this laboratory.

Since in nine cases out of ten only the small sample formula is exact enough for practical purposes, the formula for the standard error of the correlation coefficient may soon be classed among the things "which students have to know, but only a fool would use."

R. A. FISHER.

Rothamsted Experimental Station,
Harpenden, Herts.

The Golgi Bodies of Plants.

I RECENTLY directed attention to the discovery of Golgi bodies in plants, which was made by Bowen, and is of interest to all botanists.

In this laboratory two of my senior students, Miss Patten and Miss Scott, have gone over a part of Bowen's work, and I have therefore had the opportunity of studying slides of plant tissues prepared according to the methods which Bowen has used. In hyacinth root, and pea root and stem, we have been able to conform Bowen's results, especially in material prepared by the Kolatchev method. Bowen's bodies are discoidal structures, or osmiophilic platelets as he calls them, and very like the hæmatids of mammals. There is a stainable cortex and a thinner, or at least less chromophile, central area. They are very small, but stain very sharply by the Kolatchev method, and there can be no doubt as to their presence. They are not osmium granulations.

For the benefit of those students of botany who may care to investigate these bodies, I give full details of the Kolatchev method; if it is carried out properly it never fails: Slit up root tips, etc., and fix in Champy's fluid, or the following modified Champy. Equal parts of 6 per cent. bichromate of potassium, 1 per cent. chromic acid, and 2 per cent. osmic acid. After 24 hours the material is washed overnight in a gauze-covered vessel, under a running tap. Transfer to 2 per cent. osmic acid, and keep at 30° to 35° C. for from 3 to 7 days, 4 days usually being enough. Wash in running water for several hours, transfer to 30 per cent. alcohol, upgrade and embed in wax. Cut sections thinly and mount unstained. The Golgi bodies are black discs, while the cell and nucleus are a more or less uniform yellow colour. As a control one may add to the pieces of plant tissue, fragments of mollusc ovotestis (in which Golgi bodies can be seen *intra vitam*), the intestinal tracts of centipedes, and pieces of dorsal root ganglion, or guinea-pig testis (in which Golgi bodies have been stained *intra vitam* by Subba Rau and Brambell (*Jour. R. Micr. Soc.*, 1925, p. 438)).

Thus in one operation it is possible to show Golgi bodies in a protozoon (Coccidium or Adelea, in the gut wall of the centipede), in an insect (gut cells), in a mammal, and in plant cells. The fragments, which must be small ($\frac{1}{8}$ inch in diameter), can all be carried through together, and cut in the same wax block.

Careful details of techniques suitable for plant tissues will be found in the last-mentioned of Bowen's papers: *Science*, vol. 64; *Anat. Record*, vol. 34, 1926; *Biol. Bull.*, vol. 53, 1927; *Zeit. f. Zellf. u. mikr. Anat.*, vi. Band 6, Heft 5, 1928.

J. BRONTË GATENBY.

Trinity College, Dublin,
April 16.

Milk Pasteurisation and the Tubercle Bacillus.

MY attention has been directed to a paragraph in NATURE of Mar. 31, p. 513, referring to my recent research into the effect of pasteurisation on the bovine tubercle bacillus in naturally infected tuberculous milk. The note concludes with the words "we still seem to lack experimental information of the efficiency of a *commercial* pasteurising plant for destroying the tubercle bacillus in naturally infected milk."

While this statement is correct, I feel that it needs some amplification. In the laboratory experiments it was possible to maintain a constant temperature of 145° F., which in the commercial process is almost an impossibility—the temperature usually fluctuating from 1° to 5° F., which fluctuation usually tends towards the lower temperatures in an effort to use the minimum temperature in order to conserve the cream line of the milk. In addition to this tendency to subject the milk to the minimum temperature, there is the further possibility of mechanical defects in commercial plants—defects that were shown to be present in certain machines that were tested in connexion with an American investigation in 1924, the results of which are published in the *United States Public Health Bulletin, No. 147*.

In view of these facts, I think it is fair to assume that laboratory experiments may be taken as applicable only to perfect commercial pasteurisation, and that given perfect commercial pasteurisation at 145° F. for 30 minutes, we are still forced to the conclusion that this combination of time and temperature does not invariably kill the tubercle bacillus.

LEONARD J. MEANWELL.

The National Institute for Research
in Dairying,
Shinfield, Nr. Reading,
April 2.

World Weather.[1]

By Sir GILBERT WALKER, C.S.I., F.R.S.

THE data recognised as necessary for the forecasting of weather come from a region that is ever widening. Before telegraphic charts were prepared the local observatory had to suffice; but the daily maps now used in predicting the weather of a single country of Europe may cover several thousand miles from west to east. Further, the desirability of warnings of the famines that have devastated semi-tropical and tropical countries has led to thinking in terms of seasons rather than days, and it soon became clear that seasonal variations over much of the earth are related to a surprising extent.

The first fact emerged in 1878 when Hoffmeyer pointed out the association between pressure in the North Atlantic and weather in Europe; and he was shortly followed by Blanford in India and by a group of continental meteorologists, including Teisserenc de Bort, Hann, Meinardus, and Pettersson. The far-reaching character of the subject was first visualised by Hildebrandsson, who in 1897 published the pressure data for ten years of 68 stations scattered over the world, and directed attention to certain relations between them as indicated by plotted curves. But in this and in his later papers the graphic methods used, and the shortness of the series of data available, generally prevented him from reaching final conclusions. In 1902 the Lockyers confirmed his discovery of the 'see-saw' of pressure in the Argentine and in India or Australia, and, still using purely graphical methods, they made it the basis of a classification of pressures over the world according as they oscillated with India or with Cordoba.

Since then, work on the Continent has been chiefly occupied with conditions in northern latitudes, and the more general problem has been mainly studied in connexion with Indian monsoon forecasting. For this purpose it was necessary to have quantitative information as to relationships, not merely visual impressions from plotted curves, and to work with seasonal, not annual, values. Also there was no hope of unravelling the tangled threads of causes and effects unless help was got by finding cases in which the conditions in one place were related with those in another in a subsequent season. Statistical methods were therefore indicated, and these efforts have culminated in the production of tables of relationships between conditions of pressure, temperature, rain, or river-flood at 32 centres scattered over the world. For each of these the correlation coefficient has been worked out for each quarter with those of contemporary quarters of the other stations, and also with those of one quarter before and after, and with those of two quarters before and after.

The total number of coefficients worked out is considerable, but simplification of the process has reduced the time spent on each to one or two minutes; also, by confining attention to those figures which are larger than the biggest that chance can be expected to produce, the number of significant figures is reduced to 396, and these fall very consistently into the scheme of oscillations indicated below.

The main conclusion reached is that there are three big swayings or surgings:

(*a*) The North Atlantic oscillation of pressure between the Azores or Vienna on one hand and Iceland or Greenland on the other;

(*b*) The North Pacific oscillation between the high-pressure belt and the winter depression near the Aleutian Islands; and

(*c*) The southern oscillation mainly between the South Pacific and the land areas round the Indian Ocean.

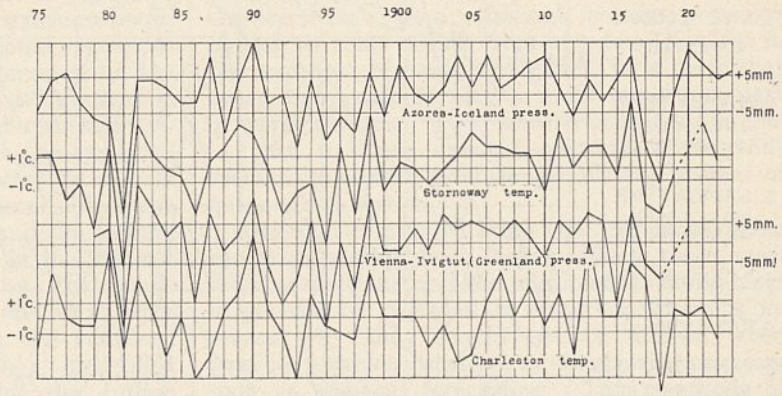

FIG. 1.—The North Atlantic oscillation.

Regarding (*a*), it is well established that a strengthening of the pressure gradients and of the ocean winds (indicated in Fig. 1 by the pressure differences Azores—Iceland and Vienna—Greenland) is associated with a strengthening of the Gulf Stream and higher temperatures in northern Europe (*e.g.* Stornoway in Fig. 1) and along the east coast of the United States (*e.g.* Charleston). The diagram shows the variations of these quantities in successive Januaries from 1875 for nearly fifty years, and the relationships are closer than is generally realised, the correlation coefficient (or degree of association) between the second and third curves being 0·88. Increased circulation goes also with higher temperature in Siberia and Java and less monsoon rainfall in India.

The North Pacific oscillation is rather like that of the North Atlantic, strengthening of the winter pressure differences and winds being associated with higher winter temperatures in central and

[1] This article contains the substance of a recent presidential address to the Royal Meteorological Society.

western Canada, and increased rain in the North Pacific coast states.

The southern oscillation is more far-reaching than the two oscillations just described, and as the effect of an abnormal season is propagated slowly, it may not appear at the other side of the earth until after an interval of six months or more. In illustration we may see in Fig. 2 in the topmost curve the variations of the Nile floods of July to October in successive years from 1889 to 1925; they are, however, reversed, so that a dip below the normal line like that of 1916 means a high Nile. The next curve shows the variations of temperature at Samoa in the following summer, December to February, and the correspondence is obvious, the coefficient between the departures being 0·72. The third curve is that of Samoa temperature during the succeeding autumn, March to May, which brings out the great persistence of the ocean temperatures. Following this we have

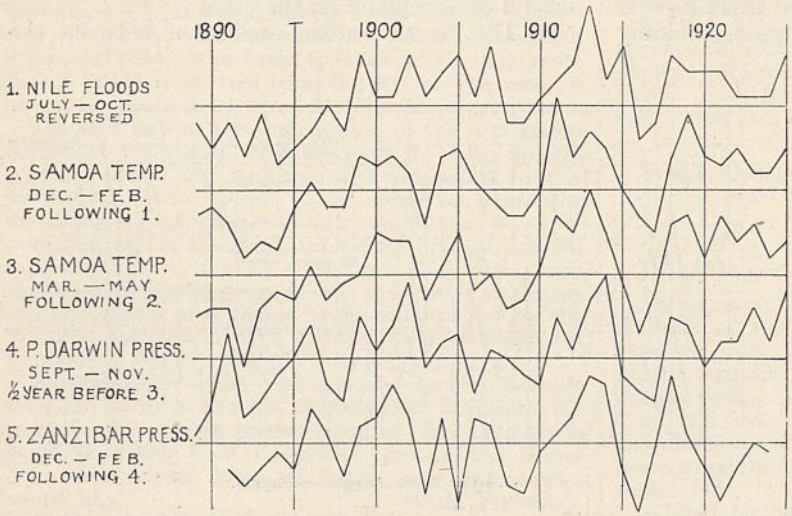

FIG. 2.—The southern oscillation.

the pressure at Port Darwin in North Australia for September to November, six months before the third curve, yet with so close a correspondence that the coefficient between them is 0·80. Lastly, we have the pressure at Zanzibar of December to February three months later, and so three months after the third curve, with which its coefficient is 0·72.

The general character of the southern oscillation may be inferred from the statement that in the season June to August the first group of stations, *i.e.* that oscillating with pressure in the Pacific, is most clearly represented by pressure at Honolulu, Samoa, the Argentine, and Chile, by India monsoon rainfall and by the Nile floods; and the second group, tending to have departures of the sign opposite to those of the first, is represented by Port Darwin pressure, and by temperature at Batavia and Samoa. During the season December to February the most representative stations are materially different. In the first group there are only Samoa pressure and rainfall at Java; and in the second, pressure at Honolulu, Zanzibar, North-West India, Port Darwin, and the Cape, with the temperatures of central North America, Batavia, and Samoa.

The first question that arises is that of the mechanism that binds together the southern oscillation; we have seen that the North Atlantic and North Pacific oscillations implied variations in the strength of the air circulation in those areas, and there is a presumption that a similar interpretation is applicable here. Now where there are areas of low pressure and areas of high pressure in the same latitude, the former are in general relatively warm and the latter relatively cool; so that in winter, seas have low pressure and in summer high; and for land the opposite obtains. Thus the low pressures of Iceland and the Aleutian Islands are much more developed in winter than in summer, and the high-pressure belts in the Atlantic and Pacific in summer than in winter. Accordingly, in the southern oscillation the first group consists of those areas the pressure of which will increase with increased temperature contrasts or increased circulation; thus, in the Pacific, Honolulu is in the first group in summer when the high-pressure area is more marked, and in the second group in winter when the reverse obtains; similarly, the Argentine and Chile as land areas are only in the high-pressure group in winter. Also Samoa as a high-pressure centre at times of increased circulation is much more marked in summer than in winter; and the Cape is only in the second group in its summer when pressure is relatively low.

This explanation is not complete, however, for Northern Australia is almost as strong in the second group in its winter as in its summer. Further, at times of increased circulation, when we should expect solar radiations to be stronger, temperatures are markedly lower except in higher latitudes. But here we are reminded of the old paradox, that at times of sunspot maxima, when there is a definite though small general increase of rainfall owing presumably to increased circulation, temperature is decidedly lower in the tropics and generally lower in the middle latitudes; and, going further, if we compare the relationships of sunspots with pressure, temperature, and rainfall, we find a remarkably close resemblance with those of the southern oscillation, extending in many cases into the detail. Thus if we consider our description of the southern oscillation in terms of representative centres, there were, in the season June to August, 5 centres in the first group and 3 in the second, while from December to February the numbers were 2 and 8; and without an exception we find the variations of centres of the first group associated positively with those of sunspots and those of the second group negatively, even when the members of the group change between summer and winter.

This correspondence would be explained if the southern oscillation were an effect of sunspots; but this hypothesis is untenable as the relationships between factors in the southern oscillation are much closer than those between the factors and sunspots. It seems too speculative to postulate some solar influence which should closely control terrestrial conditions and yet have but a small influence on the sunspot numbers. So we are led to the view that the southern oscillation merely expresses a natural oscillation or system of surges in the general circulation, and that, for example, the fall of temperature in the tropics is, on physical grounds, associated with an accentuation of low pressure in the Indian Ocean. If this is granted, we suppose that an increase in the number of sunspots or of solar radiation will increase slightly the general circulation and so bring about the observed relationships with sunspot numbers.

The belief held by Hildebrandsson in 1910 was that, in the tropical and temperate regions, circumstances were too regular to afford an explanation, and it must lie in the ice conditions of the polar seas; he believed also that in the southern hemisphere types of season were propagated eastwards like waves, the character of the pressure at the Cape during its summer appearing at Mauritius in the next winter, in Java and Australia the succeeding summer, and finally in South America six months later, or eighteen months after its original appearance at the Cape. This generalisation was founded on inadequate materials, and the feature which stood out most prominently in the first set of relations worked out in India was that while winter pressures in the Argentine and Chile were not controlled by any centre in the southern oscillation six months before, they controlled conditions six months later round the Indian Ocean, appearing as a reversed pressure wave which took six months to reach the Cape. It seemed therefore as if South America was the origin of the variations.

At first it appeared that a modification of Hildebrandsson's hypothesis would solve the problem. For, owing to the shape of the Antarctic continent, it would seem inevitable that the ice which flows in a westerly direction along the coast would be thrown off northwards into the Drake Strait by the projection of Graham Land, so that it would then flow north-eastward and eastward in the currents of the 'roaring forties.' The few data forthcoming from that neighbourhood indicated that a winter of low pressure in Chile was a winter of much ice at the South Orkneys, and as this would take some months to produce an area of chilled ocean and therefore of high pressure at the Cape, it seemed as if we might hope to understand how a period of low winter pressure in South America could produce a period of high summer pressure at the Cape. But subsequent examination showed that although low winter temperature at the South Orkneys produced low temperature at the Cape a year later, the coefficient between the two temperatures being +0·56, the effect six months later was small; and, apart from this, the explanation would break down because the effect of Cape temperature on Cape pressure proves on calculation to be negligible.

Unfortunately, it is easier to reject this hypothesis than to replace it. If we count in the tables the number of significant relationships, we find that pressure at Port Darwin has no less than 76 with other places, of which 32 are with subsequent seasons; next in importance come temperatures at Batavia and Samoa, each with about 60 relationships, of which only 13 are with subsequent seasons; and then come the pressures of North-West India and Samoa with smaller numbers. So pressure in the neighbourhood of Port Darwin seems to exercise more control over other regions than any other world factor, and its influence seems to be increased by Batavia temperature, which varies in close sympathy. Temperature at Samoa, the oscillations of which closely resemble those of Batavia temperature, is an equally important world centre, but belongs to the second group, while Samoa pressure belongs to the first group and has not more than half its influence. On the whole, then, although certain pressures appear to come earlier than any temperatures in the sequence of cause and effect, it is clear that ocean temperatures play a most important part in world weather. Their effectiveness may be due in part to their extreme persistence, so that successive seasons produce cumulative instead of antagonistic results.

Although it may be some time before we learn the processes by which Nature effects these enormous oscillations, and the relationships found must in general be regarded as empirical, there is no reason why they should not be utilised when possible for administrative or commercial purposes such as seasonal forecasting. Thus methods of predicting the general character of the winter and spring temperatures of a large part of northern Europe have been known for twenty years, and much additional knowledge has been won in recent researches by Brooks, Exner, Wiese, and others. The facts of the southern oscillation have been systematically utilised in predicting the rice crops of Japan, and the Java rainfall; and the recent tables have been shown by Bliss to have an immediate application to the Nile, the final relationship for forecasting being 0·72. The latest purpose to which they have been directed is in connexion with Ceara, a state in north-east Brazil liable to terrible droughts, and, as rainfall there belongs to the second group in the southern oscillation, a formula with a coefficient of 0·82 follows at once, the effect being shown in Fig. 3.

It must be admitted that a certain amount of scepticism over these matters is of great value as an antidote to rashness; for it is obvious that if we examine short series of data of pressure, temperature, and rainfall of hundreds of stations chosen at random, and look for similarities of conditions separated by all intervals of time up to five years, the laws of chance will provide one or two promising results. But, on the other hand, it is impossible to deny the validity of conclusions

based on close relations over an adequate number of years, such as forty or fifty, and this view is confirmed by actual experience. For in 1908, in my early years in India, I published an admittedly imperfect formula for predicting the monsoon based on about 34 years of data; and its reliability can

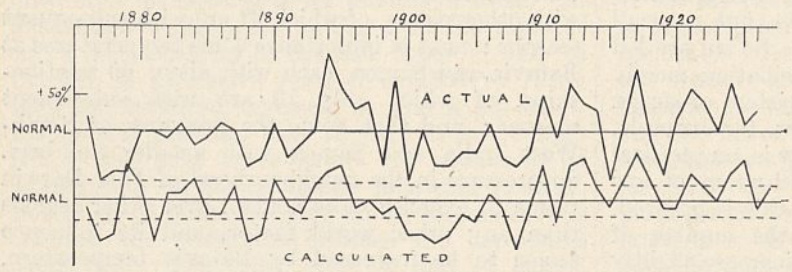

FIG. 3.—Forecast on Dec. 1 of Ceara rainfall, January–June.

be definitely estimated by comparing the indications that would have been given by it if employed during the past 19 years with the actual rainfall. Now the coefficient expressing the closeness of fit between the results of the formula and past data in 1908 was 0·58, and I should have been satisfied under the conditions if the indications of the past 19 years had a closeness of fit of 0·48 instead of 0·58; actually, however, as will be seen from Fig. 4, the foundations of the relationship have proved sound and the coefficient has worked out as 0·56; so it may be claimed that our present improved formulæ based on 50 or 55 years instead of 35 years are worthy of confidence if used with due caution. It is in my view essential that forecasts should only be issued when the indications are well marked, and if during the past 19 years a prediction had only been made in the 11 years when an excess or deficit of one inch or more had been indicated, the character of the season's rainfall, expressed merely as 'in excess' or 'in defect,' would have been correctly given 9 times (Fig. 4).

Since 1908 many new relationships have been ascertained, and the present formulæ for North-West India and for the Peninsula have coefficients of 0·76 instead of 0·58. Also, there is no reason whatever for thinking that finality has been reached; for with the seasonal changes in India are associated very big changes in the strength of the upper currents; and it is an obvious hypothesis that when the change in the upper currents takes place with unusual vigour the seasonal rainfall will be abundant. The pilot-balloon observations hitherto made strongly support this hypothesis, and what appears to hold in India very probably holds over a far wider region. Moreover, the idea that upper-air conditions are vital to the study of world weather derives support from the table of relationships with the Nile. The significant relationships with other stations for its single season number 31, while the greatest number for a single season at any other centre is 24; and as the corresponding number for pressure at Cairo is only 8, it seems likely that this effect of the Abyssinian rainfall is brought about by the agency of the upper air, not by surface conditions. Similarly,

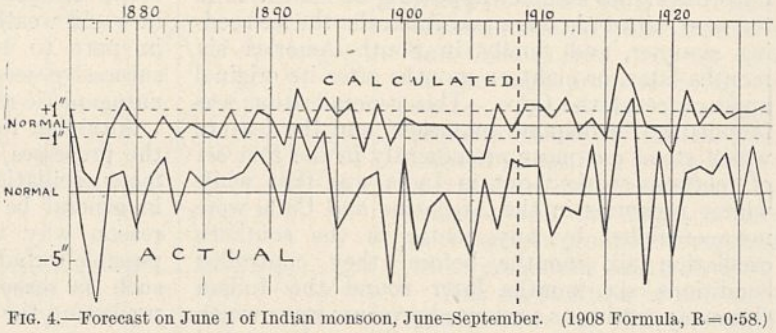

FIG. 4.—Forecast on June 1 of Indian monsoon, June–September. (1908 Formula, R=0·58.)

the monsoon rainfall of India has eight significant relationships elsewhere, but June to August pressure in North-West India only one.

It is to be hoped, therefore, that the tables of the *Réseau Mondial*, to which statistical workers have been enormously indebted in the past, will in future contain monthly means of air motion at fixed heights above such observatories as can provide the data.

Recent Earthquakes in Bulgaria and Greece.

By Dr. CHARLES DAVISON.

WITHIN the last year, destructive earthquakes have occurred in Palestine, the Crimea, Smyrna, and Asia Minor, and, so lately as Mar. 27, in north-eastern Italy. They have been followed, during the latter half of April, by a series of equally violent shocks in the south-east of Europe. Indeed, the close succession of earthquakes—and, since April 15, scarcely a day has passed without news of fresh shocks—has given rise to the impression that earthquakes have of late been more frequent than usual. There is nothing to support the impression beyond the clustering of shocks within a limited area. Assigning roughly the intensity according to Milne's scale for destructive shocks, it would seem that, in the first four months of this year, there have been one earthquake of intensity III (strong enough to destroy towns and devastate wide regions), perhaps two of intensity II (capable of shattering many buildings and overthrowing some), and two of intermediate strength. In each of ten years during the latter half of the nineteenth century there

have, during the first four months, been from three to five earthquakes of intensity III, and in each of thirteen years from three to nine earthquakes of intensity II.

The earthquakes of April 14 and 18 are described as the most violent ever felt in Bulgaria, and this is not improbable. There is a centre of some importance near Plovdiv (Philippopolis), and there are a few minor centres to the south of the Balkans, but, in the area first struck, earthquakes are exceedingly rare, if not unknown. The earthquake of April 14 occurred at about 11 A.M., and it is to this no doubt that we owe the small death-roll. The area of damage is about 70 miles long from east to west (Harmanli to Plovdiv) and 25 miles wide. The epicentre lies near Chirpan, probably a few miles to the south and close to Borisovgrade, which is almost entirely destroyed. The second great earthquake came on April 18 at 9.24 P.M., again at a time when most of the inhabitants were able to escape from the falling houses. The shock was distinctly stronger than the first and the area of damage was somewhat larger. Near Papazli, the distortion of the ground is evident; ground-levels have been changed in some places by so much as six feet, whether by crushing of the surface soil or by distortion of the underlying crust is as yet unknown. In both earthquakes the wide extent of the area of damage seems to point to a considerable depth of focus.

By far the most interesting feature of the Bulgarian earthquakes is the great and rapid oscillation of the focus. The epicentre of the earthquake of April 18 was close to Papazli, about half-way between Chirpan and Plovdiv and 10 miles to the west of the first epicentre. On the evening of April 19 it was displaced to Haskovo, 30 miles to the east of Papazli; two days later, on April 21, it had retraced its steps about 60 miles to the west, to near Golemokonare; on April 23, back 36 miles to the east, to Stara Zagora, a few miles north of Chirpan; and, lastly, on April 26, it continued its easterly march, by 24 miles farther, to the neighbourhood of Harmanli.

According to the official reports, only 103 persons were killed and 700 wounded by these earthquakes, while the total loss of property is estimated at $3\frac{3}{4}$ million pounds. In Plovdiv alone, more than five thousand houses have been damaged and two-thirds of the town rendered uninhabitable.

Very different from the Bulgarian earthquakes were those felt at and near Corinth on April 22 and following days. In the first place, they visited one of the most seismically active countries in the world. Area for area, there are more than three times as many earthquakes, weak and strong, in Greece as in Japan, and more than thirty times as many as in Italy. Or, counting only shocks of the very highest intensity, there are more than four times as many as in Italy, and nearly seven times as many as in Japan. Again, in this active country, the isthmus of Corinth is one of the most active regions, being exceeded, according to Montessus, only by the Ionian Islands to the west of Greece and, though very slightly, by the island of Eubœa to the east. In the third place, the area of destruction is small. It includes Corinth itself, in which many of the houses are damaged, the small adjoining towns of Kalamaki and Loutraki, and some of the coast villages to the west of Corinth. At the most, it may be about 10 miles in diameter, for it appears that Isthmia, four miles to the east, escaped injury during the first shock. The small area of damage, and the high intensity near its centre, combine in pointing to a shallow-seated focus. Lastly, though the foci of the after-shocks were not stationary, the limits of migration were small. On April 25 there seems to have been a slight shift to the east, most of the houses in Isthmia being destroyed.

So far as our present information goes, the Corinthian earthquakes were less important than those in Bulgaria, and owed their destructive power chiefly to the proximity of the origin to the surface.

The Voronoff Operation in Stock-breeding.

THE claims made by Dr. Voronoff and others concerning the economic value of his method of reactivation in the field of practical livestock breeding have attracted so much public interest that it was considered desirable that an authoritative report should be prepared for the information of the Ministry of Agriculture and for the Board of Agriculture for Scotland. Delegates from Great Britain, with representatives of several other countries, recently visited Algeria to witness the operation of testis-grafting in animals of agricultural importance, to examine certain animals which already had been subjected to this technique, and to examine and to report upon the claims that have been made concerning the economic value of its application. Their report has now been issued.[1]

The Voronoff operation has been employed in the case of the senile male whose own testes have become insufficient in their physiological activity, and of the sexually immature male whose testes have not yet profoundly affected the developing characterisation of the individual. It is claimed that in the first case the old, decrepit and infecund male becomes reactivated, his reproductive powers becoming restored; and that in the second, growth and general vigour are stimulated to a fuller expression as evidenced by the attainment of a larger body size and a greater sexual potency. It is also claimed that these characters are, in part at least, transmitted to the offspring. The delegates were shown a bull which had been rejuvenated, and a number of sheep in which the operation had been performed upon the sexually immature male.

The conclusions at which the delegates arrived were as follows: The claim of Dr. Voronoff to effect rejuvenation of the aged and decrepit animal

[1] Ministry of Agriculture and Fisheries: Board of Agriculture for Scotland. Report on Dr. Serge Voronoff's Experiments on the Improvement of Livestock. By Dr. F. H. A. Marshall, Dr. F. A. E. Crew, Dr. A. Walton, and Wm. C. Miller. Pp. 24. (London: H.M. Stationery Office, 1928.) 9*d*. net.

by the operation of testis-grafting is possibly justified, but the evidence presented has not been based upon critical experimentation. The delegates were not satisfied that this method, even if and when its merits have been fully demonstrated, can become of any great importance in a country such as Great Britain. The claim of Dr. Voronoff to increase the body weight and the wool-clip of the ram by the operation of testis-grafting applied to immature male, was supported by the data submitted and by the appearance of the sheep that were seen, but the conditions under which the experiments had been conducted, the inadequacy of the data submitted, and the method of the presentation of these data, made the forming of a critical opinion quite impossible. For the same reason, it was impossible to accept the evidence, which seemed to show that the improvements thus invoked were transmitted by the ordinary processes of reproduction. There is great need for repetition of these experiments with standardised material under controlled conditions of husbandry.

Obituary.

SIR DAVID FERRIER, F.R.S.

THE death of Sir David Ferrier in London on Mar. 19 removes from the roll of living neurologists a veteran pioneer, eminent in example and in service. He had reached his eighty-sixth year, and his life meant for those at work to-day a personal tie with a historic past which he conspicuously had helped to make significant.

Ferrier, as student in Aberdeen, his native city, had been a pupil of mark under the psychologist and philosopher Alexander Bain, and had graduated at the University with high honours. He had then entered upon medicine at the University of Edinburgh. The study of the nervous system attracted him early; and a gold medal was awarded to his M.D. thesis, "On the Corpora Quadrigemina." Later, in the reports of the West Riding Lunatic Asylum, where a centre of neurological research had arisen under Dr. (now Sir James) Crichton-Browne, Ferrier issued his first paper of experiments on the brain of some of the higher mammals. Hughlings-Jackson's observations upon localised discharging fits were being discussed in 1868; the famous "Study of Convulsions" followed from him in 1869. The experiments of Ferrier had for an object the "testing of the theory of Hughlings-Jackson that localised and unilateral epilepsies are caused by irritative or 'discharging' lesions of the grey matter of the hemispheres."

Ferrier's extension of these experiments to types of brain nearer the human was encouraged by the Royal Society with a grant in aid supplying the material for the work. Ferrier was able to establish that in the ape's brain, a considerable area of the surface sheet is excitable by faradism. Localised movements in the face and limbs, of the crossed side, were evoked with such definition and precision that "the experimenter can predict with certainty the result of stimulation of a given region." Ferrier described a 'motor region' stretching across the lateral aspect and thence over and upon the median aspect of the hemisphere. He pointed out that its extent was greater and its character more detailed in the ape than in any of the types less near to man. He then turned to determine the effects of localised destruction of portions of the cerebral surface. These experiments formed the main theme of a second Croonian Lecture following his earlier of 1874. He directed attention to the hemiplegic symptoms ensuent on injury of the motor region in the ape, symptoms in several respects indistinguishable from human symptoms familiar in the clinic. It is related by Sir Charles Ballance that at the International Congress of Medicine in London in 1881, on the appearance of one of the monkeys shown by Ferrier, Charcot of Paris, the physician, exclaimed, "It is a patient!"

Outside and beyond the region of cerebral surface which he termed 'motor,' Ferrier described further certain other regions which conversely he termed 'sensory.' He distinguished separate sensory fields severally related to the several special senses. Individual destruction of these entailed, he concluded, specific sensory defects and disturbances. His lectures upon all this work were followed in 1876 by a memorable volume, "The Functions of the Brain." The book reached beyond medical circles to a wide scientific public. It was translated into various languages. It and the work it embodied exerted decisive influence toward placing cerebral localisation in the forefront of movement in the physiology and medicine, and indeed in some respects in the psychology, of its time.

If we would seek to trace the origins of Ferrier's inquiry and the great and lasting effect it produced, we must pay regard to some contemporary circumstances. Current scientific opinion, both physiological and medical, had held that the cerebrum—'organ of mind' and mind a unity—revealed in its functioning no spatial differences. Further, current teaching had been that the cerebrum, unlike the spinal cord, remained in all appearance irresponsive to such stimuli, electrical and what not, as physiological experiment had resort to. There had, however, arisen recently the views of Hughlings-Jackson, based on clinical observation of epileptoid convulsions. Contrary to orthodoxy of the time, he taught the existence of motor centres situated in the grey matter of certain of the cerebral convolutions, namely, "the convolutions surrounding the corpus striatum." This teaching Ferrier's paper mentions as an impetus to, and its testing as an immediate object of, his first experiments. Ferrier's inquiry was also made in the light of observations obtained by Fritsch and Hitzig three years before, on the brain of the dog, with closing and opening of a galvanic current as stimulus. On that mode of stimulation the method adopted by Ferrier constituted an important advance. It enabled deliberate and sustained movement to be evoked and without

damage to the cerebral tissue ; it allowed elicitation and study of the 'march' (that is, the spreading) of movement which Jackson had noted to be of diagnostic value in the epileptoid convulsion ; it brought the clonus characteristic of epilepsy under observation as a feature of cerebral 'after-discharge.' Ferrier's method of stimulation has been followed by all observers since.

A conception which Ferrier formed regarding the localisation of function in the cortex held it to be primarily 'sensori-motor.' He conceived this region which yielded, in such systematic order, purpose-like actions of limb, etc., to represent so to say a motor executive ; and he distinguished outside it, in contradistinction to it, fields which he regarded as sensory inasmuch as he read them to be dominantly connected each with a special sense. In short, 'motor' and 'sensory' were the fundamental categories underlying the scheme of localisation in the cerebral cortex in his pioneer interpretation of it. Not 'motor' and 'sensory' of course with the crudity of the efferent and afferent sides of a simple reflex arc ; but yet distinguishably 'motor' and 'sensory.' The problem thus entered upon has exhibited during the succeeding fifty years continual increase of complexity at every renewal of attack. None the less, in intrinsic conformity with Ferrier's original point of view regarding the 'motor region,' we have to-day the experience of so versed and highly qualified an observer as Dr. Gordon Holmes, to the effect that "the precentral gyrus [the motor region proper] has no sensory functions." In addition, Ferrier's scheme, which assigned the major part of the cerebral surface to specific sensory fields, can stand as a prototype of that which comparative anatomy and cytoarchitecture have step by step since then substantiated. Also, the modern finding of Pavloff and his school arrives no less at a functional scheme which, even more than did Ferrier's original, allocates the cerebral surface to territories representing the several specific receptor-systems, with exclusion and negation altogether of 'pure association' fields.

The interpretation of observations regarding cortical functions forms an arena which has seemed to invite conflict. Ferrier arrived at a conception with the fundamental simplicity of which there corresponds, very probably, a fundamental truth. As regards animal mind, analytic psychology has not yet reached the elements needed in application to the problem. Be that as it may, a tribute which was quickly paid to Ferrier's work was that subsequent investigation of the nervous system, whether by adherents or by opponents of his views, for many years did little else than search for 'localisation' of something. A tide of localisation flowed with subversion of other interests. A 'localisation' era followed on Ferrier's work. The vogue became, as time went by, tedious, and in many respects infertile ; but the importance of the work which ushered it in can never be forgotten.

It is difficult now to think back to a functional neurology which resigned itself to picturing the cerebral cortex as an uncharted sea, an unknown uniformity. With Ferrier's experiments that state of things came to its term. There followed consequences theoretical and practical. One beneficent practical result was that the symptoms of certain brain tumours, etc., viewed in the light of his 'localisations' in the ape, allowed the physician to locate the seat of mischief within the skull and so sometimes enabled relief of the patient by surgery. An element of irony attaches to the fact that as a consequence of his experiments Ferrier was prosecuted by anti-vivisectionists. The charge against him fell unfounded.

If this brief notice has occupied itself chiefly with one outstanding achievement in the earlier career of a long and active life, that must not convey the impression that the subsequent years had not also their rich yield of labour given and worthy contributions made. It was as a lover of knowledge that Ferrier pursued knowledge. He had a share in many undertakings to foster and advance it. He was of those who at a meeting in London in the spring of 1876 founded the Physiological Society ; the Society elected him to its honorary membership in January of last year. On the title-page of the *Journal of Physiology* his name has stood as a collaborator for thirty-four years continuously. He was one of the small band who in 1878 launched *Brain*. He was a founder of the Neurological Society in 1886 ; its president in 1894. His zeal and interest in neurology, and indeed other science, never staled. When he no longer himself carried on experimental research it afforded him pleasure to watch others experimenting. His talk possessed a certain penetrative piquancy partly veiled in simplicity ; it had a knack of getting to bottom. In literature he enjoyed dipping within the ancient classics. He was of artistic taste, in pictures as in other matters. The sea and the sea-coast were his favourite setting for a holiday. Numerous honours came to him. He was elected F.R.S. in 1876, and he received from the Royal Society a Royal medal in 1890. He was a laureate in Paris in 1878. His knighthood was conferred in 1911. C. S. S.

MISS J. E. HARRISON.

WE regret to record the death of Miss Jane Ellen Harrison, which took place in London on April 16, at the age of seventy-seven years. She was born in East Yorkshire on Sept. 9, 1850. At an early age she showed a special aptitude for languages, which she maintained until the end of her life. Before she entered Cheltenham Ladies' College at the age of fifteen, she had already acquired a knowledge of Latin, Greek, German, and Hebrew ; while after she had attained the age of seventy, she made herself acquainted with the elements of Persian.

Miss Harrison entered Newnham in 1874 and, it was stated privately, was at the head of the Second Class in the Classical Tripos in 1879. She returned to Newnham as a fellow in 1900. On the termination of her college course she took up

the study of Greek art and literature, publishing her first book on the story of the Odyssey in 1882, her object being to elucidate the Homeric myths in the light of Greek art, especially as exemplified in the art of vase and gem. Other books on art and on the topography of Attica and primitive Athens followed; but as might have been expected from the bent of a mind which, tradition has it, would have preferred the Moral Sciences to the Classical Tripos, she found herself more and more absorbed in the study of Greek religion as time went on.

In her "Prolegomena to the Study of Greek Religion" (1903), and her admirable "Ancient Art and Ritual," Miss Harrison showed that she had given herself over to the study of Greek religion on comparative lines under the influence of Frazer and of Ridgeway's methods of utilising the customs and culture of primitive peoples in dealing with the problems of Greek archæology. Not, indeed, that she was attracted to the study of primitive custom as such, for she expressed herself as repelled by much of the material through which she had to wade. She always succeeded in keeping herself fully abreast of the literature and of the latest developments in theory in anthropology and psychology, and it is interesting to follow the development of her thought in her later books, "Themis" (1912) and "Epilegomena to the Study of Greek Religion" (1921), as she came successively under the influence of the French sociological school—Durkheim and Levy-Bruhl in particular—of Bergson, and later of Jung and Freud. Her last book, "Reminiscences of a Student's Life," appeared in 1925.

Even though Miss Harrison may have been apt to generalise too hastily and prone to allow herself to be dominated by a theory as if it were always of universal application, she was a pioneer in her field, and in the study of Greek religion her work will hold a permanent place.

WE regret to announce the following deaths:

Sir William Church, Bart., president of the Royal College of Physicians from 1899 until 1905, and a trusted leader of the medical profession in Great Britain, on April 27, aged ninety years.

Mr. A. J. Jenkinson, O.B.E., tutor, librarian, and senior dean of Brasenose College, Oxford, known for his work on philosophy and economics, on April 19, as the result of an accident, aged fifty years.

Prof. Theodore W. Richards, For. Mem. R.S., professor of chemistry at Harvard University since 1901 and director of the Gibbs' Memorial Laboratory since 1912, a distinguished authority on atomic weights, on April 2, aged sixty years.

Mr. F. W. Shurlock, formerly Principal of the Derby Technical College, on April 19.

Mrs. Sollas, wife of Prof. W. J. Sollas, and widow of Prof. H. N. Moseley, Linacre professor of human and comparative anatomy, Oxford, whose son, H. G. J. Moseley, the brilliant young physicist, was killed at Gallipoli in 1915, on April 28.

News and Views.

THE fifteenth International Geological Congress meets at Pretoria on July 29, 1929. As the British Association for the Advancement of Science is visiting South Africa at the same time, and has secured a large contribution from Government, professional people and the mining houses have raised a substantial sum privately as a guarantee for the Congress; the local committee is therefore able to offer subsidies towards the expenses of visiting members, as well as a reduction of from 35-50 per cent. in the railway fares. Negotiations are in progress with the shipping companies for similar concessions, the results of which will be announced later. So heavy have been the calls on the community in South Africa that an urgent appeal is issued to everyone who can, to apply for membership of the Congress, addressed to the General Secretary, Post Office Box 391, Pretoria, South Africa. The membership fee is one pound. The main discussions at the meeting will be on magmatic differentiation, pre-Pleistocene glaciation, and the genesis of petroleum, but the most attractive feature will be the excursions, which have been arranged so as to cover all the classic areas. At Cape Town will be seen the intrusions of granite into slate, described by Basil Hall in 1813, which were used by Dr. Hutton in illustration of his theory. North of this are the folded mountains, bringing down the Devonian beds, with fossils of an American type. On the margin of the Karroo occurs the Permian glacial deposit, the Dwyka Conglomerate, which will be seen in its full development. Later excursions will enable the members to see the Lower Cretaceous at Uitenhage, and the enormously fossiliferous Cretaceous rocks of Zululand. In the Transvaal, the Bushveld Laccolite dominates the stratigraphy, with its margin of basic rocks containing platinum. Three subsidiary structures are of special interest, the Pretoria soda caldera, the Pilandsberg, and the Vredefort granite mass.

ECONOMIC geologists attending the International Geological Congress will have an opportunity, very rarely given nowadays, of seeing the full working of the Kimberley mines, and of comparing them with the Premier Diamond Mine. In Johannesburg the surface and underground workings of a mine in the central area and on the Far East Rand will be shown, while a comparison of the Rand section with that of Pretoria with the iron deposits will be demonstrated. In Rhodesia the Great Norite Dyke is of interest, but the Victoria Falls, with the vast chasm of the Batoka Gorge, will be the greatest attraction. All the mineral deposits, chrome, asbestos, and the various gold ores will be seen in specially favourable circumstances. Applications for these excursions must be received before April 1, 1929. The meetings will be held in Pretoria on July 29–Aug. 7, but the excursions will extend from July 16 until Aug. 24, beginning and ending at Cape Town. The secretary of the Geological Society of South Africa appeals at the same time for additional members. He points out that the publications of the Society are indispensable to anyone interested in the geology of Southern Africa and the

mineral resources of that territory. The Society is dependent for its annual revenue upon subscriptions to defray the heavy cost of printing, and many who make use of, and derive benefit from the transactions, do not belong to the Society. The address is Post Office Box 1071, Johannesburg, South Africa.

IN our issue of Jan. 21 (p. 110) reference was made to the offer by the Premier of Queensland to the Commonwealth Council for Scientific and Industrial Research of an area of about 25,000 acres of land at Saltern Creek, in the middle of the State, to be used as a central scientific station for investigations into problems of the sheep industry. It was mentioned also that the Land Settlement Advisory Board had expressed a hope that the offer would be accepted in whole or in part. As a matter of fact, the offer had been declined at the time the Board reported. The Council was convinced that it could not justify the stocking and equipping of a big research station on the proffered area. Nor was it impressed by the suggestion that it might run the station in part as a commercial undertaking and recoup itself in that way for a part of the expense.

To laymen, the refusal of the Saltern Creek area seemed rather puzzling. The land is excellent sheep country for Northern Australia, carrying one sheep to 2½ acres. Its rental value is about 8d. per acre per annum, and the period of leasehold, offered free of charge, was thirty years. At first sight the offer appeared tempting, but further investigation convinced the Council that its acceptance would be very unwise. Just because the land is so good it is unsuitable for certain major lines of work. Thus, there are no parasitological diseases there at present, and it would be sheer folly to introduce them. The blowfly pest is prevalent, but so it is over vast areas in the Commonwealth, and work aiming at control can be carried out far more satisfactorily in more readily accessible places in New South Wales nearer to the Council's central entomological laboratories. For work on artificial feeding of sheep (which is generally quite unnecessary in this region) an area of poorer country would be more useful. Investigation of natural grasses best suited for wool production could be carried on there, but such investigations are needed all over Australia, and the Council hopes that pastoralists themselves will provide the necessary facilities in a great number of much smaller areas. Work on mineral deficiencies in pastures is already in hand in several places where it is urgently required. Saltern Creek has no special claim for immediate attention. The Queensland Government was disappointed at the refusal, but the scientific grounds upon which the Council based its decision have not been seriously challenged.

THE Reports of the Zoological Society of London for the year 1927 tell of progress and prosperity which must be very gratifying to those responsible for the conduct of this great concern, and are a reward of fresh adventures in methods of exhibition, as well as an indication of the increasing interest taken by the populace in living animals. The number of fellows has mounted to 7687, and it is suggested that some mode of limitation and an increased annual subscription may have to be considered in the near future. The number of visitors to the Gardens in Regent's Park reached a record of 2,158,208, and to the Aquarium, 458, 936; the surplus of income over expenditure was £16,859, in spite of the fact that more than £57,000 spent on new exhibition houses, which might well have been reckoned a capital charge, was paid from revenue. A hint of the part the Garden plays in encouraging the holiday spirit is contained in the item of more than £3000 drawn from elephant rides and the like. The difficulty of acclimatising animals is still apparent in the high death-rate within six months of arrival, but the steady reduction during the past three years in the percentage of deaths is very satisfactory, and the management is to be congratulated on the astounding improvement in pulmonary conditions, the mortality having been reduced by more than 50 per cent. since 1925. It would be interesting, and of value to other zoological gardens in Great Britain and abroad, to know whether this improvement can be ascribed to the new installations which have been described in former reports, to special feeding and a rise in tone and resistance, or to generally more healthy conditions of ventilation and isolation.

THE Zoological Society does not neglect the scientific opportunities which its unique collections afford: a new anatomist has been appointed, a panel of parasitologists, formed by the staffs of the Institute of Agricultural Parasitology and the London School of Hygiene and Tropical Medicine, has undertaken this important branch of research, and the biological investigations of the newly elected Aquarium Research Fellow should prove of scientific interest and practical value. During the year the scientific *Proceedings* absorbed £2760, and the preparation and printing of volume 63 of the *Zoological Record*, a sum of £1928. It is regrettable that, in spite of the donations received towards the publication of this invaluable guide to zoological literature, volume 63 alone should involve a loss of £1042, and societies, institutions, and individuals who wish the *Zoological Record* to be maintained, are requested to give their support in the form of annual donations to the "Record Fund."

THE frequency and sites of cancer in persons of different habits and following different occupations has from the first thrown important light on the conditions which lead up to the disease, and careful analysis of occupational statistics will be a fruitful line of further advance. One of the earliest associations to be recognised was cancer of the scrotum and chimney sweeping: with the change in the methods and personal cleanliness of chimney sweeps, their special liability of this form of cancer has disappeared. Most curiously, however, it has been replaced by the appearance of the same cancer in cotton operatives, which is variously attributed by those who have studied the matter in Lancashire either to the lubricating

oil used on the machines or to ill-fitting overalls which the decencies of industrial life have introduced. That there was some connexion with the products of the distillation of coal and shale had been proved or suspected on clinical grounds before Yamagiwa and Ichikawa showed that by patience and persistence the carcinogenic activity of any substance could be satisfactorily explored experimentally by applying it to the skin of mice repeatedly over long periods of time.

BY experimental work of this sort it has been shown that tar and soot have a unique efficacy in producing cancer, which is no doubt why the industrial labourer is so much more liable to the disease than his agricultural brother. By this method, too, it is possible to analyse the injurious action of the various lubricating oils which are used on factory machines. Dr. Leitch has done this already, and has found that shale oil is far the most harmful, illustrating the thorough clinical demonstration of its association with cancer in the Scottish oil field which was given by Dr. Scott. The particular field of mule-spinners' cancer has again been explored by Dr. C. C. Twort and Mr. H. R. Ing, working for the Manchester committee on cancer (*Lancet*, vol. i. 1928, p. 752). Applying each of 12 oils twice a week to 100 mice for periods up to 18 months, they find that sperm oil is harmless, natural petroleum oils are slightly carcinogenic (especially their higher boiling-point fractions), and shale oils are highly efficacious and act like a weak tar. Harmless oils do not become injurious by passage through the machines, and the carcinogenic action of shale oil may be removed by extraction with sulphuric acid and possibly other methods. If, then, mule-spinner's cancer is due to the lubricating oil, it seems likely that it should be possible to get rid of it.

AT the centenary of the Cockerill Works at Seraing in October last, the King of Belgium pointed out the necessity for honouring science throughout the country, since pure science is the indispensable condition for applied science, and neglect of it leads to decadence. As a result of this speech, a meeting of authorities interested in university education was held in Brussels in November to consider how best to encourage scientific work. Since then two pamphlets dealing with the subject have appeared, "La détresse de l'enseignement supérieur en Belgique," by L. C., and "Notre misére scientifique," by Q. M. Quaeris and others. The second of these traces the present paucity of intellectual effort in the country to the smallness of the Government vote for higher education, which is 5 francs per annum per head of the population, that is, less than in South American or in the Balkan States. The pay of university professors is in consequence small, and it is not possible to attract the best men to university posts. The method of selection is such as to attach less weight to a candidate's intellectual powers than to his political friendships. A particular case is cited at great length. The success of the recently established "Fonds national de la Recherche scientifique" is regarded as a sign that the country appreciates the position and is determined to improve it.

THE problem of the safe use of coal-mining explosives was dealt with by Dr. W. Payman in a paper read before the Midland Institute of Mining Engineers on April 17. He regards the production of a flameless and therefore completely safe explosive as an improbability. In practice, the explosive must be safe in spite of its flame. Safety resulting from a reduction of flame temperature is gained only at the expense of the efficiency of the explosive. Care in shot-firing would probably lead to safety more than any other obvious means, for no explosion would occur if contact of flame and explosive mixture did not occur. It is, however, desirable to improve, if possible, the composition of explosives. Considering the stringency of the official test of explosives, it is often puzzling to account for actual ignition of gas in the mine. If, however, the test were made so rigorous as to cover every possible combination of circumstances, its operation would probably exclude the use of explosives underground altogether. After contemplating the large hot flame resulting from firing a 'permitted' explosive, it is perhaps more astonishing that ignition of the fire-damp–air mixture does not always occur in the official test. Dr. Payman outlined the programme of the Safety in Mines Research Station at Buxton, which necessarily involves the analysis of explosion phenomena and the ignition of gas mixtures. His lecture was illustrated with photographs of flames produced under various conditions.

SOME further details of Capt. G. H. Wilkins' polar flight were published in the *Times* at the end of last week. From Point Barrow to about lat. 75° N., the pack-ice was heavy and rough, with a few east and west leads of open water, decreasing in number towards the north. In lat. 73° N. there was some evidence of obstruction preventing a drift to the eastward, but no land was sighted. From lat. 75° to 77° N. there was much young ice, making good landing places, but farther north the pack again became ragged. Between 78° and 80° N. the flight was over clouds. Then it was clear again to 84° N., and there was no sign of Crocker Land. The pack-ice again was rough. North of Grant Land there were clouds, but north of Greenland the visibility was good and the ice was young and relatively smooth. From Greenland to Spitsbergen the flight was across much open water. Capt. Wilkins was tempted to descend north of Greenland, but held on in spite of bad weather. If he had descended he could have fallen back on foot on Etah or the Royal Canadian Police post in Ellesmere Island. He explains that a descent to take a sounding on the earlier stretches of his flight, where soundings would have been valuable, was impossible on account of the heavy load of his machine and consequent difficulty of ascending again.

HIS MAJESTY THE KING has approved the award by the Royal Geographical Society of the Royal Medals as follows: *Founder's Medal* to Dr. T. G. Longstaff, for his discovery of the Siachen Glacier and long-continued geographical work in the Himalaya; *Patron's Medal* to Captain G. H. Wilkins, for his many years' systematic work in Polar regions, culminating

in his remarkable flight from Point Barrow to Spitsbergen. The Council has made the following rewards: *Murchison Grant* to Captain C. J. Morris, for his recent journey in Hunza; *Back Grant* to Mr. George Binney, for his journey across North-east Land and his successful conduct of the Oxford Expeditions to Spitsbergen; *Cuthbert Peek Grant* to Mr. H. G. Watkins, in recognition of his leadership of the Cambridge Expedition to Edge Island and to assist him in his proposed expedition to Labrador; *Gill Memorial* to Mr. C. P. Skrine, for his exploration of the Qungur area and his work on Chinese Central Asia.

A CORRESPONDENT has written pointing out an apparent discrepancy between a note entitled "The Cosmic Rays" in our issue of Mar. 24, p. 477, on Prof. Millikan and Dr. Cameron's work on cosmic rays, and a remark made by Dr. J. H. Jeans in the supplement to the same issue of NATURE. The note refers to the "progressive hardening of the [cosmic] rays in their passage through the air," while Dr. Jeans (p. 468) says: "There are many ways known to physics of softening radiation, but none of hardening it." It should be remembered, however, that Prof. Millikan and Dr. Jeans were discussing two different effects. The radiation with which Prof. Millikan is concerned is heterogeneous. During its passage through the air—or other absorbing media—the components of greater wave-length (the 'softer') are removed by absorption at a proportionately greater rate than those of shorter wave-length (the 'harder'). The result is that the fraction of the latter in the radiation increases as the rays pass through the air, which can be expressed in Prof. Millikan's own words, as ". . . a definite hardening of the cosmic rays . . . between 13 and 23 meters (of water) beneath the surface of the atmosphere" (*Physical Review*, February 1928, p. 170). Dr. Jeans, on the contrary, is referring implicitly to homogeneous radiation or individual quanta, for which any such effect as that considered by Prof. Millikan is out of the question. Homogeneous radiation can only be 'softened,' as, for example, by the type of scattering studied by Prof. A. H. Compton and Prof. Debye.

MAJOR P. H. G. POWELL-COTTON has recently presented to the Department of Zoology of the British Museum (Natural History) a selection from the collection of mammals shot by him in the Cameroons and Lake Chad district. The specimens are of great scientific importance, as they include the co-types of several new forms, including a new kudu. This animal is smaller than the eastern kudu and has smaller horns; its discovery extends the range of the species many hundreds of miles in a westerly direction. There are also some fine specimens of the western giraffe (*Giraffa camelopardalis peralta*) and of the Congo race of Lord Derby's eland (*Taurotragus derbianus congolanus*). The collection is one of the most important additions to the study series of Ungulates and Primates that has been received by the Museum in recent years. Another important gift to the Department comprises the greater part of the scientific collections of the late Mr J. J. Lister, presented by Mrs Lister, including 700 microscopic preparations of Foraminifera, together with a series of notebooks relating to them. The Department of Entomology of the Museum has received the Eustace Ralph Bankes collection of British Lepidoptera, presented by Mrs Grace Bankes, which includes many of the tiny moths of the families Tortricidæ and Tineidæ, among which are several type specimens. From Mr Arthur Lea, entomologist to the South Australian Museum, there have been received some remarkable cocoons, many of them larger than a fowl's egg; they are the abandoned cocoons of beetles, which have become filled with sand and afterwards solidified by the infiltration of lime in solution. A very fine example of the fossil fish *Lepidotus elvensis* (Blainville), from the Upper Lias of Holzmaden, Würtemberg, measuring 2¼ ft. in total length, has been purchased for the Department of Geology.

ACCORDING to a *Daily Science News Bulletin*, issued by Science Service of Washington, some concern is being expressed on the present condition of the giant sequoia trees in the Yosemite National Park, California. Dr. E. P. Meinecke, of the U.S. Forest Service, states that they are suffering from the trampling of the thousands of tourists, which has in part destroyed the fine root endings. Some five and twenty years ago, 'Grizzly Giant,' one of the finest of the big trees, was similarly threatened, but by loosening the soil, and placing additional soil to a depth of 3-4 ft. around the tree, the veteran has regained its vigour.

THE issue for March of *The World's Health* (vol. 9, No. 3) contains an article by Dr. Roeschmann on the new German law against venereal disease, which was approved by the Reichsrat last year. Coercive measures are dispensed with as much as possible. A sufferer is required to submit to treatment by a qualified doctor, whose duty it is to make his patient fully conversant with the nature and dangers of the disease. So long as the patient follows his doctor's orders, he is not notified to the health authorities or molested in any way. If he fails to do so, the national insurance agencies first summon him to report for treatment. If this summons is neglected, a report is made to the health authorities, who then direct the patient to submit to treatment. If this should fail, coercive measures may be taken, involving compulsory treatment. The law contains special provisions for the protection of new-born infants and wet nurses, and a complete reform of the regulation of prostitution.

THE Department of Terrestrial Magnetism of the Carnegie Institution of Washington has a total staff of nearly sixty, of whom more than twenty are trained scientific workers. The *Annual Report* of the Director for the year 1926–27 indicates that the chief recent activities of this important body of investigators have been varied, but largely consisted of the reduction and preparation for publication of former observations made by the Department, and of numerous special researches of a non-routine character; no great

programme of surveying on land or at sea was in progress, though the non-magnetic ship *Carnegie* was being prepared for a new three-year cruise. The principal observing work of the Department consisted in the maintenance of two magnetic and electric observatories at Watheroo, Australia, and Huancayo, Peru. Among the special researches were included investigations into atomic physics, correlations between magnetic variations and the transmissibility of radio signals, and soil-resistivity surveys in Australia and at Ebro in Spain.

FROM the Bulletin of Information with regard to Professional Courses in Optometry at Columbia University, New York, in 1928–29, it appears that in the United States and in Canada opticians are required to pass through an extensive course of training before they receive a licence to practise. Before entering on the prescribed course of professional training, candidates are required to have attended an accredited high school for four years and to have been awarded a qualifying certificate. After attending courses on optometry for several years, and gaining the Certificate of Graduation, a candidate is eligible to take the licence examination. After 1930 a candidate must have spent four years in professional study, and must have graduated either B.A. or B.Sc. before he is eligible. At Columbia University the work is done in the physics building under the direction of Prof. P. C. Southall. University fees amount to £60 per annum, and board and lodging to £150 per annum as an average. The courses are open to men and women on the same terms.

THE eighty-first annual meeting of the Palæontographical Society was held in the rooms of the Geological Society, Burlington House, on April 20, Dr. F. A. Bather, vice-president, in the chair. The annual report recorded the publication of further instalments of the Monographs of Gault Ammonites, Macrurous Crustacea, and Palæozoic Asterozoa, and the beginning of a new Monograph of Dendroid Graptolites by Dr. O. M. B. Bulman. It also announced the preparation of a Monograph of the Irish Deer by Prof. S. H. Reynolds, and of the Corallian Lamellibranchia by Mr. W. J. Arkell. The Council especially regretted the resignation of Mr. E. T. Newton from the office of president, and expressed its deep appreciation of his valuable services since his election in 1921. Dr. W. D. Lang, Mr. W. E. F. Macmillan, Mr. R. W. Pocock, and Mr. W. P. D. Stebbing were elected new members of Council. Dr. F. A. Bather was elected president, and Dr. F. L. Kitchin new vice-president. Mr. Robert S. Herries and Sir A. Smith Woodward were re-elected treasurer and secretary respectively.

AT the meeting of the Illuminating Engineering Society on April 24, a discussion on "Daylight, Artificial Light, and Artificial Daylight" was opened by Mr. J. S. Dow. In the first section of his paper Mr. Dow directed attention to the chief respects in which daylight differed from artificial light, pointing out that natural lighting in most buildings is far from ideal. It was suggested that in general, owing to the eye being adapted to the bright sky overhead, somewhat higher illuminations are required by natural than by artificial light. The difficulty of working in a mixture of natural and artificial light was also analysed, the author suggesting that one of the chief causes of the feeling of discomfort is the progressive diminution in daylight intensity during the twilight period. It was pointed out that in many buildings, especially offices in congested areas, artificial light has to be frequently used to supplement daylight. There is therefore some reason to advocate the adoption of a form of 'modified artificial daylight,' that is, lamps so screened that the light is visually a match for daylight, provided the absorption of light occasioned is not too high. The Council Room of the Chartered Institute of Secretaries was mentioned as an interior in which this method has been followed with happy results. Mr. Dow also touched on the debatable question whether light resembling average daylight in colour is more favourable to acuteness of vision than uncorrected artificial light. Detail illuminated by red light is most distinct when viewed at a distance, whereas for very close vision the reverse is often the case. The effect is apparently associated with the chromatic aberration of the eye, and it is probable that this explains to a great extent why some people find reading by daylight easier than by artificial light of similar intensity.

THE first conversazione this year of the Royal Society will be held on Thursday, May 17, at 8.30 P.M.

SIR JAMES WALKER will deliver the Arrhenius Memorial Lecture of the Chemical Society on Thursday, May 10, at 5.30 P.M., in the theatre of the Royal Institution. With regard to ordinary scientific meetings, it has been decided to hold the May and June meetings of the Society at 5.30 P.M. instead of 8 P.M.

THE British Aquarists' Association will hold its third annual exhibition at Trinity Hall, Great Portland Street, W.C.1, on July 24–28. The exhibition will be of an international character, intending participants including exhibitors from Germany, Holland, America, Italy, and Japan.

MAJOR WALTER ELLIOT will give a Chadwick Public Lecture on "Sunlight—Natural and Manufactured—and its Use in Modern Medicine," at the house of the British Medical Association on May 15 at 8.15 P.M. He will review some recent research work and discuss the experience of certain local authorities.

A CORRESPONDENT points out, with reference to the lately announced death of Lord Eversley, that before elevation to the peerage, and when known as Mr. G. J. Shaw Lefevre, he was elected (in 1899) a fellow of the Royal Society under the old statutory provision relating to the occasional inclusion of privy councillors. This was during the presidency of Lord Lister. Later, Lord Eversley withdrew from the Society.

THE proceedings at the annual conference of the Institute of Quarrying at Blackpool, June 4-9, include

papers by Prof. P. G. H. Boswell, University of Liverpool, on "Silica—its Commercial Properties and Markets," and by Mr. W. J. Rees, University of Sheffield, on "Commercial Sands." Among other papers to be read are "Electric Traction as Applied to Quarries and Slate Mines," by Mr. M. I. Williams-Ellis; "Cutting Costs in Slate Quarries," by Mr. T. R. Druitt; and "Research," by Mr. Hadleigh S. Seaborne.

SIR THOMAS ARNOLD, professor of Arabic, University of London; Mr. W. R. Halliday, Principal of King's College, London; and Prof. A. G. Tansley, F.R.S., Sherardian professor of botany in the University of Oxford, have been elected members of the Athenæum Club under the provisions of Rule II. of the club, which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for public services.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A fully experienced and capable designer at the Admiralty, intimately conversant with design and detail of small turbines and internal-combustion engines—The Secretary of the Admiralty (C.E.), Whitehall, S.W.1 (May 7). A warden of the Hostel for Men Students of Stranmillis Training College, Belfast—The Principal, Stranmillis Training College, Queen's University, Belfast (May 15). Lecturers in physics and botany respectively in the Durham Division of the University of Durham—The Head of the Department of Science, University of Durham, South Road, Durham (May 19). A professor of physiology in the University of Hong-Kong—The Chief Medical Officer, Ministry of Health, London, S.W.1 (May 21). A half-time assistant in the department of mathematics of the University College of Swansea—The Registrar, University College, Swansea (May 23). An Academic Secretary of the University of Wales—The Registrar, University of Wales, Cathays Park, Cardiff (June 8). A wheat chemist at the Wheat Research Institute, New Zealand—The High Commissioner for New Zealand, 415 Strand, W.C.2 (June 30). A lecturer in experimental psychology in the Queen's University of Belfast—The Secretary, Queen's University, Belfast (July 1). A professor of pathology in the Queen's University of Belfast—The Secretary, Queen's University, Belfast (July 16). A master to take entire charge of teaching and supervising chemistry and physics, with some mathematics, at the King Henry VIII. School, Coventry—The Headmaster, King Henry VIII. School, Coventry. A metallurgist (or engineer with metallurgical training) having a thorough knowledge of the theory, treatment, and application of alloy steels, and a technical assistant, each for the Mond Nickel Company, Ltd.—The Secretary, Research and Development Department, Mond Nickel Co., Ltd., Victoria Station House, S.W.1. A teacher for building subjects at the Derby Technical College—F. C. Smithard, Education Office, Derby. An assistant physiologist in the Clinical Laboratory of the Sheffield Royal Hospital—The Supt. and Secretary, Royal Hospital, Sheffield. An assistant, and junior assistants under the Directorate of Ballistics Research of the Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

METEOR SHOWERS OF APRIL AND EARLY MAY.—Mr. W. F. Denning writes: "The April shower of Lyrids appears to have formed a display of minor importance this year. Mr. A. King watched from near Scunthorpe, Lincolnshire, on April 21, and recorded 12 Lyrids from a point 272° + 33¼°, and on April 22 he noted 5 meteors from 273° + 33°. Bright meteors were observed on April 16 about 12h 44m P.M., on April 19, 12.21 P.M., and on April 21, 12.21 P.M. At Bristol, on April 19, an assistant of Mr. Denning's observed for 4 hours, but saw only 14 meteors, and on April 21 in 2½ hours about 10 meteors were noted, the radiant being at 270° + 35° on April 19 and 273° + 34° on April 21. A brilliant Lyrid equal to Venus was seen at both places on April 21, and its real path will be computed.

"The Aquarid meteors of Halley's Comet are due on the mornings of May 2–7, but the moon will be near the full at the time. This need not, however, interfere materially with the display, for the meteors are often very bright and traverse considerable arcs. The shower apparently returns annually, but can only be witnessed in the couple of hours preceding sunrise, as the radiant is below the horizon in the earlier hours."

THE STRUCTURE OF THE GALACTIC SYSTEM.—An important paper by Dr. Seares on this subject appears in the current number of the *Astrophysical Journal* (vol. 67, p. 123). The problem is treated by statistical methods, based on assumptions concerning surface densities (expressed as logarithms of the number of stars of different apparent magnitude per square degree), and space densities, of stellar distribution.

The conclusions, which seem to satisfy all known peculiarities of stellar distribution, imply that our galactic system closely resembles the highly resolved spiral nebulæ such as M. 33; consisting of a central condensation and 'knots,' as well as scattered stars and diffuse nebulosity. The diameter of the system is 80,000 to 90,000 parsecs, and the central condensation is situated in longitude 325° at a distance of about 20,000 parsecs from the sun, though the effect of this condensation on the apparent surface density is masked by the dark nebulosity comprising the rift in the Milky Way. The sun is situated exactly in the galactic plane, except as defined by Cepheids, faint *B*-type stars, and other special objects.

There is also a smaller local cluster, forming an outlying aggregation or 'knot' of exceptional size and density, with a central condensation 100 parsecs from the sun. This is spheroidal in shape, 6000 to 8000 parsecs in diameter, with its centre in longitude 230° and 40 to 50 parsecs south of the galactic plane. The bright helium stars form a nucleus of this local cluster, which includes stars so faint as mag. 16 and has a dominating effect on the apparent stellar distribution, being responsible for three-quarters of the total space density near the sun, and one-half the mean density at distances of 700 parsecs in the galactic plane.

Research Items.

CANDLES AND LAMPS.—Mr. Walter Hough, in *Bulletin 141* of the United States National Museum, has described the collection of heating and lighting utensils in the Museum—a collection which was begun about forty years ago by bringing together specimens from the ethnological series and other material acquired by the Museum. It numbers at present about 1000 specimens. Mr. Hough's description of the collection is in reality a study of a very interesting and suggestive by-path of human invention, in which the significant element is that not only did it give scope to considerable inventive ingenuity, but also that ingenuity is still constantly being exercised. From observation of peoples of low culture to-day it is conjectured that the use of fire was primarily for light giving. The series epitomising the use of the candle begins with the firefly, and the burning of fat bodies of fishes or birds, and of faggots of resinous woods. Then follow torches consisting of rudely aggregated slivers of wood or sheets of bark, passing to torches made of wax or resin enclosed in palm leaf forming an exterior wick, torches of rope or cord soaked in wax or resin—the crude candle ; and then formed candles, dipped candles, and moulded candles to the art candles of to-day. In the line of development the lamp comes at the stage when oils and fats come into use. Interesting examples of the natural torch are the bark of the Mexican candle tree (*Jacquinia pungens*), naturally so waxy that a small piece will give a good light, and, in another category, the stormy petrel of the Shetland islanders, who used to thrust a wick down the throat of the dead bird and applied a light. A wide-spread form of illuminating device is made from the candlenut (*Aleurites triloba*). Meats are strung on a strip of bamboo and the topmost lighted, when they burn to the bottom of the strip. This is generally in use among the Polynesians, and the Tule Indians of San Blas, Panama, use the palm nut in identical fashion.

STUDIES IN TROPICAL WASPS.—Bulletin 19, Entomological Series of the Experiment Station of the Hawaiian Sugar Planters' Association, contains a series of very interesting articles by Dr. F. X. Williams on the habits of tropical wasps. The importance of this group of insects to the sugar industry of the Hawaiian Islands is well illustrated in the species *Scolia manilæ*, which is now so valuable an agent in controlling the introduced Asiatic beetle (*Anomala orientalis*). The publication affords a striking example of the wise policy of the Planters' Association to encourage and foster the prosecution of fundamental research bearing upon all insects affecting, or likely to affect, the sugar and other industries of the Islands. Dr. Williams provides an admirable account of the part played by fig-wasps in the fertilisation of wild figs in the Philippines, which is of special interest in connexion with the recent introduction of such insects into Hawaii to ensure the maintenance of fig-trees in that territory. The greater part of the publication, however, is devoted to an account of the family Larridæ, and more especially of the Philippine species. At least ten species of the genus Larra are known to prey upon mole crickets, which in many parts of the world are agricultural pests of some importance : in the Hawaiian Islands the species *Gryllotalpa africana* frequently attracts notice by destroying newly planted sugar cane. A small experiment, attempting the introduction of *Larra guiana* Cam. from Brazil into the island of Oahu, is mentioned. Among other articles Dr. Williams has some interesting field observations on wasps which prey upon cockroaches, and others which attack the giant South American avicularíid spiders.

STAINING AND STRUCTURE IN MICROSCOPIC ANATOMY.—For his presidential address to the Royal Microscopical Society (*Jour. R. Micr. Soc.*, March 1928) Dr. J. A. Murray chose the subject of staining and structure, for discovery in microscopic anatomy has been closely bound up with advances in the technical manipulation of the material which formed the subject of investigation. Tissues were at first examined in their own watery fluids, and this method is still practised, in fact probably to a greater extent than ever before because of the enormous improvements in present-day optical methods. Then came the development of methods of fixation, hardening, staining, and mounting, which was briefly traced. The methods devised for producing thin sections not only accelerated discovery in all branches of microscopic anatomy, but also exercised a profound effect on every branch of microscopical manipulation, more especially on methods of staining and mounting. The most important advance in staining methods was the iron-alum hæmatoxylin of M. Heidenhain, the special advantages of which were considered. Dr. Murray instanced an application of this technique to the age-old microscopic problem of the nature and form of the markings on diatoms. Cleaned diatoms were immersed in a solution of gelatine for several days, and samples were then spread on slides, fixed in formol, stained with iron-alum hæmatoxylin and mounted in euparal. The markings on the diatoms were then seen as very dark lines and dots, and the appearances suggested that the characteristic markings are indentations on the inner surface of the frustule which are filled during life with protoplasmic processes. In conclusion, Dr. Murray said that it might appear inappropriate to many in the Society, so largely representative of the amateur element, that he should have devoted his address to a subject which mainly concerns the professional biologist. But the so-called professional microscopist must be in a very real sense an amateur if he would go far in the science. "If he has not the humble enthusiasm which is sustained by the pleasure in viewing microscopic images pushed to the limit of technical perfection in every way, the path of discovery in microscopic anatomy is not for him."

THE PENETRATION OF METHYLENE BLUE INTO LIVING CELLS.—Much use has recently been made by American physiologists of the alga Valonia, on account of the suitability of its large cells, for studies on the permeability of protoplasm. A single cell contains enough sap for the colorimetric and spectrophotometric examination of the contents. M. M. Brooks (*Proc. U.S. Nat. Acad. Sci.*, **13**, 821–23 ; 1927) has found that though the rate of penetration of the dye depends both upon temperature and the hydrogen ion concentration of the external medium, yet the concentration found in the sap when equilibrium has been attained is independent of the external hydrogen ion concentration. The methylene blue, moreover, penetrates as such, and it is not the lower homologue, trimethylthionine, that penetrates as Irwin thought. The latter is found in sap which has stood for some time after being expressed and arises from oxidation of methylene blue.

SEX CHROMOSOMES IN EMPETRUM.—*Empetrum nigrum* is a well-known Ericaceous plant found in Europe and circum-polar in its distribution, extend-

ing into the mountains of South America. A variety *hermaphroditum* has long been known, and is now recognised by Mr. O. Hagerup (*Dansk Botanisk Arkiv*, vol. 5, No. 2) as a separate species. He found it common in Greenland. It is also circum-polar, but in higher latitudes, being found in Newfoundland, Iceland, the Faroes, Scandinavia, Finland, Spitsbergen, and Siberia. It occurs also at high altitudes in the Alps, Vosges, and Auvergne. The species is stouter than *E. nigrum*, with shorter internodes, and the flowers are nearly always hermaphrodite, whereas in *E. nigrum*, which is the only form occurring in Denmark, the sexes are separate. Hagerup finds that the haploid number of chromosomes in *E. nigrum* is 13, and that there is an unequal *XY* pair of sex chromosomes. *E. hermaphroditum* is a tetraploid cell giant having 26 pairs of chromosomes. According to his account, there are two *XY* pairs; but they are arranged inversely on the heterotypic spindle, so that each pollen grain gets an *XY* pair. If the eggs also have an *XY* pair, the resulting plants might be expected to be hermaphrodite. This new sex chromosome situation is of much interest. It would appear that a tetraploid mutation has produced a form which is adapted to colder conditions and has acquired a balance of its double set of sex chromosomes, giving a stable bisexual species. It is possible that similar conditions may explain the peculiar behaviour of some of the polyploid willows.

SILURIAN CORALS.—Although much attention has been paid in recent years to the Rugose Corals of the Carboniferous and Devonian, but little work has been done on those of earlier formations. Revived interest is shown by the publication by R. Wedekind of a monograph on the Rugose Corals of Gotland (*Sveriges Geol. Undersök*, Ca, No. 19, 1927). He divides these corals into two sub-orders, the Streptelasmacea and the Cystiphyllacea, and describes several new genera. The stratigraphical significance of the coral faunas is discussed. The Lower Gotlandian is characterised by the occurrence together of the last of the Streptelasmacea and the first of the Cystiphyllacea, and the genera Dinophyllum and Chonophyllum are dominant at this stage. The Middle Gotlandian is dominated by the Cystiphyllacea, and there is no Streptelasmid except the long-lived Calostylis; this division of the Silurian is divided into three stages, each with its characteristic coral fauna. The Upper Gotlandian is distinguished by the Omphymatids, especially by the genus Omphyma. Other recently published papers on Silurian Rugose corals are: (1) Revision of the Rugose Corals described in Murchison's Silurian System, by W. D. Lang and S. Smith, *Quart. Jour. Geol. Soc.*, **83**, p. 448; 1927. (2) *Tryplasma rugosum*, by S. Smith and W. D. Lang, *Ann. Mag. Nat. Hist.*, **20**, p. 305; 1927. (3) Ptilophyllum and Rhysodes, by S. Smith and R. Tremberth, *ibid.*, p. 309. (4) Structure and Development of Stauria, by S. Smith and T. A. Ryder, *ibid.*, p. 337.

THE ST. LAWRENCE EARTHQUAKE OF FEB. 28, 1925.—This remarkable earthquake has already been noticed in these columns (vol. 116, pp. 56 and 948), and a detailed report on it by Mr. Ernest A. Hodgson, seismologist in the Dominion Observatory of Ottawa, has recently appeared in the *Transactions of the Royal Society of Canada* (vol. 21, pp. 145–52; 1927). The earthquake was felt strongly in eastern Canada and the New England States, and slightly as far as Virginia and the Mississippi, and even at Duluth, about 1200 miles from the origin. The disturbed area may thus have contained more than a million square miles. The damage caused by the shock was confined to a narrow belt, about 20 miles long, crossing the St. Lawrence near Rivière Ouelle (about 90 miles below Quebec), the epicentre (as determined by instrumental observations) being near the centre of this band, in lat. 47°·6 N., long. 70°·1 W. The earthquake was probably due to a sharp upward thrust on the north-east side of a fault traversing the band, coupled with a horizontal movement of the south-west side towards the north-east. The only line of levels in the district was one made in 1915 from Levis to Rivière du Loup. A series made in 1925 after the earthquake showed no displacements exceeding the order of the errors of observation, but, assuming that the Levis end of the line was undisturbed, it is worthy of notice that the differences to the east of St. Pacome and Rivière Ouelle were all in the same sense and upwards, while those to the west were in the opposite direction.

INCIPIENT IONISATION.—A process described by Prof. J. Franck in the *Zeitschrift für Physik* of Mar. 6 shows how it is possible for an electron to part with more energy than is needed to produce ionisation when it collides with an atom, without the actual formation of new charged particles. The electron which would be liberated normally is supposed to pass into one of the exterior quantum orbits which is usually vacant, and to emit in the form of radiation the excess energy that it could have carried away from this position to a point outside of the sphere of influence of the positive residue. Such radiation would be mainly in the infra-red, but arc lines would be emitted in the subsequent return to the normal state, and it is suggested by Prof. Franck that this explains why the intensity of the latter varies with the energy of the impacting particles in much the same way as the number of ions produced.

LARGE MERCURY ARC CONVERTERS.—For several purposes, notably in connexion with storage, railway, and tramway traction, direct current supply is better than alternating current supply. Hitherto machines for converting alternating current into direct current, called rotary converters, have been generally used. Now, however, judging from an article which appears in the March number of the *Brown Boveri Review*, the mercury arc rectifier, which twelve years ago was a modest piece of laboratory apparatus, has developed into a formidable rival of the rotary converter. Continuous research on the phenomena which accompany the working of the electric arc has enabled the difficulties in the way of designing large current rectifiers to be overcome. Now rectifiers having outputs so great as 16,000 amperes are made. It is claimed that all risks of 'back-fires' have been eliminated, and that this static converter, the depreciation of which is very small, surpasses all types of rotary converter. It is possible to convert alternating currents at the very highest pressures into direct current by its means. Continuous tests have been made on a rectifier having an output of 200 amperes at 16,000 volts. At present, however, there is no great demand for conversion at very high pressures. When speaking of the rating of a rectifier, the current for which it has been designed is understood, as by merely altering slightly the current input it can be used over a wide range of pressures. In the 16,000 ampere mercury arc rectifier with steel cylinder there are 24 anodes.

RAILWAY ELECTRIFICATION.—As it is highly probable that in the immediate future extensive developments of main line railway electrification will be made, it is necessary for traction engineers to study very carefully the working of the electric railways of all countries. Unfortunately, very different systems are in use, and the solutions which are successful in one

country may be quite unsuited for another. A paper by F. Lydall on the electrification of the Pietermaritzburg—Glencoe section of the South African railways was read to the Institution of Electrical Engineers on Mar. 29. It describes the electrification of 170 miles of narrow-gauge railway which runs through difficult country. Glencoe is approximately the centre of the Natal coalfields, and most of the traffic consists of coal consigned to Durban. As most of the line is single track and very powerful locomotives (3600 horse-power) had to be used, it was necessary to use a pressure of 3000 volts owing to the limited carrying capacity of the rails. The power station is close to Colenso and is about 60 miles from Glencoe. The river Tugela supplies the necessary cooling water. The station generates 3-phase 50-frequency current at 6600 volts. The power is then stepped up to 88,000 volts, at which pressure it is transmitted to 12 substations spaced about 15 miles apart. This distance is very short compared with the Chicago and St. Paul Railway, where the average spacing is about 35 miles, but it was chosen in view of the density of the traffic and the necessity of working to schedule speeds. All the substations are fully automatic, so that attendants are not required. As thunderstorms in Natal are frequent and severe, their effects on the overhead equipment caused some dislocation of the service during the first two summers. The lightning flash sometimes caused a spark over an insulator, and this started a 3000-volt arc. By the adoption of high-speed automatic circuit breakers, it was found that this arc was prevented from doing damage, and so it was unnecessary to use special lightning arresters.

ELECTRIC FURNACES IN METALLURGY.—A pamphlet recently issued by the Birmingham Electric Furnaces, Ltd., is an indication of the rapid strides which are being taken in connexion with the application of electric heating in the metallurgical industries. Photographs of quite large, internally heated electric furnaces with automatic charging gear are shown which have recently been installed in Birmingham and, in simplicity of design and convenience of operation, would appear to be of high promise. A feature of particular interest is the type of door fitted in these units. This is, in general, both a source of loss and at the same time one of inconvenience to the workers. The patented design adopted in these furnaces swings outward with a parallel motion, so that the hot face is never presented to the operator. It is counterbalanced to facilitate movement and well lagged to minimise heat losses. By means of a door switch, the furnace is rendered electrically dead immediately the door is opened and any danger to workmen thus removed. The material used for its framework is nickel-chromium.

THE EFFECT OF QUENCHING AND TEMPERING NON-FERROUS ALLOYS.—Two papers read at the spring meeting of the Institute of Metals, by T. Matsuda and A. L. Norbury respectively, both deal with the effect of quenching and tempering on non-ferrous alloys, and in both papers it is shown that in certain cases it is possible to bring about a very considerable increase in the hardness and strength by tempering the quenched alloy at an appropriate temperature. For example, a brass containing 60·44 per cent. of copper, which when quenched at 800° C. has a Brinell hardness of just above 90, attains a hardness of about 125 when it is afterwards tempered at 300° C. There is corresponding increase in the tensile strength, very little change in the elongation or the Izod-value, but a very profound increase in the Stanton impact-number. In the quenched state this was about 3800; tempered at 300° C., it had risen to nearly 6000. Norbury, dealing with standard silver (92·5 per cent. silver, 7·5 per cent. copper), has shown that when quenched from 770° C., the alloy is about 30 per cent. softer and 20-30 per cent. more ductile than it is in the ordinary annealed condition. On tempering the quenched alloy for about half an hour at 300° C., its Brinell hardness is about trebled, the tensile strength being increased by about 50 per cent. At the same time, however, the ductility falls by about 50 per cent. The hardening obtainable by tempering is uniform throughout the sample, and is superior, therefore, to the similar hardening effected by cold-working operations, which set up internal stresses. It is possible to harden the quenched alloy by cold-working and then further harden it by suitable tempering. When in the quenched and tempered condition, the alloy is more resistant to oxidation and tarnishing than when it is in the annealed state.

THE PURIFICATION AND ATOMIC WEIGHT OF ERBIUM.—In the *Journal of the American Chemical Society* for February, A. E. Boss and B. S. Hopkins describe the preparation of pure erbium compounds from yttrium-erbium mixtures by fractional decomposition of the nitrates by fusion and by treatment with sodium nitrite. The ratio of erbium chloride to silver was determined, and the average of six analyses gave the value 167·64 for the atomic weight of erbium. This is in close agreement with the previously accepted value of Hofmann, namely, 167·68.

THE POSITION OF THE RARE EARTH ELEMENTS IN THE PERIODIC SYSTEM.—The difficult problem of the position of the rare earth elements in Mendeléeff's system is discussed in an interesting paper by Prof. J. F. Spencer in the *Journal of the American Chemical Society* for February. Apart from scandium and yttrium, which can be easily accommodated in the periodic system, there is a series of fifteen elements, from atomic number 57 (lanthanum) to atomic number 71 (lutecium), between barium (56) and hafnium (72). Since these elements are basic and tervalent, they must be placed in the six places of the periodic system in Groups III and IV, Series 8, 9, and 10. They can be divided into two groups according to the ionic magnetic moments and the solubilities of their compounds, and Prof. Spencer discusses the distribution of the rare earths among the possible places, taking into consideration these characteristics, together with such chemical evidence as is available.

THE ACTION OF ACTIVE NITROGEN ON IODINE VAPOUR.—In the *Proceedings of the Royal Society of Edinburgh*, vol. 48, Part 1, L. H. Easson and R. W. Armour describe a spectroscopic investigation of the effect of active nitrogen on iodine vapour. The authors support Willey's view that the glow of active nitrogen is due to the recombination of nitrogen atoms, while the complex band spectrum is due to nitrogen molecules in many different states of activation. A line at 185$\mu\mu$, corresponding to an energy content of 6·7 volts (equivalent to 154,000 gm. cal.), was observed in the spectrum of iodine excited by active nitrogen. The shortest line previously known to be excited by active nitrogen was the iodine line at 206$\mu\mu$ observed by Lord Rayleigh. In view of the very low pressures used during this work, it is considered that no chemical action took place, the iodine merely receiving and radiating energy. When the iodine pressure was about the same as that of the active nitrogen, the blue glow produced on mixing with iodine vapour was only visible as an instantaneous flash, the duration of which was found by the use of a kinematograph camera to be less than 1/100 sec.

The Steam Wells of California.

THE utilisation of the steam of the *soffioni* of Tuscany as a source of mechanical power has steadily developed since 1904 when the first pioneer experiments were carried out at Larderello by Prince Ginori Conti. The remarkable results which have since been achieved were described in NATURE of Jan. 14 last. Similar sources of geothermal energy were first tapped in California in 1921, and since then several deep wells have been successfully sunk, some of them being superior both in pressure and steam output to any yet reported from Italy. The active region is known as 'The Geysers,' and lies on the western side of the St. Helena Range, one of the coast ranges of California. Along a line some twenty-five miles in length, which appears to mark a fault or shatter belt, hot springs, some of which are associated with quicksilver deposits, occur at intervals. There are no actual geysers at 'The Geysers,' but over an area of thirty-five acres the ground is dotted with hot springs and fumaroles and salt patches, and steam and gases are constantly seeping through the surface. A thorough investigation of the locality has been made by Dr. E. T. Allen and Dr. A. L. Day, and the results, beautifully published by the Carnegie Institution of Washington,[1] add very materially to our knowledge of subterranean supplies of magmatic steam.

The hot springs mainly occur where the ground-water drainage would naturally be expected to emerge; they are clearly related to a thin zone of groundwater and show seasonal variation with the rainfall. Some of the waters are acid, and contain acid sulphates produced by the oxidation of sulphuretted hydrogen. Others have become alkaline through their prolonged action upon the superficial rocks, this leading to the production of neutral sulphates, and allowing the alkaline character of the bicarbonates in the water to make itself felt. The fumaroles, known as the Smokestack, the Safety Valve, and the Steamboat, and the steam vents, are unrelated to the topography; and neither these nor the artificial wells are affected by the weather. The exceptionally dry winter and spring of 1923–24 had no measurable influence on the steam flow, and all the evidence bearing on the origin of the steam points conclusively to a deep-seated magmatic source.

In all, eight wells had been sunk by June 1926, at depths gradually increasing from 200 to 650 feet. There is a marked temperature gradient, measurements revealing a rise of 130° to 165° C. within a depth of 500 feet from the surface. As at Larderello, and also at Katmai and Lassen National Park, the steam is supersaturated as it rises from the depths, but becomes saturated eventually after it has stood in a closed well for some time. "The opening of a well after the tools are removed presents an imposing spectacle. As the valve is opened steam and hot water rush violently out with a great roar, rising in successive leaps like a geyser and carrying a shower of sand and loose rocks which bombard the steel frame of the derrick with a rattle like a fire of musketry. The column quickly reaches its maximum height of 200 to 300 feet, and in a few moments much of the excess water and loose debris are cleared out, leaving a huge jet of intensely hot roaring steam rushing from the well at high velocity, the noise of which can be heard for several miles and which at close range is absolutely deafening." Considering that the pioneers of so dangerous an enterprise had no previous experience of the kind and were even unaware that similar projects had been carried out in Tuscany, it is remarkable that the first wells were completed without serious accident.

Gases accompany the steam, making up between 1 and 2 per cent. of the whole. Carbon dioxide is, as usual, the dominant gas, but hydrogen and methane are present to the unusual extent of about 15 per cent. each, and there are smaller quantities of sulphuretted hydrogen, nitrogen, and ammonia. This is a characteristically volcanic assemblage, and taken together with the meagre supply of meteoric water, and the enormous volume of high-pressure steam rising in a superheated condition, it points indubitably to a magmatic source. In general, it is found that the deeper the well the hotter the steam, but not uniformly from well to well, indicating that the rock is not equally pervious to steam in all directions. The steam probably rises through a fault zone of shattered rocks which interpose a resistance that is generally, but not everywhere, completely effective. Only so can the difference in activity in the different fumarole and hot spring localities along the St. Helena Range be explained.

Following along the lines justified by their earlier investigations, the authors direct attention to the profound significance of the occurrence of volcanic gases as "the one thread logically connecting all phases of igneous activity, the cause alike of the volcanic explosions with their imposing steam clouds, the rise of lava in craters, the intense surface temperatures in some volcanic eruptions, the formation of fumaroles with their various characteristics, and finally of the heat of hot-spring waters and of the distinctive features in hot-spring areas."

ARTHUR HOLMES.

[1] "Steam Wells and other Thermal Activity at 'The Geysers,' California." By E. T. Allen and A. L. Day. Carnegie Inst. of Washington, Pub. No. 378, 1927, pp. 106.

Movements of British Industry and Trade.

THE latest report of the Committee on Industry and Trade, entitled "Further Factors in Industrial and Commercial Efficiency," provides much useful information regarding the important and far-reaching changes which have recently taken place in the relative prosperity and the geographical distribution of British industries.

Between 1901 and 1911 the number of persons employed in the main export industries increased by 20 per cent., as compared with an increase of 12½ per cent. in the total occupied population. In the next decade (including the abnormal War period) the total occupied population grew by 5½ per cent., but the rate of increase in the great industries was 21 per cent. In particular, coal mining and the metal and engineering trades increased much faster than industry as a whole. In the earlier decade the increase can be accounted for by the normal development of overseas trade. In the later period expansion was mainly in the munition industries, so that after the War Great Britain was left with an unduly expanded group of 'hypertrophied' industries. Statistics based on returns relating to the number of insured workers show that from 1923 to 1927 the number of persons engaged in the insured trades increased by nearly 6 per cent. from about 11¼ millions to about 12 millions. This increase was, however, very unevenly distributed. Coal mining, iron and steel, general

engineering, shipbuilding and marine engineering, and the woollen and worsted trades accounted in the aggregate for a decline of 200,000 persons. The only important export industries to show substantial increases were the electrical trades (27 per cent.), the motor industry (21 per cent.), and artificial silk (48 per cent.), all comparatively new and progressive branches of production. Among non-export industries which have shown a high rate of expansion are the distributive trades (25 per cent.) and the building and furnishing trades (19 per cent.). That the old established exporting industries have not kept pace with other trades is borne out by statistics of unemployment. Between 1923 and 1927 the percentage of unemployment averaged 13·5 per cent. in the exporting group, and only 9·2 in other insured industries.

Geographical Redistribution.

The migration of industry from the northern to the southern counties of England is perhaps the most interesting development in post-War Britain. The tendency has been noted by a number of observers, but it does not seem to have received the attention which it deserves. The Committee on Trade and Industry points out that in July 1923 the insured persons were divided between the southern and northern sections of the country in the proportion 45·7 (south) to 54·3 (north). In 1927 the proportion in the south had increased to 47 and in the north had declined to 53. Still more striking figures are obtained when smaller areas are examined, as will be seen from the following table:

Percentage Increase, 1923–27, in the Number of Insured Persons.

London	7·29	Midlands	6·03	Wales	1·81
South-Eastern	15·83	North-Eastern	3·09	Scotland	1·38
South-Western	8·60	North-Western	3·73	N. Ireland	0·47

The figures for unemployment tell the same tale of greater economic activity in the south than in the north.

Percentage Unemployed (Mid-Year).

	Whole Country.	North.	South.
1923	11·3	13·1	10·2
1925	11·9	14·3	8·0
1927	8·8	12·6	6·7

Statistics show that certain industries, for example, stove, grate, pipe, and general iron founding, glue, soap, ink, match, and carpet manufacture, have expanded in the south but have declined in the north. Other trades, such as constructional engineering, bleaching, dyeing, furniture making, motor vehicle construction, silk, electrical engineering, etc., have increased more rapidly in the south than in the north. Even the steel industry has shifted southwards, Lincolnshire and the Midlands having increased their steel production by 700,000 tons, while on the east coast and in Scotland output declined 500,000 tons. The coke industry has tended to follow the movement of iron and steel, and the coke production of Durham has declined relatively to that of Yorkshire, and the industry has appeared in Lincolnshire.

The Committee considers that an important cause of the shift southwards has been the exhaustion of the northern ores, which in 1924 supplied only one-third of the national output as compared with one-half in 1913. In other industries, different, but no less potent, causes of migration have been at work, among which the Committee cites the greater freedom in the south from restraints due to hard-and-fast trade customs and the desire to obtain the full benefit from more economic organisation. Another probable cause which does not seem to have been directly considered by the Committee is the fact that local rates are generally lower in the south than in the north.

Further industrialisation of non-urban areas in the south of England will probably be stimulated by the development of electric power distribution and other forces, such as the development of road transport, making for de-centralisation. It would seem that now the process of concentration of industry in the north which commenced in the eighteenth century may be reversed, and a gradual though perhaps partial process of de-centralisation substituted.

Tobacco Culture.

TOBACCO is no exception to the rule that plants require phosphorus for growth, but it needs little compared with other crops. Under certain conditions, the growers may profitably take advantage of this property. Field tests have been carried out at Windsor, U.S.A. (Report for 1926 of the Connecticut Agricultural Experiment Station), on *old* tobacco land which has carried the same crop for a long period of years regularly manured with a complete fertiliser. On such land, no response to phosphorus treatment was obtained, neither the yield, quality, nor burning properties of the tobacco being affected by withholding the application. This is considered due to the fact that, as so little phosphorus is taken up by the crop, and only a small quantity removed by leaching, a surplus supply has been built up through the continued manurial treatment. Growers on this land can therefore effect considerable saving by omitting phosphate from their fertiliser mixtures for an indefinite number of years without incurring any risk, as the organic constituents of the manure applied are considered capable of supplying sufficient phosphorus to guard against depletion. However, on tobacco land where some rotation of crops is practised or on new fields, the same conditions do not obtain, and it would probably not be economic to omit the phosphatic dressings.

Experiments have also been carried out on the new Heber process of sweating tobacco recently developed in Germany. After the leaves are cured, a fermentation or sweating process is necessary before they are suitable for manufacture into cigars. The two methods in common use are the 'bulk' and 'case' processes. In the former, large piles of tobacco are allowed to heat up to 120° F., then shaken out and repiled, the process being repeated a number of times and requiring three to six weeks. In the 'case' method the tobacco is tightly packed in wooden cases and kept artificially heated at about 100° F. for six weeks or longer. The Heber process is applicable to either method, and consists in spraying the layers of tobacco, as the 'bulk' or 'case' is being made up, with a solution containing an 'active principle,' fermentation being by this means completed in eight days. In a control test where water was substituted for the solution, the tobacco was still very raw when the treated tobacco was completely fermented.

Besides the immense reduction in time and labour obtained by using this process, further advantages noticeable were that the leaves were lighter in colour and incurred less breakage and loss in weight. On other points, however, such as aroma and burning properties, no consistent differences were found between leaves sweated by the old or new processes.

University and Educational Intelligence.

ABERDEEN.—Lord Meston has been elected by the General Council to the Chancellorship of the University in succession to the late Duke of Richmond and Gordon.

CAMBRIDGE.—Honorary degrees are to be conferred upon Prof. A. Einstein, Prof. Cumont, Prof. W. A. Craigie, Lord Lugard, Lord Justice Scrutton, Sir Cecil Hurst, and Sir D. Y. Cameron.

The Linacre lecture is being delivered on May 5 by Sir George Newman, chief medical officer, Ministry of Health, on "Linacre's Influence on English Medicine."

Emmanuel College announces a scholarship of £120 a year for mathematics, founded by Mrs. Braithwaite Batty in memory of the late Rev. R. B. Batty, second wrangler in 1853 and a fellow of the College. Preference will be given to candidates who are sons of clergymen or of certain officers in His Majesty's Army or Navy.

The continued generosity of three anonymous benefactors to the University, who have increased their contributions to the building and upkeep of the extension of the Fitzwilliam Museum to £37,000, £37,000, and £26,000, is announced in a Grace by which the University expresses its thanks.

OXFORD.—The subject of the Halley Lecture to be delivered on Monday, June 18, at the University Museum, by Dr. Harlow Shapley, Director of the Harvard College Observatory, will be "A Search for the Centre of the Milky Way," instead of "The Extent and Structure of the Milky Way," as previously announced.

THE latest date for the receipt of applications for grants from the Thomas Smythe Hughes Fund for assisting medical research is June 15. They should be addressed to the Academic Registrar, University of London, South Kensington, S.W.7.

APPLICATIONS are invited by the Senate of the University of London for the Laura de Saliceto studentship for the advancement of cancer research, tenable for not less than two years and value £150 annually. Applications must reach the Academic Registrar, University of London, South Kensington, S.W.7, by July 1.

APPLICATIONS are invited by the Salters' Institute of Industrial Chemistry for a limited number of fellowships of the normal value of from £250 to £300 each. The fellowships are open to chemists of post-graduate standing who are desirous of adopting a career in industrial chemistry. The latest date for the receipt of applications by the Director of the Institute, Salters' Hall, St. Swithin's Lane, E.C.4, is June 1. Forms can be had upon request.

THE British Institute of Philosophical Studies has arranged a course of six lectures on "Mind in Nature," by Prof. C. Lloyd Morgan, which began on May 1 at 5.30 P.M., and will continue on succeeding Tuesdays. Prof. Clement C. J. Webb will deliver a course of four lectures on "The Philosophy of Religion" on Wednesdays at 5.45 P.M., beginning on May 23. Both courses are being given at the University of London Club, Gower Street, W.C. Particulars can be obtained from the Director of Studies, British Institute of Philosophical Studies, 88 Kingsway, London, W.C.2.

WE have received from the University of Leeds a copy of its report for 1926–27—one of the most eventful, the report says, in its history. Conspicuous among the events of the year are Sir Edward Brotherton's gift of £100,000 for the new library, the definite adoption of a design for the future University buildings (a bird's-eye view of which forms the frontispiece of the report), the completion of the University playing fields and of a new building for the Department of Agriculture, the acquisition of a house for the Department of Geology, and the institution of a chair of experimental pathology and cancer research. Progress was made with the building of additional hostel accommodation for women students and with the dental block of the medical school. Arrangements have been completed for beginning during the current year the first unit of the new University buildings—the mining block—and a new wing for the textiles section of the clothworkers' buildings. This new wing will provide increased accommodation for the Dyeing Department and will also be able to house the laboratories of the British Silk Research Association. A scheme has been elaborated for enabling graduate students to carry on research work for higher degrees in the laboratories of the British Research Association for the Woollen and Worsted Industries. Day students numbered 1366, of whom 80 per cent. belonged to Yorkshire, 12½ per cent. came from other parts of England, and 4½ per cent. from Egypt, India, and the Far East. There has been a small but continuous decrease in the number of full-time day students from 1922–23 (1559) to 1926–27 (1366). The staff list contains the names of a fair number of Leeds graduates, but many more who have taken degrees elsewhere, including graduates of every university of Great Britain and Ireland except Sheffield and Reading.

ANOTHER milestone on the road to educational progress was reached at Kingston-upon-Hull on Saturday, April 28, when Their Royal Highnesses the Duke and Duchess of York visited the city, and the Duke placed in position the foundation-stone of Hull's new University College. This has been possible through the generosity of the Right Hon. T. R. Ferens, who has given nearly £300,000 towards the scheme; the Hull Corporation, which has given £150,000 and an annual grant of £2500, as well as 18½ acres of land (originally a gift to the city by Mr. Ferens), and by several other generous gifts made by prominent citizens and firms of Hull. A list of the various donations was handed to the Duke by Principal Morgan. The building of the College is well advanced, and it is expected that part will be ready for occupation by October. The College is extending its site to close upon seventy acres, all within the residential area of the city, and a large house and estate has also recently been secured at Cottingham, a neighbouring village, for residential purposes. Most of the professors have been appointed. A circular route of six miles was planned for the Royal procession, thus enabling a crowd estimated at 200,000 to view it without overcrowding in any part. At the College the chairman of the Council, Archdeacon J. M. Lambert, gave an address, after which the Archbishop of York dedicated the stone. The Duke of York replied and placed the stone in position. The Duchess hoisted the College flag, which had been presented by the Hull Women's Co-operative Guilds. Among those present were the Lord Mayor and Sheriff of Hull, the mayors and principals of neighbouring towns and universities, local members of Parliament, Sir W. Henry Hadow, the Right Rev. Bishop Shine, Lord Deramore, and Prof. A. C. Seward.

Calendar of Customs and Festivals.

May.

ADDENDA.—It is perhaps more than a coincidence that the stories of a disproportionately large number of the saints whose days fall at the beginning of May are obscure or legendary. In Ireland they are perhaps more frequently associated with holy wells and, significantly enough in relation to the prominence of goddesses in Celtic religion, female saints, often known only by name, are numerous. The lives of these early saints frequently record contact with paganism in various forms. Serpent worship, for example, appears in the story of St. Philip (May 1), whose martyrdom was a consequence of his opposition to the idolatry of Hierapolis in Phrygia, and especially to the worship of a huge serpent of which he procured the death by his prayers. The life of St. Amator, Bishop of Auxerre (May 1, A.D. 418), records an interesting conflict with pagan observances in the story of Germanus, chief man of Auxerre, who used to hang up the heads of the wild boars and stags he killed as offerings to Woden on the branches of a large pear tree in the middle of the town, which Amator caused to be destroyed.

ST. MARCULF (May 1, A.D. 558), of Frank parentage, as his name (Forest Wolf) shows, is connected with the last ceremony of touching for the king's evil. The relics of the saint were preserved at Corbeny in the diocese of Laon, and the French kings, after their coronation at Rheims, used to make a pilgrimage to Laon, and, after touching the relics of Marculf, heal the king's evil. This was observed for the last time by Charles X. in 1825, at Rheims.

An annual ceremony still commemorates the death of St. Evermar and his companions, who were slain at a fountain while on a pilgrimage through Belgium (May 1, 700). In each year, on May 1, a procession takes place which is headed by two 'greenmen' representing savages, clothed in leaves and armed with clubs, followed by seven pilgrims, and then by Hako, the robber chief, and his men. After High Mass the murder is re-enacted, Hako shooting one of the pilgrims with a pistol as he runs away.

A saint who is more obviously connected with well-worship is St. Fumack (May 3), of uncertain date and unknown history, who is said to have bathed every morning in a well situated in what is now the manse garden at Botriphnie, then to have dressed himself in green tartans, and crawled round the parish bounds on his hands and knees. The image of the saint in wood was long preserved and became degraded into a local idol. In 1726, it was still washed on May 3 in the well with much formality by an old woman.

On two occasions in each year, of which April 30 or May 1 is the first, the dried blood of St. Januarius, the patron saint of Naples, is liquefied. In the morning a golden bust of the saint, and in the afternoon the blood in two phials, is carried in procession. In the evening, at about 7 o'clock, prayers begin in the Church of Santa Chiara and the liquefaction of the blood takes place after a longer or shorter interval, any unusual delay portending ill-fortune.

May 6.

ST. AVIA.—Of uncertain date, possibly beginning of third century A.D. After her death she is said to have appeared at Ploermel in the diocese of Vannes, Brittany, and to have touched a stone and a fountain. Thereafter infants were laid on the stone, which is hollowed in the centre, and dipped into the fountain to enable them to walk.

May 7.

ST. DOMITIAN OF MAESTRICHT (A.D. 560), according to a popular tradition, delivered the neighbourhood of Huy from an enormous serpent which infested the waters of a fountain with venom. He is invoked against fever, and on May 7 his shrine is borne in procession around Huy and to the fountain where he slew the serpent, while all the fever patients of the town follow in their shirts and carrying candles.

ST. STANISLAUS, A.D. 1079, was flayed and miraculously restored to life. A pious legend explains that a votive offering of a wax horse to St. Stanislaus at Cracow was dedicated by the head of a family whose horse died while they were on their way to the elevation of the remains of the saint to a new shrine in 1254. The sacrifice of the horse was a feature of Nordic ritual which long survived and was expressly forbidden in churchyards.

May 8.

THE APPARITION OF ST. MICHAEL on Monte Gargano, near Manfredonia.—A bull when wounded by an arrow took refuge in a cave. When the herdsman attempted to withdraw the arrow it spontaneously sprang from the wound and wounded him. After a supplication and fast of three days at the instance of the bishop, the saint appeared to the prelate and informed him that the cave was his favourite resort, over which he wished a shrine to be erected. The story is curiously reminiscent of the Mithraic cult.

HELSTON FURRY FESTIVAL.—At Helston, in Cornwall, this day was celebrated as a general holiday. At dawn it was greeted with the music of drums and kettles and the singing of the well-known Furry Song. Anyone who attempted to work on this day was ridden on a pole to a brook over which he was compelled to attempt to jump, but usually failed. An excursion was made to the country (known as to *fadé*), from which flowers and oak branches were brought back worn in the hats. All then took part in dancing up and down the street, and passing through any, or perhaps originally every, house.

May 10.

ST. COMGALL, A.D. 601.—An Irish saint, a member of a Dalriadha family, of whom many stories are told. One nearly parallels the myth of Bishop Hatto. When the saint endeavoured to obtain corn from a noble in a time of scarcity, he was refused on the ground that the owner required all for his mother 'Old Mouse,' whereupon mice devoured all his grain. Several other stories turn on the magical ideas connected with saliva. Saliva ejected by the saint while fasting, when gathered from the ground, healed a leper. On another occasion it turned to a gold ring in the pocket of a beggar; and it changed the obdurate heart of a king when the saint spat on a stone and it split into pieces.

May 12.

ST. EPIPHANIUS, A.D. 403.—A protagonist in the controversies relating to heresy of this time. Of the Apollinarianism which assumed definite shape about 369 as the result of an extreme view of the divinity of Christ, one form was a denial of the perpetual virginity of the Virgin Mary, while by reaction another made her an object of idolatrous veneration. The influence of pagan ideas is to be seen in the custom adopted by the women first of Thrace, and afterwards of Arabia, of placing cakes (collyrides) on a stool covered with linen, offering them to the Virgin, and then eating them as sacrificial food. This custom was denounced by Epiphanius.

Societies and Academies.

LONDON.

Physical Society, Mar. 23.—**W. D. Flower**: The terminal velocity of drops. The distance a drop of given volume has to fall through in order that it may attain a constant terminal velocity has been determined for both water and methyl salicylate. The terminal velocities have been determined for drops 0·2-0·55 cm. in diameter.—**Satyendra Ray**: The longitudinal wave along a rod. That longitudinal waves are propagated with the same velocity for all wave-lengths only when the waves are 'geometrically similar' is here proved in exactly the same manner as for either strings, air columns, or transverse waves along stretched strings. The expression for the velocity is of course different.

Royal Meteorological Society, April 18.—**C. K. M. Douglas**: Some Alpine cloud forms. 'Banner clouds' are formed as the result of an eddy drawing air up the lee side of a steep mountain in a strong wind, and are very turbulent. Lenticular caps, or 'föhn clouds,' are smooth in appearance, and are formed in a damp current crossing the mountain top with vertical displacements, which do not seem to be large as a rule, most of the air apparently flowing round the mountain. Banner clouds appear to draw their moisture from lower down than caps, so that the two forms often exist independently, though both are produced by strong winds. The existence of caps, but no banners, may be attributed to a damp layer with dry air below, a condition known frequently to exist.—**N. K. Johnson**: A strong wind of small gustiness. Records of wind velocity and direction obtained at Leafield, Oxen, on two days in December 1926, are discussed. On the first day the weather was that corresponding to equatorial air, with overcast sky, slight rain, and a strong wind. The autographic traces of wind velocity and direction possess considerable width. The second occasion relates to polar air, the sky being practically clear but the wind velocity being approximately equal to that on the first occasion. The records of wind velocity and direction in this case are characterised by the extreme narrowness of the traces. Whilst polar air normally gives somewhat narrower traces than equatorial, the great difference found in the present examples is to be attributed to the difference in the lapse rates. During the clear night an inversion of nearly 3° F. existed between heights of 1 m. and 87 m. in spite of the wind velocity being 18 m./sec. (40 miles/hour).—**T. N. Hoblyn**: A statistical analysis of the daily observations of the maximum and minimum thermometers at Rothamsted. An account is given of the work carried out on 48 years' temperature records at Rothamsted. At this station, both maximum and minimum temperatures vary significantly from year to year at all periods of the year, although the variation is much greater in some months than in others. The correlation between the different measures differs quite definitely in the various months.

PARIS.

Academy of Sciences, Mar. 26.—**A. Mesnager**: The thickness required in triangular barrages; deduced from the official report of the failure of the reservoir barrage of Oued Fergoug (Perrégaux). A discussion of the effects of water pressure from below, and the effects of such pressures on the formulæ ordinarily in use. The usual factor of safety is insufficient in such cases.—**P. Helbronner**: The common sides of the fundamental Italian triangulation and the detailed geometrical description of the French Alps. The French and Italian measurements are fundamentally based on slightly different metres, and a minus correction of 1/74,000 must be applied to the Italian metre, to make the two series strictly comparable. The improvement produced by applying this correction is shown in tabular form.—**E. L. Bouvier**: The Saturnian Lepidoptera of the family of the Hemileucideæ.—**Pierre Weiss and R. Forrer**: New measurements of the atomic moments of iron and nickel at low temperatures. The experiments were carried out with the purest iron obtainable (Heraus), and two specimens of nickel containing 99·91 per cent. nickel (Heraus) and 99·76 per cent. nickel (Mond). The possible errors in the extrapolations involved are discussed and shown to be small. The atomic moments of iron and nickel are, with high accuracy, integral multiples, 11 and 3, of the same moment, the experimental magneton.—**A. Kolmogoroff**: A limiting formula of A. Khintchine.—**Finikoff**: The intrinsic equation of a surface.—**Bertrand Gambier**: Convex closed surfaces; ds^2 of Liouville; geodesic antipodes.—**A. Buhl**: Permutable operators and mobile trihedra.—**Renato Caccioppoli**: A general theorem for the passage to the limit under the sign of an indefinite integral.—**Soula**: Remarks on the principle of M. Picard.—**Paul Flamant**: An idea for integral functions analogous to that of the normal family for holomorph functions.—**S. A. Gheorghiu**: The growth of the denominators $D(\lambda)$ of Fredholm.—**Serge Bernstein**: Some asymptotic properties of the best approximation.—**R. Swyngedauw**: The characteristic differences presented by the movement of a pulley belt approaching and leaving the pulley.—**Jacques Mesnager**: The theory of heavy masses of masonry submitted to pressure from below and its application to the stability of barrages.—**Baticle**: The theory of equilibrium of heavy massifs submitted to pressures from below, and its application to the stability of barrages and talus.—**V. Nechvile**: The theory of two star streams and the ellipsoidal theory. The frequency curves given by the ellipsoidal theory (Schwarzschild) for certain values of ϵ assume forms exactly similar to those of the two stream theory (Eddington).—**Eligio Perucca**: The triboelectrical effect between solid bodies and gaseous bodies. Experiments are described proving that the electrification produced by a jet of mercury vapour impinging on a metal plate cannot be attributed to contact of mercury droplets with the collector, and the electrification produced must be regarded as due to the vapour.—**R. de Mallemann**: The electro-optical theory of quartz. The theory suggested by the author is confirmed by experimental results recently published by Ny Tsé Ze: the theory is developed in more detail in the present paper.—**Jean Rey**: Comparison of glass and metallic reflectors for lighthouse use. The metal reflectors are superior to glass.—**René Lucas**: The action of temperature on the rotatory powers of optically active substances.—**Jean J. Trillat**: The study of cellulose and the acetates of cellulose by means of X-rays. Cellulose, the oxycelluloses, and the hydrocelluloses, give similar X-ray diagrams. As regards the acetyl celluloses, the variations on the diagrams are sufficiently marked to serve as a control on chemical analyses.—**G. Guében**: The action of radioactive radiation on the dielectric constant of dielectrics. Various solid dielectrics were examined, paraffin, glass, celluloid, bakelite, sulphur, ebonite, wax, etc. No variation of the dielectric constant was produced by irradiation with the rays from radium. If any such effect exists, it is less than one-thousandth of the value of the dielectric constant.—**Paul Bary**:

A new property of certain silica gels.—**Trividic**: The absorption of iodine by carbon in some organic solvents. The solvents employed in these experiments included ethyl, methyl, and isoamyl alcohols, benzene, toluene, the three xylenes, chloroform, carbon tetrachloride, and carbon disulphide. The progressive increase of iodine absorption with the time observed by Davis could not be confirmed. Contrary to the views of Davis and of Schmidt, the general formula due to Freundlich fully expressed the experimental results.—**Jean Cournot**: The action of small additions of tin and cadmium on the qualities of lead. A series of nine alloys was prepared containing up to 3 per cent. of cadmium and 3 per cent. of tin, and the breaking load, elongation, elastic limit, crushing load (at two temperatures), and hardness determined for each. An improvement in strength and elastic properties is produced by addition of cadmium. To give good malleability, some tin as well as cadmium is required: the ternary alloys are also less oxidisable when fused.—**P. Cordier**: Phenylethylmaleic acid and its *cis-trans* isomer phenylethylfumaric acid.—**L. Palfray** and **L. Rothstein**: The stereoisomers of quinite (1, 4, cyclohexanediol).—**Mlle. Marthe Montagne**: New researches relating to the action of organo-magnesium compounds on some fatty dialkylamides.—**C. Gaudefroy**: An apparatus for measuring the true angle of the optic axes.—**Ch. Mauguin**: The study of micas by means of the X-rays.—**J. Repelin**: The Aquitaine basin at the Helvetian epoch: the continental formations.—**Louis Besson**: The visibility and amount of dust in the air of Paris. For the same season of the year, at the same time of day, and with the same humidity, the visibility in 1919–26 was clearly less than during 1896–1903. It is calculated that the number of smoke or dust particles has increased in the air of Paris about 50 per cent. in twenty-five years.—**A. Maige**: The phenomena of fatigue of the plastids during amylogenesis.—**Pierre Gavaudan**: The presence of the oil-bearing system in the organs of multiplication of the Jungermanniaceæ.—**Albert Guillaume**: The variations in the alkaloid content in the lupin under the influence of feeding.—**H. Colin** and **R. Franquet**: A new plant containing maltose, *Schizopepon Fargesii*. This plant, more commonly known under the erroneous name of *Actinostemma paniculatum*, has tubercles from which maltose has been extracted.—**Pierre Dangeard**: The release of free iodine in marine algæ. The emission of free iodine by Fucus is not dependent on the plants being crushed, since paper containing starch can be turned blue without actual contact. It is proved that the emission of free iodine by certain varieties of Fucus and Laminaria takes place during their normal life.—**G. Athanassopoulos**: The limited numbers of young eels ascending the rivers in the eastern part of the Mediterranean. The fact that young eels are not found in the Black Sea, or in the rivers flowing into it, has been attributed to the sulphurous nature of the sea-floor preventing breeding. The author shows that the number of eels diminishes as the distance east from the Straits of Gibraltar increases. He regards the young eels as entering the Mediterranean Sea through the Straits of Gibraltar, the number diminishing progressively owing to the ascent by the fish of the rivers nearer Spain.—**E. F. Terroine** and **R. Bonnet**: The influence of the amount of glycæmia on the magnitude of the exchanges and the problems of specific dynamic action of excessive food supply.—**Jules Amar**: The laws of physical education.—**E. Rothlin** and **Th. Oliaro**: The biological estimation of the quantities of cardio-active glucosides fixed by the frog's heart.—**Georges Bourguignon**: The transcerebral excitation of the pyramidal system in man. Measurements of normal and pathological chronaxy.—**Henry** and **Edouard Lassalle**: A new theoretical expression of the limiting intensities as a function of the duration of the stimuli.—**Mlle. Goldsmith**: The evolution of a tropism.—**E. Brumpt**: The rôle of the viviparous American fish *Gambusia Holbrooki* in the struggle against paludism in Corsica. Biological methods based on the marked predilection of certain fish for the larvæ of mosquitoes have the advantage of low cost and of not interfering with the habits of the population of regions infested with fever. The efficacy of the American fish *Gambusia Holbrooki* in reducing the number of mosquito larvæ has been proved by experiments in Corsica.—**C. Dawydoff**: The reversibility of the process of development. The extreme phases of the reduction of Nemertes.—**N. Bezssonoff**: The immediate physiological action of a vitamin. A marked change in the bromine absorption figure of the urine after administration of vitamin C can be proved after 48 hours.—**Mlle. Suzanne Guery**: A new method of auscultation called differential binaural auscultation and apparatus for permitting its realisation.—**R. Cambier** and **F. Marcy**: The composition of the air of Paris streets.

BRUSSELS.

Royal Academy of Belgium, Oct. 8.—**Ad. Mineur**: The Hamiltonian equations. A proof independent of the calculus of variations.—**A. Demoulin**: The point correspondence between two surfaces by parallelism of the tangent planes, and on the infinitely small deformation.—**Victor Willem**: Observations on the locomotion of Actinia.—**Louis van den Berghe**: Experiments on the cardiac origin of the inspiratory reflex in fishes.—**G. Erdtman**: Vestiges of the recent quaternary history of Belgian forests. Conclusions based in pollen statistics from the peat deposits in the Hautes-Fagnes and Ardennes. The predominating trees are classified for five periods, starting about 7500 B.C.—**L. Rosenfeld**: The five dimension universe and undulatory mechanics.

Nov. 5.—**Th. de Donder**: The relativistic and quantic problem of n bodies.—**Th. de Donder**: The relativistic problem of n bodies to the first approximation.—**E. de Wildeman**: The morphology of the male flowers in the genus Scleria (Cyperaceæ).—**Lucien Godeaux**: The regular involutions of order three belonging to an irregular surface.—**Serge Avsitidysky**: Note relating to the work of M. M. Barzin and A. Errera, "Sur la logique de M. Brouwer."—**Marcel Homès**: The evolution of the vacuome in the course of the differentiation of the tissues in *Drosera intermedia*.

Dec. 3.—**Paul Stroobant**: (1) Observations of the transit of Mercury on Nov. 10, 1927, made at the Royal Observatory of Belgium at Uccle. (2) Observations on the same, made at the Astronomical Institute of the University of Brussels.—**Th. de Donder**: The equation of quantification of molecules comprising n electrified particles.—**P. Bruylants** and **A. Castille**: The butenoic amides.—**R. Ferrier**: The theory of the Amperian.—**Seligmann**: An account of the third general meeting of the International Geodesic and Geophysical Union.—**Paul Ledoux**: The histological characters of the cylinder axis in *Entandrophragma Lepłœi* and *Entandrophragma roburoides* (Meliaceæ from the Belgian Congo).—**L. Godeaux**: The asymptotic lines of a surface and ruled space.—**Mlle. L. de Brouckère**: The adsorption of ferric chloride by crystallised barium sulphate.—**P. Swings**: The change of magnification in the aplanatic telescope.

Dec. 15.—**Th. de Donder**: The invariant form of linear partial differential equations of any order.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 14, No. 1, January).—**Oscar Knefler Rice**: (1) The quantum theory of quasi-unimolecular gas reactions. (2) The theory of the decomposition of azomethane. The considerations of the earlier paper are applied to this reaction, which is unimolecular at high pressures; they give results in fair accord with experiment. It is concluded that activation is by collision and that the chance of reaction of an activated molecule depends on the energy in about the way to be expected if the energy is localised in a particular place in the molecule.—**John R. Bates** and **Donald H. Andrews**: Fundamental frequencies, interatomic forces and molecular properties. There appears to be some relationship between (*a*) fundamental frequency and force of binding, and (*b*) heats of linkage, boiling points, and directive influence in non-polar molecules.—**Worth H. Rodebush** and **John C. Michalek**: The effect of intensive drying on the vapour pressure and vapour density of ammonium chloride.—**C. Dale Beers**: Some effects of dietary insufficiency in the ciliate *Didinium nasutum*. Didiniums fed on excessive quantities of normal Paramœcia remained healthy; those fed on Paramœcia which had been starved for a week died off after showing decrease in fission rate, loss of ability to encyst, inability to ingest food, decrease in size, monstrosities due to incomplete fission, etc. (qualitative insufficiency). Didiniums on nine Paramœcia daily rapidly encysted (quantitative insufficiency).—**Edwin B. Wilson**: Mendelian inheritance with assortive mating. A mathematical discussion.—**Chas. W. Metz**: Genetic evidence of a selective segregation of chromosomes in a second species of Sciara (Diptera). During the first spermatocyte division of Sciara, the maternal chromosomes separate from the paternal chromosomes without synapsis, and one group is thrown out. In *S. similans*, as in *S. coprophila*, the paternal haploid group is thrown out and the males transmit only the maternal chromosome. Probably all the paired chromosomes in Sciara undergo this segregation.—**George H. Shull**: (1) The 'outside-in' Œnothera flower, a new morphological type produced by the interaction of two recessive Mendelian factors. The characteristic feature of this flower is the rhythmic repetition of calyx, corolla, and androecium. It appears to be a double recessive, *brevistylis supplena*, in which these characters are complementary. (2) Linkage with crossing-over between *rubricalyx* buds and old-gold flower colour in Œnothera. The linkage observed is contrary to previous results. The explanation found is that old-gold flower colour is a compound character produced by the interaction of a dominant, *S*, the normal allele of the *sulphurea* factor, *s*, and a recessive, *v*, the *vetaurea* or old-gold factor.—**H. Hopf**: A new proof of the Lefschetz formula on invariant points.—**H. P. Robertson**: Note on projective co-ordinates.—**Oswald Veblen**: Projective tensors and connections. An introductory account is given of a system of differential invariants the algebraic theory of which is closely analogous to that of ordinary affine tensors, though the analytical theory is quite distinct from classical tensor analysis. It may have physical applications.—**Jared Kirtland Morse**: The molecular structures of methane. Scale models of diamond, graphite, and ethane using a cube structure for carbon have already been discussed. The model for ethane has more positions available for hydrogen than can be occupied, and it is suggested that, in ethane gas, molecular collisions may lead to the displacement of hydrogen from one position to another, giving rise to 'dynamic isomers.' Similar 'dynamic isomers' are possible with methane, some of which, since they have different moments of inertia, can be predicted from measurements of band spectra.—**Bergen Davis** and **Harris Purks**: Additional lines in the *K*-series of molybdenum and the natural breadth of spectral lines. The resolving power of the double X-ray spectrometer has been increased by turning the second crystal to increase the angular reflection. The new lines are regarded as 'spark' lines arising from multiple ionisation of the atom rather than 'fine structure.' The natural breadth of a spectral line is calculated as 0·00012 A.; the measurements made here seem to suggest a narrower line. If this is so, the radiation cannot come from a damped oscillating electron.—**J. H. Van Vleck**: The correspondence principle in the statistical interpretation of quantum mechanics.—**Carl Barus**: Experiments with modified mucronate electrodes. It was previously recorded that anode and cathode behave alike; this is incorrect.—**Leonard B. Loeb** and **L. DuSault**: The mobilities of gaseous ions in $H_2S - H_2$ mixtures. The corrected absolute velocities of the ions in carefully purified hydrogen sulphide are 0·69 and 0·71 cm./sec. per volt/cm. for the negative and positive ions respectively. It was found that the electrons do not attach themselves readily to hydrogen sulphide molecules. Work with mixtures of hydrogen sulphide and hydrogen showed, first, that in very pure hydrogen the electrons remain permanently free, and secondly, that a trace of hydrogen sulphide reduces both the positive and negative mobilities below that computed from Blanc's law, thus indicating clustering.

Official Publications Received.

BRITISH.

Proceedings of the Royal Irish Academy. Vol. 38, Section B, No. 1: On some Doubtful Species of the African Section of the Sempervivum Group. By Dr. R. Lloyd Praeger. Pp. 24. 6*d*. Vol. 38, Section B, No. 2: The Cephalopoda of the Irish Coast. By Anne L. Massy. Pp. 25-37. 6*d*. Vol. 38, Section B, No. 3: Salmon of the River Shannon, 1924, 1925 and 1926. By R. Southern. Pp. 38-64+3 plates 1*s*. Vol. 38, Section B, No. 4: On the Boiling Points of the Normal Paraffins at different Pressures. By Prof. Sydney Young. Pp. 65-92. 1*s*. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Education, India Pamphlet No. 25: Experiments in Primary Education in the Orissa Feudatory States. By H. Dippie. Pp. 14. (Calcutta: Government of India Central Publication Branch.) 4 annas; 6*d*.

Catalogue of Indian Insects. Part 15: Cecidomyidae. By R. Senior-White. Pp. 23. (Calcutta: Government of India Central Publication Branch.) 7 annas; 9*d*.

Transactions and Proceedings of the Royal Society of South Australia (Incorporated). Vol. 51. Pp. iv+450+20 plates. (Adelaide.) 26*s*.

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 15, No. 3: Fruitrot Disease of Cultivated Cucurbitaceae caused by *Pythium aphanidermatum* (Eds.) Fitz. By M. Mitra and L. S. Subramaniam. Pp. 79-84+3 plates. 6 annas; 8*d*. Botanical Series, Vol. 15, No. 4: Colour Inheritance in Rice. By Dr. S. K. Mitra and S. N. Gupta and P. M. Ganguli. Pp. 85-102. 6 annas; 8*d*. Botanical Series, Vol. 15, No. 5: Asterina spp. from India, by Dr. Ruth Ryan; and Meliola spp. from India and one from Malay, by Prof. F. L. Stevens. Pp. 102-111+3 plates. 4 annas; 5*d*. (Calcutta: Government of India Central Publication Branch.)

Survey of India. Map Publication and Office Work, 1926 to 1927. Pp. vi+23+5 maps. 1 rupee; 1*s*. 9*d*. General Report, 1926 to 1927. Pp. iv+95+2 maps. 1 rupee; 1*s*. 9*d*. (Calcutta.)

FOREIGN.

Transactions of the San Diego Society of Natural History. Vol. 5, No. 10: Notes on the Vaqueros and Temblor Formations of the California Miocene, with Descriptions of New Species. By Lionel William Wiedey. Pp. 95-182+plates 9-21. (San Diego, Cal.) 1 dollar.

United States Department of Agriculture. Technical Bulletin No. 20: A Study of Phylloxera Infestation in California as related to Types of Soils. By R. L. Nougaret and Macy H. Lapham. Pp. 39. (Washington, D.C.: Government Printing Office.) 10 cents.

Anthropological Papers of the American Museum of Natural History. Vol. 29, Part 3: Havasupai Ethnography. By Leslie Spier. Pp. 81-392. (New York.) 3 dollars.

Department of Commerce: Bureau of Standards. Circular of the Bureau of Standards, No. 139: United States Government Master Specification for Cells and Batteries, Dry. Federal Specifications Board Specification No. 58a. Pp. 10. (Washington, D.C.: Government Printing Office.) 5 cents.

University of Illinois: Engineering Experiment Station. Bulletin No. 175: An Investigation of Web Stresses in Reinforced Concrete Beams. Part 2: Restrained Beams. By Frank E. Richart and Louis J. Larson. Pp. 76. 45 cents. Bulletin No. 176: A Metallographic Study of the Path of Fatigue Failure in Copper. By Prof. Herbert F. Moore and Frank C. Howard. Pp. 31. 20 cents. (Urbana, Ill.)

CATALOGUE.

The Beck Pathological Microscope. Pp. F8. (London: R. and J. Beck, Ltd.)

Diary of Societies.

SATURDAY, MAY 5.

ROYAL SANITARY INSTITUTE (at Guildhall, Preston), at 10 A.M.—Prof. F. E. Wynne and others: Discussion on The Present Position of the Milk Supply.

ROYAL SOCIETY OF MEDICINE (Otology Section) (Annual General Meeting), at 10.30 A.M.—J. P. Stuart: The Histo-pathology of Mastoiditis.—Dr. R. Graham Brown: Case of Spherical Bulging of the Floor of the Third Ventricle, Secondary to Internal Hydrocephalus and Simulating a Pituitary Tumour.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Eastern District Meeting) (at Thornaby-on-Tees).

BRITISH MYCOLOGICAL SOCIETY (at Cheshunt).—Phytopathological Meeting.

MONDAY, MAY 7.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Cavendish Laboratory, Cambridge), at 4.30.—Dr. A. A. Robb: On the Connexion of a Certain Identity with the Extension of Conical Order to n Dimensions.—J. Taylor: On the Action of the Geiger α-particle Counter.—J. Taylor and W. Taylor: The High Frequency Electric Discharge at Low Pressures.—E. J. Williams: Some Applications and Implications of Duane's Quantum Theory of Diffraction.—E. B. Moullin and A. D. Browne: On the Periods of a Free-free Bar Immersed in Water.—*To be communicated by title only:*—H. Lob: Note on Kuhne's Theorem.—J. M. Whittaker: The Electron in a Gravitational Field.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—G. S. Carter: The Work of an Expedition to Paraguay and Brazil, 1926-27 (Address).—G. S. Carter and L. C. Beadle: Fauna of the Swamps of the Paraguayan Chaco in Relation to its Environment. I. Physico-Chemical Nature of the Environment.—E. Meyrick: Micro-Lepidoptera from the Chaco in Paraguay.—H. W. Parker: Some Reptiles and Amphibians from the Paraguayan Chaco.—R. Gurney: Some Branchiopoda from Paraguay.—J. Stephenson: The Oligochæta from Paraguay.—D. A. Allan: Geology of the Highland Border from Tayside to Noranside.—F. Walker and J. Irving: Igneous Intrusions between St. Andrews and Loch Leven.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Pastor R. Saillens: Protestantism and Rationalism in France.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 6.—J. N. H. Duke: Technical Education in Relation to Industrial Development in India.

NORTH STAFFORDSHIRE INSTITUTE OF MINING ENGINEERS (in North Staffordshire Technical College, Stoke-on-Trent), at 6.—A. Marshall: 'Whitewash' and its Application to Underground Roadways.—*Paper open for discussion:*—Description of the Bullhurst Coal Seam, and the method of working same at the Rookery Colliery of the Bignall Hill Colliery Co., Ltd., having regard to its Liability to Spontaneous Combustion, by J. Cowcill.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.

SURVEYORS' INSTITUTION (at Institution of Mechanical Engineers), at 8.—Discussion: The Report of the Royal Commission on Land Drainage in England and Wales.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Lt.-Col. L. N. F. I. King and Capt. E. H. M. Clifford: The Jubaland Boundary.

ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.15.—P. B. Tustin: Milk—from Cow to Consumer.

TUESDAY, MAY 8.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—H. S. Rowell and D. Finlayson: Experiments in Viscometry.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—A. T. Ridout: Non-chemical Method for the Prevention of Scale Accumulation in Boilers, Diesel-jackets, and Water Circulating Systems in general.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—E. A. Bierman and others: Discussion (with demonstration) on the Control of Gradation in Bromide Prints by Development.—H. E. Tomkins: Lunar Photography with a 24-inch Cassegrain Reflector.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. E. J. Salisbury: Stomata.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Prof. C. H. Desch: The Chemical Properties of Crystals (May Lecture).

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—E. Torday: Dualism in Western Bantu Religious and Social Organisation.

WEDNESDAY, MAY 9.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Proctology) (Annual General Meeting), at 4.45.—At 5.—Sir William de Courcy Wheeler (Surgery), Dr. G. Hodgson (Radiology), Dr. C. Dukes (Pathology), and others: Discussion on The Early Diagnosis of Carcinoma of the Rectum and Colon.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—W. B. R. King: The Geology of the District around Meifod (Montgomeryshire).—H. Dewey: Exhibition of a Palæolithic Flint-implement found in Gravel on the Dover House Estate, Putney Heath.

ROYAL SOCIETY OF ARTS, at 8.—Capt. R. W. Lane: The Sterilisation of Milk.

EUGENICS SOCIETY (at Royal Society), at 8.30.—Dr. N. East and Prof. Van Loon: Crime and Heredity.

THURSDAY, MAY 10.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—Prof. I. P. Pavlov: Some Problems of the Physiology of the Cerebral Hemisphere (Croonian Lecture).

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. W. E. H. Berwick: Some Recent Advances in the Theory of Equations (Lecture).

CHEMICAL SOCIETY (at Royal Institution), at 5.30.—Sir James Walker: Arrhenius Memorial Lecture.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—B. N. Wallis: Design and Construction of Modern Rigid Airships.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group, Informal Meeting), at 7.—Major P. Bull: A Pocket Apparatus for Three-Colour Photography.—C. H. Clarke: A New Departure in Exposure Meters.

INSTITUTION OF AUTOMOBILE ENGINEERS (Derby Graduates) (at Cavendish Café, Derby), at 7.30.—C. Mercy: Free Wheel Devices.

OPTICAL SOCIETY (at Imperial College of Science), at 7.30.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Annual General Meeting) (at 30 Russell Square, W.C.1).—H. Hepworth: Nitrocellulose Lacquers.

FRIDAY, MAY 11.

ROYAL ASTRONOMICAL SOCIETY, at 5

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Dr. E. G. Richardson: The Amplitude of Sound Waves in Resonators.—R. E. Clay: The Focus of a Gas-filled X-ray Tube.—Demonstration of an Electric Harmonic Analyser, by Dr. R. T. Coe.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. T. Henly: Notes on the Drying of Industrial Products.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (Annual General Meeting) (at Chemical Society), at 8.—F. H. Carr: Some Chemical Engineering Aspects of the Fine Chemical Industry.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. Doris L. Mackinnon: Life's Unsuspected Partnerships.

SATURDAY, MAY 12.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Bath).

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Western District Meeting) (at Totnes).

PUBLIC LECTURES.

SATURDAY, MAY 5.

ARTS SCHOOL, CAMBRIDGE, at 3.—Sir George Newman: Linacre's Influence on English Medicine (Linacre Lecture).

MONDAY, MAY 7.

UNIVERSITY COLLEGE, at 5.—Dr. G. E. Coghill: Anatomy and the Problem of Behaviour. (Succeeding Lectures on May 8 and 10.)

TUESDAY, MAY 8.

THE UNIVERSITY, BIRMINGHAM, at 5.30.—Prof. Fichter: Electrochemistry. (Succeeding Lectures on May 10, 11, 14, 15, 17, and 18.)

WEDNESDAY, MAY 9.

MEDICAL SCHOOL, LEEDS, at 3.30.—Prof. G. G. Turner: Cancer of the Rectum.

THURSDAY, MAY 10.

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Prof. E. C. Dodds: The Ovarian Hormone.

IMPERIAL INSTITUTE, at 5.30.—Dr. J. M. Rendall: The Empire.

KING'S COLLEGE, at 5.30.—Prof. J. O. Thomson: Problems of Ancient Geography.

FRIDAY, MAY 11.

UNIVERSITY COLLEGE, at 5.30.—Sir Samuel Hoare: The Value of Aviation to the British Empire.

CONFERENCES.

MAY 10 AND 11 (AT BATH).

RHEUMATIC DISEASES.—President: Sir George Newman. Presidents of Sessions: Social Aspects, Lord Dawson of Penn; Causation, Sir Humphry Rolleston, Bart.; Treatment, Sir E. Farquhar Buzzard.

MAY 11 TO 15.

CHEMICAL INDUSTRY CONFERENCE (organised by Society of Chemical Industry in connexion with its London Section, Chemical Engineering Group, and Institution of Chemical Engineers).

Friday, May 11 (at Les Gebelins Restaurant, 1 Heddon Street, W.1), at 8.30.—F. H. Carr: Some Chemical Engineering Aspects of the Fine Chemical Industry.

Saturday, May 12.—Visit to Rothamsted Agricultural Experiment Station.

Monday, May 14 (at Institution of Civil Engineers), at 10.30 A.M.—Sir Arthur Duckham: The Fuel Industries and the Work of the Chemical Engineer.—Prof. G. T. Morgan: The Chemical Study of Low Temperature Tar.

At 2.30.—Sir Alexander Houston: Water Purification.—J. H. Coste: The Pollution of Tidal and Non-Tidal Streams.

May 15 (at Institution of Civil Engineers), at 10.30 A.M.—Sir Alfred Mond, Bt.: Scientific Research as applied to Industry.—Sir John Russell: The Part played by British Workers in the Application of Fixed Nitrogen to the Soil.

At 2.30.—Lt.-Col. G. P. Pollitt: Developments in the Heavy Chemical Industry.