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What is Life?

OUR knowledge of the past history of life upon earth, obtained from studies both of the earth's crust and of the organisms which are found inhabiting it at the present time, suggests that living beings developed from non-living material, the organic from the inorganic. But the conditions on the surface of this globe must have been widely different from those which obtain at the present day, and the question whether life can arise from the non-living to-day is still unanswered. It is generally held that the evidence indicates that a living organism can only arise from another living being, experiments favouring the view that spontaneous generation does occur having failed to withstand the strictest tests of criticism.

The answer to this question, however, depends on the definition of the terms 'living' and 'non-living'; at first sight the distinction between the two appears sharp and unmistakable, but a little consideration shows that certain living organisms show many analogies with non-living material, and that on the borderland of life it may be difficult to say with certainty whether any given material is 'alive' or not. To the analogies between live and dead things and their possible implications, Prof. A. E. Boycott devoted his recent presidential address to the Section of Pathology of the Royal Society of Medicine, a revised version of which we publish as a supplement this week. Such a comparison is useful, since, although chemistry and physics have helped greatly in the interpretation and understanding of the mechanisms of living organisms, they have not yet succeeded in explaining life.

A living organism is an entity, a discrete unit; the live world is made up of such discontinuous pieces. But though at first sight the dead world may appear continuous, it also in reality is composed of particulate matter and energy, molecules, atoms, quanta. Ultimate analysis has merely led to the discovery of smaller particles, and a fractional atom is as impossible as a fractional animal.

Again, the origin of one species from another in the course of evolution has its modern analogy in the derivation of one element from another; apart from the time factor, chemical elements are not necessarily more stable than zoological species; lead or a dog may not always have been so, and cannot be trusted to be so indefinitely in the future. It is even possible that as the disintegration of radioactive elements cannot be controlled, so also may the evolutionary sequence of animals be predetermined, although the actual course may be deflected by changes in the environment. Both elements and species can be arranged in groups according to their general characteristics; the position in the table indicates their properties or characters and gives a clue to their past history.

The capacity of self-repair is one of the greatest characteristics of living beings; a multicellular organism repairs injury by the growth of certain cells usually specifically set aside for this purpose and endowed with the capacity of growth and proliferation, even though some of the cells actually injured die and are not replaced. Whether an injured unicellular organism, such as a bacterium, ever undergoes a similar process of repair is more doubtful; it is more probable that the repair is reflected in an increase in the numbers of the race rather than in a recovery of the individual. Atoms are continually losing electrons, as, for example, when electrical energy is manifested; but they do not change in nature so that repair, the picking up of an electron, must take place.

The variations among the organisms of a single species are obvious enough, and it is known that atoms show a similar variability, and that the atomic weight is merely the mean value for the whole species. Biological measurements made on a similar scale to physical or chemical might result in biology also becoming an 'exact' science.

A further analogy between the living and the non-living can be drawn from the examination of the courses of the reactions in the hydrolysis of cane-sugar by dilute acid and the destruction of bacteria by heat or disinfectants. Both follow a similar path; the bacterium behaves as the molecule of cane-sugar, the proportion killed or hydrolysed depending on the number of organisms still living or on the number of molecules still unchanged. The organism acts as the unit. If the molecules of the organism were the units and had been destroyed according to the same law, it would have been expected that a stage would have been reached when all the organisms would have died together, whereas, in fact, this destruction only occurs gradually.

There is difficulty, however, in finding an analogy to reproduction in animals. Reproduction appears to be necessary because organisms are unstable; without it they could not maintain themselves. But provided that conditions remain constant, the number of any given species does not change greatly from year to year; the capacity for reproduction enables organisms to adapt themselves to varying conditions rather than to increase, except perhaps slowly, in numbers. The simpler units of the inorganic world are more stable and do not need therefore to reproduce. But if speculation embraces the universe rather than the earth alone, it appears possible that the disintegration of atoms into radiation in the immense heat of the stars may be accompanied elsewhere by the regeneration of matter from energy under conditions of intense cold, giving a true reproduction of inorganic material, and the atoms formed need not be the same as those from which the protons and electrons originally came.

It thus appears that living and non-living form one continuous series, and that no sharp distinction can be drawn between them. But if so, what sort of matter forms the borderland between the two? Is it the filtrable virus, the bacteriophage and similar agents? These bodies show some of the properties both of bacteria and of non-living matter. It is probable that the average diameter of the viruses is about 25 $\mu\mu$, whilst that of the smallest known bacillus is about ten times greater, just at the limit of visibility. Organisms of this small diameter can pass through filters, and are about equal to the colloidal aggregates of dissolved hæmoglobin in size and can contain from 200 to 400 protein molecules. There appears to be a break in the series of micro-organisms between bacteria and viruses, perhaps analogous to the fact that even the smallest mammal has a very definite size. The range in size in the bacterial group is of the same order as in the mammals, and the ultramicroscopic viruses may show a similar range. The composition of the latter is unknown; it is probable that protein is present, since a virus infection frequently gives rise to a long-lasting immunity; on the other hand, provided a minimum dose is given, the severity of the infection is little altered by giving doses even many thousands of times greater; viruses apparently do not produce poisonous substances as do so many bacteria.

Many viruses are extremely resistant to destructive agents; others are much more delicate. But, unlike bacteria, no virus has been successfully grown in artificial culture without the presence of other cells; in fact, they seem to multiply only in the presence of living cells and preferably young growing cells. It is quite possible that they are obligatory intracellular parasites and that this habit of life may explain some of their peculiarities.

Though, however, the viruses are related to the bacteria in some of their characteristics, they also show phenomena analogous to those produced by material which is usually considered to be non-living. Thus the products of autolysis of dead cells stimulate growth as well as an agent obtainable from malignant tumour cells. The presence of the latter is indicated when malignant epithelial cells stimulate normal connective tissue cells to grow into a transplantable tumour, a carcinoma stimulating the development of a sarcoma. This agent is presumably usually very labile, but in the case of the Rous fowl sarcoma can be obtained in the filtrate from the growth and initiate a tumour on injection into another bird; no living agent can be seen or cultivated in such a filtrate.

The products of autolysis are 'dead' or non-living: Is the Rous agent living, or simply a non-living material which can stimulate certain cells to pathological overgrowth? It multiplies only where its specific activity is displayed, and it may survive drastic methods of purification. There is good evidence that tumours produced by chronic irritation contain a carcinogenic 'virus'; that is, the irritation stimulates the cells to overgrowth, with the result that they produce the virus. Hence the latter arises *de novo* in each tumour in the growing cells, and the means of propagation of the disease are not the same as those by which it was originally started.

Applying such reasoning to the true virus diseases, for example, foot-and-mouth disease, the question arises whether the disease may not itself produce the virus; in other words, although the infection is spread by a minute dose of virus, multiplication only occurs in the presence of the specific lesion, so that the virus obtained from the lesion need not be the direct descendant of the infecting virus, in the same way as bacteria only arise from pre-existing organisms. In spite of difficulties, epidemiological, immunological, and other, against this view, there are items of evidence in its favour, such as the production of a transmissible inflammatory disease of the rabbit's testis, by inoculating a filtrate of testis emulsion from one rabbit into another's testis; although compounds from an animal's own tissues do not usually behave as antigens in the same animal, there are exceptions to this rule. Lysozyme, again, has many of the properties of an enzyme, but it is increased in amount when it acts upon its specific micrococcus.

It is therefore possible that viruses are pieces of living cells, which apart from their proper environment have abnormal actions, in this case harmful, since those with the harmful actions are the more easily apprehended. They would therefore form part of a continuous series stretching from obviously non-living matter through the growth-promoting substances, the viruses, and the bacteria to the higher plants and animals. But even if such substances can be considered as both living and arising *de novo* under the appropriate stimulus, the problem of their evolution into a higher microbe is still unsolved, and the conditions for this evolution may not obtain on the earth at the present time; whilst if they are held to be non-living, there appears to be no trustworthy evidence that life can arise except from living matter. Science still has far to travel before even the humblest bacillus can be produced at will.

Wild Nature and Gentle Savages.

Wanderings in Wild Australia. By Sir Baldwin Spencer. Vol. 1. Pp. xxviii + 455 + 210 plates. Vol. 2. Pp. xiv + 457-930 + 194 plates. (London: Macmillan and Co., Ltd., 1928.) 42*s.* net.

No one has done more valuable work in elucidating the ethnography of the aborigines of Australia than Sir Baldwin Spencer, and therefore a new book by him deserves careful consideration. "Wanderings in Wild Australia" is possibly the final record of travels and field-work begun thirty-four years ago and continued at intervals until within a few years. The area of the wanderings is, roughly, between 132° and 136° E. long., and from Lake Eyre in the south to Bathurst Island and the Gulf of Carpentaria in the north.

The first two parts of the present work closely follow the information given in "Across Australia," by Spencer and Gillen (1912), together with ethnographical additions which are to be found in "The Native Tribes of Central Australia," by Spencer and Gillen (1899), and the new and improved edition of "The Arunta" (1927), which has already been noticed in Nature (Mar. 17, 1928, p. 411), as well as observations from "The Northern Tribes of Central Australia," by Spencer and Gillen (1904). The third part deals with the Kakadu of the East Alligator River (Arnhem Land), Port Darwin, and Melville and Bathurst Islands, the ethnographical matter being abstracted from "The Northern Tribes of the Northern Territory of Australia," by Baldwin Spencer (1914). It will thus be seen that the fortunate possessor of the earlier books will have little occasion to consult the new book so far as anthropological information is concerned, but attention must be directed to the fact that there are a few new photographs which illustrate parts of ceremonies, and several new representations of the very interesting carved and painted grave posts of Melville and Bathurst Islands. Those interested in gesture language (vol. 1, pp. 436-444) will find nineteen additional signs in " The Arunta," vol. 2, Appendix F. There are several new sketches, mainly of scenery, by the author, and three or four new maps and two instructive block diagrams showing the relation of the geology of the scenery of the Macdonnell Range.

The foregoing is written from the point of view of an ethnologist, but there is another aspect from which the book may be judged. The author gives records of various journeys which bring before the reader a vivid picture of the geographical and biological conditions from south to north of the central belt of Australia, and as he was the professor of biology in the University of Melbourne, we have the satisfaction of finding the plants and animals correctly identified. The great differences in the flora and fauna and in the country itself during a dry spell from those immediately following a fall of rain account for the diverse opinions expressed by travellers in the past. We are told how certain plants and animals adapt themselves to these very contrasted conditions—of succulent and spiny plants, of the æstivation of animals, and of the frogs which are dug up by the natives in the dry season in order that the latter may drink the water with which the frogs have distended themselves.

So from stage to stage we are pleasantly conveyed, and learn how travellers and settlers fare in those remote and often most inhospitable regions, and the information is appropriately illustrated by numerous beautiful photographs of scenery and vegetation, with a few representations of animals. In this way the stage is set for the human performers in the drama of Australian physical and biological conditions.

Most travellers have come across only small bands of wandering natives, with few and crude belongings, who were wresting a precarious living from niggard Nature, and not unnaturally a common opinion has arisen that the people are a miserable, poor, and cultureless folk. But, thanks to the researches of Sir Baldwin, we now know that on stated occasions the natives assemble from far and wide to spots where water and food are temporarily abundant, and then the dull, isolated, secular life is exchanged for a period of happy social intercourse and the performance of numerous spectacular religious performances. It is impossible to give even a summary of the wealth of information here given concerning these most interesting ceremonies, which, by the way, are fully illustrated by excellent photographs. The reader of the book will get, as he cannot obtain anywhere else, a picturesque but scientific account of the daily life, social organisation, ceremonial life, magic, religion, death, burial, and mourning of various tribes; nor are the objects they make and the method of their manufacture neglected.

Towards the end of 1911, the Minister for External Affairs of the Commonwealth Government wisely appointed Sir Baldwin Spencer as Special Commissioner for Aboriginals of the newly established Northern Territory, and in the chapter entitled " Work in Darwin " we have a hitherto unpublished account of the first two months of his actions as Chief Protector in charge of the department instituted to safeguard the interests of the aboriginal population. This very interesting chapter shows how necessary such an appointment was, since the natives were being hopelessly demoralised by Chinese and Malays. The Commonwealth Government has shown in this way, and in appointing a Government anthropologist for the Mandated Territory of New Guinea, that it appreciates the practical value of ethnology, as indeed the Government of Papua has done for many years.

A. C. HADDON.

Marine Engine Practice.

Marine Engineering in Theory and Practice: a Complete Text-Book on Heat Engines and Mechanical Engineering connected with them, including Steam Engines and Boilers, Turbines and Internal Combustion Engines and Auxiliary Machinery, both in their General Application and in particular Reference to Types used and to Practice at Sea; for Marine and other Engineers, and Naval Architects, Officers, Apprentices, and Students. By Eng. Comdr. S. G. Wheeler. Vol. 1: *Elementary.* Re-issue with Appendix. Pp. xi + 182 + 8. Vol. 2: *Applied.* With a Special Chapter on Metals and Strength of Materials, by Comdr. G. C. Malden. Pp. xi + 183-597. (London: Crosby Lockwood and Son, 1928.) Vol. 1, 10*s.* 6*d.* net. Vol. 2, 35*s.* net.

THE principal part of Vol. 1 of Wheeler's work is devoted to an explanation of the elementary theory of heat engines and of the fundamental principles of their action. There is nothing new in the subject matter, but the treatment differs from that ordinarily adopted. It is intended for the primary education of engineers engaged in the naval and merchant services, and the style has been modelled to suit. Throughout, the aim is to impart a sound grasp of the rudimentary principles, rather than to describe exact methods of calculation. Elaborate mathematics are carefully avoided and diagrams used freely. The reader is always encouraged to visualise what actually occurs during any operation that is being explained, and tentative theories and analogies are resorted to in order to facilitate explanation.

To the trained engineer, some of the attempts in this direction appear at first to be somewhat crude, but their effectiveness has no doubt been proved in a wide experience in teaching this subject. The diagrams employed are those which give the simplest and most direct representation of the function or performance concerned. The pressure–volume chart is used wherever possible, and the temperature–entropy chart, which the more advanced student would in many instances find more convenient, is studiously avoided. However, the employment of the pressure–volume chart in connexion with unrestricted expansion of steam, while useful as a connecting link between the cases of restricted and unrestricted expansion, is not the most satisfactory for representing the energy transformation of the latter. Diagrams showing the losses which occur in the various transitional stages between the burning of the fuel and the development of power on the propeller shaft are particularly useful.

Generally speaking, the attempt to present the case in a simple and easily understandable manner is commendably successful, but a few suggestions might be made for a future edition. The means adopted for the purpose of getting the reader to appreciate physical facts and functions rather than abstract formulæ, lead to some redundancy, and while this, as a consequence, is probably inevitable, its effect could be largely counteracted by effective summarisation. The statement is made that it is impossible to obtain a steam velocity greater than the velocity of sound with a nozzle which has no divergence at outlet. This is quite a common mis-statement of fact in books of this kind, and yet in actual pressure-compounded impulse turbines such nozzles are quite commonly employed for pressure drops greater than the critical.

In some cases where values are given by way of example, it should be made clear that they are not absolute and are liable to considerable variation in practice. For example, it is stated that the 'design factor' or ratio of work actually obtainable to that which the pressure–volume diagrams show to be theoretically available should be taken as 0·49 for triple expansion reciprocating engines. This factor, of course, varies over a wide range for different engines and conditions. Again, it is stated that for the steam consumption rate of marine turbines a value of 14 lb. per shaft horsepower per hour may be taken, whereas there are actually on service at the present time marine turbine installations operating with a steam consumption rate of approximately half that value.

However, the general treatment of the subject is good, and the book should be much appreciated by young engineering students and those responsible for their education.

The major portion of Vol. 2 is devoted to describing systems of marine propulsion and types of engines, boilers, and accessories. The description is of a very practical nature, is very well done, and accompanied by a large number of excellent illustrations. The first chapter deals with turbines, and commences with a very logical classification of all types, land turbines being wisely included for the sake of completeness. The principle of operation and the practical features of the various types are then separately described, and a large number of actual examples illustrated. This is followed by a similar description of the most important constructive details. The special requirements for ship propulsion are then discussed, and the chapter concludes with a useful review of recent tendencies in practice and design. The means which have been adopted for reducing the loss due to the velocity of the steam leaving the final stage are very fully examined, although this is primarily a land turbine problem.

Internal combustion engines are dealt with in a similar manner in the next chapter, which commences with a proper classification and then proceeds with the description of the principle of operation, and the constructional features of each type. The special apparatus required to meet marine requirements, such as reversing gear, are then dealt with, and 'heat engines reversed,' or refrigerators, are included in this section. There is no corresponding chapter on reciprocating steam engines, the treatment of which in the first volume is presumably deemed sufficient. The chapter on ship propulsion gives a brief account of the laws of resistance of ships and the action of the screw propeller, and then describes a large number of arrangements of propelling machinery of various types. The methods which have been adopted for gearing the engine shaft to the propeller shaft, namely, mechanical, electrical, and hydraulic, receive appropriate attention, and torsion meters are also included.

In the chapters on boilers, every type which has been used at all extensively in either land or marine practice is suitably illustrated and described, with the most important boiler-room auxiliaries. The chapter on feed-water, etc., opens appropriately with a full discussion on the necessity of and methods for preserving boiler feed-water from impurities, after which, condensers and their auxiliaries are dealt with. This concludes the purely descriptive portion, and its comprehensiveness may be gathered from the above résumé and from the fact that this portion of the book contains more than 300 illustrations.

The treatment of the subject of combustion is very thorough, both from the theoretical and practical point of view, and the chapter on metals, etc., takes an excellent survey of the factors which influence the physical properties of the metals ordinarily employed in engineering structures. The last chapter describes various steam charts and their uses, and the book concludes with a supplementary set of examples, exercises, and explanatory notes.

Taking into consideration the time which the collection of so much matter must have occupied, and the recent rapid progress in marine engineering, the book is remarkably well up-to-date. A few of the examples illustrated are obsolete types, but have been wisely included in order to show on what lines progress has been made. In a future edition, reference could with advantage be made to the recent development of high pressure and temperature geared turbine installations, to the combination of reciprocating engines with exhaust steam turbines geared to the same propeller shaft, to the development of the double acting internal combustion engine for large powers, and to the experimental work which has been done in connexion with internal combustion turbines.

This volume should prove useful both for text-book and for reference purposes.

Evolution.

(1) *Charles Darwin: the Man and his Warfare.* By Henshaw Ward. Pp. viii + 472 + 27 plates. (London: John Murray, n.d.) 21*s.* net.

(2) *The Evolution of Charles Darwin.* By George A. Dorsey. Pp. xii + 300. (London: George Allen and Unwin, Ltd., 1928.) 7*s.* 6*d.* net.

(3) *Darwinism and What it Implies.* By Prof. Sir Arthur Keith. (The Forum Series, No. 8.) Pp. vii + 56. (London: Watts and Co., 1928.) 1*s.* net.

THE large number of publications which have made their appearance during the last few months upon the subject of evolution affords interesting evidence of a growing appreciation on the part of the general public of the importance of some acquaintance with the general conclusions of biological science as part of the mental equipment of the ordinary citizen.

(1) Mr. Henshaw Ward's "Charles Darwin: the Man and his Warfare" is a book of quite unusual merit. The professional biologist will while away a few hours in its perusal with much pleasure, while the layman interested in Darwinism will gain from it a vivid picture alike of the personality of the master and of the various steps in the long campaign which culminated in the conversion of the intellectual world to belief in evolution. The author, while apparently not a specialist in biology, shows a wide acquaintance not merely with the works of Darwin himself but also with the writings of others about him and his philosophy, and about his chief contemporaries in the world of science, and this has enabled him to form in his mind a peculiarly vivid picture of Darwin's personality and surroundings—a picture he puts before us with much literary skill in the book under review.

The book is really a scientific biography written for the general reader. In its fourteen chapters the life of Darwin is divided up into contrasted sections. "A Year with Fitz-Roy and Lyell," "Six Years of Coral Islands and Species," "Eight Years of Barnacles," "Writing the 'Origin,'" "The Reception of the 'Origin,'" "Darwin's Life after 1850," are chapter headings which will give an idea of the general plan of the book. What they give no idea of is the lively and graphic style in which it is written, or the remarkable vividness of the picture of Darwin and his life which they call into being in the mind of the reader. The book is not merely a picture of Darwin himself and his doings: it also brings in excellent portraits of those of his contemporaries who played important parts in relation to it. Hooker was "a brawny tar, with a handshake like a taut sheet, and a laugh like a favoring gale." "An odd figure he was. The head was prone to be cocked at a sort of owlish angle for careful inspection of whatever came into view." "Such a handling of men in a complicated situation [during his travels in Sikkim] is good training for the battle at Oxford in 1860." Lyell, Huxley, Owen, Wallace, are all faithfully portrayed. "There was in Wallace's nature a beauty that will shine when the splendour of Agassiz and the greatness of Lyell are dim. He never laid claims to more honour than the Linnean paper gave him, and so gained a higher kind of fame than scientific discovery can bring."

As may have been gathered, the language in which the book is written is the American variety of English, but any little peculiarities that jar on the purist in literary style may well be pardoned for the sake of the end result: an extraordinarily readable and useful book. It is, by the way, provided with numerous and excellent illustrations.

(2) Dr. George A. Dorsey is well known as the author of "Why we behave as Human Beings," a book which in the United States enjoys deservedly a big circulation, giving as it does an excellent sketch of those results of modern physiology which are of greatest importance to the ordinary citizen. Dr. Dorsey has now published a book entitled "The Evolution of Charles Darwin." "To understand Darwin is to understand human beings," he says in his preface, and the whole book is a study of Darwin as a human being. It is well done, and in parts is charming, such as the chapter on Darwin as the father of his family, where the author recalls the little daughter running downstairs with the stolen pinch of snuff for her father, and the four-year-old son approaching him with a bribe of sixpence to induce him to come and play during working hours. The book is interesting and well worth reading, though many a biologist will demur to the statement that Darwin became a man of science "in spite of his germ plasm," and many a Trinity man to that which attributes to Christ's the honour of having nurtured Isaac Newton.

(3) Sir Arthur Keith's "Darwinism and What it Implies" is a sequel to his earlier volume in the Forum Series, "Concerning Man's Origin," and deals with some of the bearings of Darwinism upon problems of everyday life. The nature of mind, foundations of human nature, problems of sex, the spirit of competition, are headings that catch the eye. "Every fact known to them [medical men] compels the inference that mind, spirit, soul, are the manifestations of a living brain, just as flame is the manifest spirit of a burning candle." In this connexion the old-fashioned philosopher may well ponder over the fact that by drugging the brain we can "alter the mentality" of any man or woman. The chapter has in it much that is wise, and scattered through its pages are shrewd sayings. "The day man becomes a perfectly rational being marks his end." "To extinguish the spirit of competition is to seek for racial suicide": that spirit "has lifted us from savagedom, and our hopes of the future are bound in it."

The short middle chapter of the three concerns itself with "The Nature of Man's Brain," while the third, "Modern Critics of Evolution," is a reply to articles in the *Nineteenth Century* by Mr. George H. Bonner and Prof. J. A. Fleming. It may perhaps be doubted whether such articles merit even the small expenditure of Sir Arthur Keith's time involved in replying to them. Anyone desiring trustworthy information as to what is known of the evolution of the animal kingdom will surely turn to those whose life's work is the investigation of the subject. It may be of psychological interest to learn what some distinguished biologist thinks about one of the great generalisations of physical science, or conversely, what a distinguished worker in one of these sciences thinks about the evolution of plants or animals, but it is of no particular moment otherwise. While it is no doubt true even to-day that there are many men of letters entirely unacquainted with the facts which demonstrate the evolution of man, surely there are few so oblivious of their limitations as to assert dogmatically with Mr. Bonner: "There is not a shred of conclusive evidence for the animal ancestry of man."

Our Bookshelf.

(1) *Heat, Light and Sound: for School Certificate Students.* By E. Nightingale. (Bell's Natural Science Series.) Pp. xiii + 381 + ix + 11 plates. (London: G. Bell and Sons, Ltd., 1928.) 6*s.* 6*d.*

(2) *Sound: for School Certificate Students.* By E. Nightingale. (Bell's Natural Science Series.) Pp. ix + 273-381 + ii. (London: G. Bell and Sons, Ltd., 1928.) 2*s.* 6*d.*

(1) THE author of this little text-book is to be congratulated. His aim has been "to cover the school certificate and matriculation syllabuses in Heat, Light, and Sound in a manner which will appeal to the student." In this aim he certainly appears to be very successful. The subject matter contains the latest available information, obtained from the most trustworthy sources. The whole is presented in an instructive and attractive manner. The illustrations alone are worthy of special mention, in many cases being self-explanatory and thus relieving the text of an unnecessary burden. The author has not forgotten the historical side of the subject, and short biographies and experiments of famous physicists have been introduced in appropriate places.

Experiments which 'work' are well described, and there is little excuse for failure to repeat them. An excellent feature of the book which must be noticed is the delightful selection of homely and *effective* illustrations and examples. Some of these are reminiscent of Bragg's "World of Sound," and the author has been wise in following the example of such an eminent leader.

Mr. Nightingale's effort is an example of what a text-book for young students should be. The information it contains is accurate and up-to-date and is presented in the style of an experienced teacher. It can be recommended unreservedly to teachers and students as an excellent text-book.

(2) This little book is one of a set of three written for matriculation and school certificate students. It forms Part III of the combined text-book mentioned above.

The Protamines and Histones. By the late Prof. Albrecht Kossel. Translated from the original German Manuscript by Dr. William Veale Thorpe. (Monographs on Bio-chemistry.) Pp. xi + 107. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1928.) 9*s*. net.

IT is indeed fortunate that Prof. Albrecht Kossel was able to complete the manuscript of this little volume before his death, since more than any other single investigator he had contributed greatly to our knowledge of these two groups of protein compounds. The protamines, the simplest known proteins, are characterised by yielding on hydrolysis only about four different amino-acids, whereas about twenty units may be obtained from a typical complex protein. Moreover, the amino-acids found are chiefly those of basic character, arginine, lysine, and histidine. The protamines are found solely in the sperm and testicles of certain fish. The histones are more complex, containing a greater variety of units; they are, however, like the protamines, of a basic nature. They are found in the ripe sperm of certain vertebrates and invertebrates, including some fish, as well as in the nucleus of the red blood cell of the bird and in the thymus gland of the mammal. Both protamines and histones occur in Nature in combination with nucleic acids.

The monograph describes in detail the methods available for the preparation of these compounds and the separation of the various units after their hydrolysis. Separate chapters are devoted to a description of the various individuals of these two groups which have so far been isolated as chemical individuals. The importance of the study of such proteins lies in the light which it may shed on the composition and origin of the more complex of these nitrogenous compounds. Although primarily a work for the specialist, the volume has an interest also for those who wish to know something of a group of compounds which are not usually considered in much detail in text-books of bio-chemistry. The bibliography extends to upwards of two hundred references.

Leached Outcrops as Guides to Copper Ore. By Augustus Locke. Pp. vii + 175 + 24 plates. (London: Baillière, Tindall and Cox, 1926.) 22*s*. 6*d*. net.

THE object of this book is stated by the author to be the task of "reconstruction of the sulphide formerly existing." In the majority of cases a deposit consisting of iron pyrites closely intermixed with chalcopyrite or other copper ores, and possibly also other sulphides, does not often come up to the surface in this form, but is usually overlain by a capping, sometimes of very great thickness, of the oxidised products of this ore, and the problem which the author desires to investigate is that of predicting from the nature of the capping the character and richness of the primary ore. He has turned his attention mainly to disseminated deposits and has practically neglected the massive ones, which are by far the more important on the continent of Europe. The result is that the book is, to use the author's words, "overwhelmingly American"; obviously the complete study of the subject would have included an investigation of the cappings of such deposits as the cupriferous pyrites of Huelva and those of Sulitelma and other Norwegian occurrences, about which there is in fact a great deal known.

The author has gone into very much minute detail, more especially as to the character and appearance of the limonite which generally results from the oxidation of iron pyrites, but it cannot be said that his results are of any very general use. As he himself says: "The kind of capping that means ore in one district, does not necessarily mean ore in another." Obviously, if this statement is true, and there is little reason to doubt it, of two districts in the western United States, it applies with even greater force to more remote regions or to other continents. The author appears here and there to realise that his theoretical methods are of little real value, and most mining engineers will concur in his dictum.

Farm Soils: their Management and Fertilization. By Prof. Edmund L. Worthen. (The Wiley Farm Series, edited by A. K. Getman and C. E. Ladd.) Pp. x + 410. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1927.) 13*s*. 6*d*. net.

UNDER modern systems of farming, it is recognised that soil management must be considered in relation to the specific crops to be grown, and the present volume attempts to correlate the various farm operations with economic crop production. The management of any soil will necessarily vary with the type of crop, as treatment that is merely adequate for fruit or garden produce might be hopelessly extravagant and uneconomic for large scale field crops.

Prof. Worthen keeps the practical aspect in view throughout, and by means of 'community studies' the student is led to investigate problems in the field for himself and to consider the best means for their solution. The main farming operations are dealt with in detail from various aspects, chapters being devoted to water supply, tillering, manuring, liming and green manuring. The correlation between soil management and the crop grown is brought out by short accounts of the appropriate treatments for field, pasture, garden, and fruit soils, and emphasis is laid on the importance of the cultivator becoming as familiar as possible with the local practices of his district. Special care has been taken with the illustrations, which are selected to bear directly upon particular points in the text, and numerous references, solely of American origin, are also included.

Lehrbuch der Protozoenkunde: eine Darstellung der Naturgeschichte der Protozoen, mit besonderer Berücksichtigung der parasitischen und pathogenen Formen. Begründet von Franz Doflein. Neubearbeitet von Prof. Dr. Eduard Reichenow. Fünfte Auflage. Teil 1: *Allgemeine Naturgeschichte der Protozoen.* Pp. iv + 436. Teil 2: *Spezielle Naturgeschichte der Protozoen.* Hälfte 1: *Mastigophoren und Rhizopoden.* Pp. iv + 439-864. (Jena: Gustav Fischer, 1927–1928.) Teil 1, 21 gold marks; Teil 2, 22 gold marks.

DOFLEIN's text-book of Protista has been for many years the classical volume for students of protozoa. Owing to the number of recent contributions to the literature of this subject, the last edition published in 1916 rapidly became out-of-date. The new volume, of which the first two parts have appeared rearranged and edited by Prof. Eduard Reichenow, is therefore a welcome production. In the main it follows the lines laid down in the fourth edition, but new sections have been introduced, such as a brief account of the comparatively new subject of soil protozoology. The first part ends with an account of the physiology of protozoa, and it is unfortunate that, in common with so many other modern text-books, this aspect of the subject receives rather scanty attention. In Part 2 the various groups of protozoa are considered, taking the reader to the beginning of the Sporozoa group. The present volumes maintain the high standard set by the late Prof. Doflein, and will be an indispensable part of any zoology library.

Air Ministry: Meteorological Office. The Observatories' Year Book, 1926: comprising the Meteorological and Geophysical Results obtained from Autographic Records and Eye Observations at the Observatories at Lerwick, Aberdeen, Eskdalemuir, Cahirciveen (Valencia Observatory), and Richmond (Kew Observatory), and the Results of Soundings of the Upper Atmosphere by means of Registering Balloons. (M.O. 304.) Published by the Authority of the Meteorological Committee. Pp. 411. (London: H.M. Stationery Office, 1928.) 63*s*. net.

THE Observatories' Year Book for 1926 has followed that for 1925 at an interval of 9½ months, indicating progress towards the desirable goal of the issue of each year's observations during the following year. The volume is enlarged by about forty pages by the inclusion, for the first time, of hourly magnetic data from Lerwick, the most northerly British observatory (60° 8′ N.). In going from the Abinger magnetic observatory (the results for which are published in the Greenwich volumes) to Eskdalemuir, 4° to the north, there is a transition towards more disturbed conditions, but the increase of disturbance in going 5° farther north still, to Lerwick, is much greater. The immense mass of meteorological and geophysical data recorded in these volumes with such convenient uniformity provides material not only for present researches, but will also almost certainly prove of use in ways yet unthought of to future generations.

Orcharding. By V. R. Gardner, F. C. Bradford and H. D. Hooker. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. xi + 311. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 15*s*. net.

THIS volume marks a definite attempt to fill the gap which exists between the practical considerations which govern the growing of fruit trees and the fundamental principles upon which such practice is founded. Scientific explanations are suggested for many of the problems which beset the grower, as, for example, the biennial fruiting habit of the majority of apples. Under questions of growth and nutrition, that of the carbohydrate supply of the tree is specially dealt with, as being of much importance in relation to the production and quality of the fruit.

Quality is becoming of increasing importance with increasing competition, and in consequence greater attention is necessary to keep fruit trees free from insect and fungus pests, chiefly by means of various types of spray. Appropriate marketing includes grading, attractive packing, careful transport with refrigeration if necessary, and the best choice of locality and salesmen, and due attention to all these details is essential for success and profit in fruit-growing on a commercial scale.

A B C of Adler's Psychology. By Philippe Mairet. Pp. 116. (London: Kegan Paul and Co., Ltd., 1928.) 3*s*. 6*d*. net.

AN excellent book. Adler's individual psychology makes an appeal to those people who do not like to accept the more extreme views of Freud, Jung, or Stekel, but still feel the need of a practical psychology to explain many of the mal-adaptations and neurotic features of the individual. In this short summary, Mairet has made a very satisfactory presentation. The author briefly traces the development of modern psychological ideas, and shows how Adler was led from his wide experience as a physician to build up his theory of inferiority and the individuals striving for superiority. Throughout the book there is a sound emphasis on the importance of individual psychology to the social, religious, and educational aspects of the community.

Man: What? Whence? Whither? or, The Faith that is in Me. By Capt. R. C. T. Evans. Fourth edition. Pp. viii + 218 + 11. (Chatham: Parrett and Neves, Ltd., 1928.) 2*s*. 6*d*.

THOSE who like a book to deal with a wide range of topics will be well satisfied with Capt. Evans's encyclopædic little volume. It deals with free-will, conscience, suffering, reincarnation, prayer and miracle, the flood, psychical phenomena, sacraments, the Trinity, and so on. The sincerity and earnestness of the writer are transparent, and as arousing reflection his work should prove valuable to many readers. It is intended primarily for those who are troubled by the apparent antagonism between religion and science, "in the hope that what comforted me may comfort them." The book is fertile in argument and contains much ingenious speculation. J. C. H.

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.]*

The Constitution of Nitrated Cellulose.

IN a recent publication (*Zeit. für physikal. Chem.*, **130**, 616; 1927), Herzog and von Náray-Szabó gave an account of the X-ray examination of ramie fibre nitrated in various ways, and concluded that for any nitrocellulose containing from 4·41 to 13·31 per cent of nitrogen the diffraction spots on the 'fibre diagrams' were produced mainly by the substance cellulose trinitrate, two spots from unchanged cellulose occasionally persisting, and that all nitrocelluloses were therefore principally mixtures of cellulose trinitrate and cellulose.

Two rather diffuse diagrams were given, one of which (for 12·99 per cent nitrogen) seems to show evidence of imperfect nitration. In the later paper by von Náray-Szabó and von Susich (*Zeit. für physikal. Chem.*, **134**, 264; 1928), this diagram, with the unit cell proposed for cellulose, is withdrawn and replaced by a new diagram in which the layer lines are closer together, but the claim is still made that the nitrocellulose diagram is always compounded of those of cellulose and its trinitrate. This theory is open to serious objections from many aspects of the chemistry and technology of nitrocellulose. Many of these have been presented by Brunswig in two interesting articles (*Zeit. für ges. Schiess- und Sprengstoffwesen*, **23**, 337 and 384; 1928).

In an investigation which has been carried on in these laboratories for more than a year, a complete range of samples of nitroramie nitrated in widely different mixed acids, together with their denitration products, has been examined by X-ray diffraction methods. The fibre diagrams of the nitrates are frequently lacking in definition and are difficult to interpret, but whenever measurements have been possible they have been found to afford only the slightest basis for Herzog's theory.

The nitration of cellulose in mixed acid is complicated by a loss of fibre structure which occurs with all mixed acids, for example, with those containing from about 30 per cent to 60 per cent of nitric acid, whenever the nitrogen content of the nitrocellulose reaches about 7·5 per cent. It continues until 10·5 per cent of nitrogen is exceeded. If the content of sulphuric acid is increased and the ratio H_2SO_4/H_2O has a certain value (about 1·7 to 1), the disintegration of the fibre structure may be greatly accentuated. It is therefore convenient to consider three groups.

The diagram of a nitroramie of less than 7·5 per cent of nitrogen shows the same spacings as that of its denitrated product but different relative intensities and is much weaker. The spacings remain constant with increasing degree of nitration. This type of diagram (B) may be contrasted with that of unaltered cellulose (A). It resembles that of fully mercerised cellulose, but excels it in sharpness and the intensities of the two are different. The diffractions characteristic of the trinitrate do not appear, although from a mixture of unnitrated ramie with comparatively little of the highly nitrated fibre it is quite easy to produce them.

In the second group (7·5 to 10·5 per cent) the nitrated material loses its fibre structure more or less, diffuse diffraction rings appear, but the denitrated product is still of type B and gives sharp lines.

As to the third and technically important class, sharper diagrams of which have been produced by von Náray-Szabó (loc. cit.) and by Andress (*Berichte*, **61**, 603; 1928), nitration in acids of technical composition nearly always results in diffuse spots, and the most important factor in securing definition seems to be a high content of nitric acid, say 50 per cent of the nitration mixture. In the cases of both cotton and ramie, as the nitrogen content falls to about 11 per cent, certain spots from planes parallel to the fibre axis are altered in spacing through small ranges in which confusion with diffractions of remanent cellulose of either type is not possible. In some instances the diagrams show an equatorial spot which falls in the same position as the $A4$ spot of cellulose, but its intensity is quite disproportionate to the possible cellulose content and its position changes on denitration. The denitration product from highly nitrated ramie is practically indistinguishable from that of pure cellulose (type A), but as the nitrogen content decreases to about 12 per cent, type A passes into type B more or less gradually, according to other conditions holding in the nitration.

It appears, therefore, that by the action of the mixed acid the cellulose residue is converted into type B for all but the highest degrees of nitration, and that the lines obtained in the range 10-12 per cent of nitrogen do not coincide with those given by the trinitrate or by cellulose of either type. Even if spots of type B were present it would not be certain, in view of the diffractions given by the less nitrated products, that they originated from unnitrated cellulose.

To account for these facts in a systematic way further data will be required, and it will probably be of great use to determine accurately the densities of certain nitrocelluloses and their denitration products and so obtain some indication of the closeness with which their structures are packed.

F. D. MILES.
J. CRAIK.

Nobel Research Laboratories,
Ardeer, Jan. 7.

The Distribution in Space of the Sunlit Aurora Rays.

SOME time ago (NATURE, Sept. 3, 1927) I discussed the position of the sunlit aurora rays with my colleague, Prof. Krogness, and he made the suggestion that the great heights of these rays might perhaps be explained by assuming that the sun's radiation pressure pushes away the upper atmosphere like a small tail of a comet, and if the corpuscular rays hit this tail they produce aurora at unusual heights.

As this idea seemed very promising, I again took up the calculations of the aurora rays in the period from 1911 to 1922, mentioned in my letter to NATURE of Sept. 3, 1927. The only two occasions when sunlit aurora rays were photographed simultaneously from two stations in order to obtain their altitude were during the nights of Mar. 22–23, 1920, and May 13–14, 1921.

In Fig. 1 we see the position of all the rays from these two nights compared with the position of the earth's shadow. The figure represents a vertical section of the earth, and the tangent to the earth's surface is the boundary between the sunlit and dark atmosphere. For each point of an aurora ray the position in the vertical plane through the centre of the earth and the sun is marked by a small circle for aurora of Mar. 22–23, and by a black dot for aurora of May 13–14. On each aurora ray two points are calculated and combined with a straight line representing the ray. This line is continued beyond the points as far as the photographs indicate. If the ray passes out of the photographic field it is marked by an arrow, and if the foot or summit can be seen on the photograph no arrow is given. Some rays form a rather large angle with the vertical, but this is only due to observation errors on account of a small parallax.

The figure gives a very suggestive idea of the action of the sunlight; the following conclusions seem to be well founded:

1. The action is not a direct one, because the rays situated nearer the sunset point O are lower than those farther away.

2. The action of the sunlight seems to be a pressure on the upper atmosphere, driving it away tangentially to the earth, like a tail.

3. When the corpuscular rays hit this tail they produce aurora rays the height of which increases with their distance from the sunset point.

4. The sunlit aurora rays situated in this tail seem to be confined to it, and do not descend beyond the frontier line between sunlit and dark atmosphere.

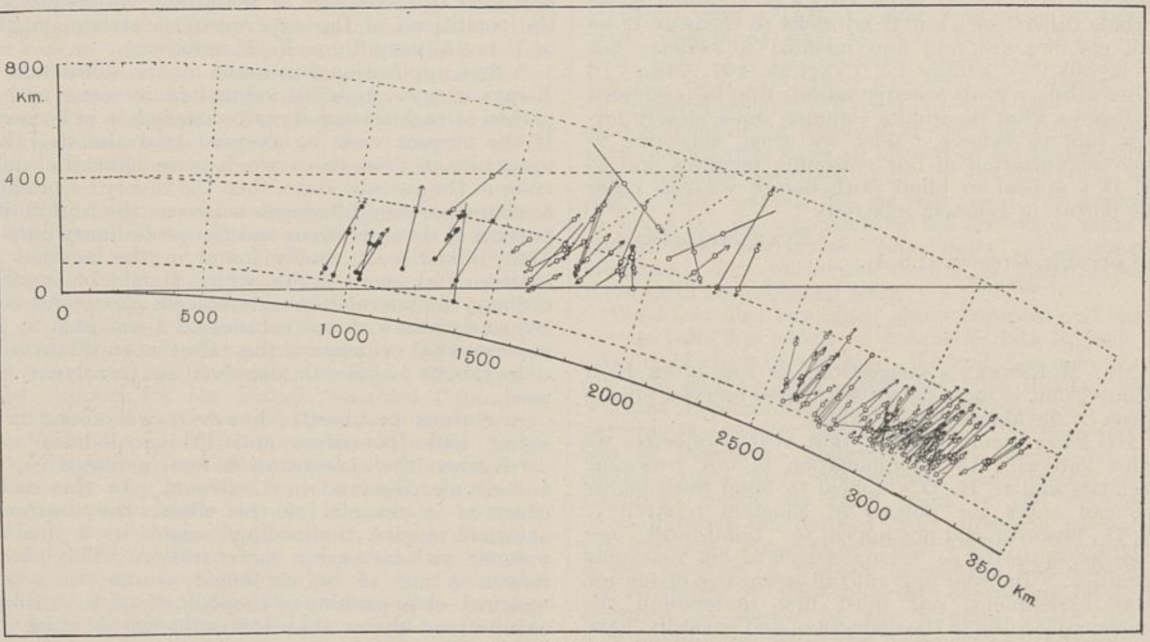

FIG. 1.

In the space between the tail and the earth up to distances of 2500 km. from the sunset point, no aurora rays are seen.

5. From 2500 km. and farther, reckoning from the sunset point, the action of the tail seems to have ceased, so that aurora rays here occur with the usual night altitude from 100 to 400 km.

From 1922 to now a large amount of material of more than 500 photograms of auroræ from southern Norway has been collected, and amongst this are many photograms of sunlit aurora rays. It will be very interesting to see if the measurement and calculation of these rays confirms the above-mentioned conclusions or not.

A still more interesting problem for solution will be to obtain the spectrum of these sunlit aurora rays.

CARL STØRMER.

Bygdö, near Oslo, Dec. 16.

The Understanding of Relativity.

THE leading article in NATURE of Nov. 3, 1928, by H. D., on this subject, contains views so unusual as apparently to deserve some notice. I have waited some time for more competent authorities to express themselves regarding these views, but as no such expression has yet been seen by me, a few brief thoughts are offered here in lieu thereof.

H. D. refers to the difficulty of explaining the theory of relativity. The attempts to do so, he says, "represent the most conspicuous failure of modern scientific exposition." He says further: "The real difficulty that besets the beginner in the subject is, not to *understand* what he is told, but to *believe* it," and that, to escape this difficulty, "Salvation must be by faith and not by reason." It does seem regrettable, to say the least, that men of science should have to resort to the rôle of the 'hot gospeller,' which rarely, if indeed ever before, has been the method of scientific investigation.

Let me refer to just one point in the theory of relativity. On p. 16 of Einstein's "Relativity, the Special and the General Theory" (3rd ed., Methuen and Co., London, 1920), a man in a moving railway carriage is supposed to walk in the carriage in the same direction in which the carriage is moving; What would be the velocity of the man with respect to the railway embankment? This velocity, as everybody knows, would be the sum of the man's walking velocity added to the velocity of the carriage. But, according to Einstein, this result "canot be maintained." On p. 18 Einstein modifies the illustration, taking the earth for the railway carriage and a ray of light for the man, both moving in the same direction; in which case, according to classical mechanics, the resultant velocity of the light with respect to the earth would, of course, be the difference of the two velocities. But not so according to Einstein's theory. The velocity of the light is not at all affected by the velocity of the earth. In other words, either the sum or the difference of these two velocities is always equal to one of the velocities alone. This certainly appears to call for H. D.'s appeal to faith; for the slightest grain of common sense would never permit us to believe that $V+v=V$, or $V-v=V$, when each velocity has a real value.

It is true that Einstein endeavours to justify his views in this case by the results of the experiments of Michelson and Morley, which clearly show that the velocity of light upon the earth is always the same in all directions, whether parallel to the earth's orbital motion or at right angles to it. But is it not far more rational to account for this fact by supposing the earth to have an ethereal atmosphere of its own by means of which the light is transmitted on the earth's surface and which is always carried with the earth in its orbital motion and also in its daily rotation near the earth's surface? We certainly do not know that such an atmosphere does not exist; and it certainly would account for the facts perfectly, without the violation of a single principle of mechanics.

Now the negative result of Michelson and Morley's experiments, in the supposed absence of this local atmosphere, constitutes the corner-stone of Einstein's theory of relativity (see NATURE, **111**, 240, and **117**, 6), and the effect of this paradoxical foundation upon even the highest intellects is illustrated by the following quotation from Sir Oliver Lodge: "The relative velocity of the light and the observer (travelling with speed u to meet it) must be $c+u$—common sense forbids otherwise,—but if he seeks to measure it he will get, we are told and inclined to believe, not $c+u$, but . . . simply c" (NATURE, **107**, 748). In other words, a great scientist admits that he is inclined to believe what he admits common sense clearly forbids him to believe. Must we, then, subscribe to such renunciation of our reasoning faculties and to H. D.'s appeal to blind faith before we can enter the portals of Einstein relativity?

EVAN MCLENNAN.

Corvallis, Oregon, U.S.A.,
Dec. 7.

MR. MCLENNAN's suggestion, as has often been pointed out, is inconsistent with the observed phenomena of the aberration of light.

His letter seems to imply that, if it is rejected, we must subscribe to "renunciation of our reasoning faculties and to H. D.'s appeal to blind faith before we can enter the portals of Einstein relativity." H. D., however, did not appeal to "blind faith," nor does he subscribe to "renunciation of our reasoning faculties." In order to grant full assent to a deduction from experiment, one must first understand the reasoning leading to the deduction, and secondly, have faith that reasoning on such foundations will not mislead. The failure of many people to give full assent to relativity is generally believed to be associated with the first factor; the article in question contended that it is actually associated with the second. The difficulty—at any rate in the special theory, which contains the paradoxes mainly responsible for the theory's bad reputation—is, not to understand a fairly simple argument, but to trust the understanding to lead to the truth when deep-rooted prejudice points in the opposite direction. H. D.

Dec. 29.

The Diffraction of X-rays in Liquids containing Heavy Atoms.

IT is now generally accepted[1,2,3,4] that X-ray diffraction in liquids is mainly due to the relative positions of the molecules and only in second instance to their inner structure. If the effect of the last factor is known, some information regarding the first factor may be obtained from an analysis of the observed diffraction pattern.[3] This circumstance is realised in the case of monatomic molecules, for example, argon, or mercury.[5,6] In most cases, however, as when using organic compounds, the inner structure is not known, and then no unequivocal conclusion, or nearly none, may be drawn from the diffraction pattern.

The use of an especial X-ray spectrograph[6] constructed by Prof. Coster and myself for the investigation of heavy (that is, absorbing) liquids has opened up a new line of attack. The guiding principle is to introduce very heavy atoms into the liquid and to get definite evidence concerning their mutual arrangement by their diffraction pattern. This diffraction pattern will depend almost entirely on the relative positions of the heavy atoms, as in comparison to their scattering power that of the other atoms may be neglected, the scattering power being roughly proportional to the square of the atomic number under the conditions of the experiment (scattering angles of 1° to 15° using Cu or Fe K radiation).

A first application was made on the diffraction of X-rays in a solution[7] of iodine ions in water and of carbon tetrachloride and methylene iodide in benzene. If the current view is accepted that the dissolved molecules in these cases are dispersed like the molecules in the gaseous state, then the theory[1,3] predicts a characteristic difference between the diffraction pattern of these solutions and that of ordinary liquids. This difference is chiefly found in the amount of scattering at small angles, which should be small in ordinary liquids and considerable in gases, and consequently also with our solutions. I was able to get experimental evidence of this effect when dilute solutions (about 1 molecule dissolved in 15 solvent) are used.

A curious peculiarity, however, was found with iodine ions (potassium and lithium iodides were used) when the concentration was increased (up to 1 molecule dissolved in 3 solvent). In this case I observed a reversal of the effect, the scattering at small angles diminishing again in a marked manner with increasing concentration. This phenomenon is not to be explained as due to a geometrical close-packing of the iodine ions, for a simple calculation[2] shows that this influence is much too small. The effect is, however, readily explained as due to the electrostatic repulsion of the iodine ions. Indeed, this will tend to keep them apart, as if the ions were much bigger, causing in this way an apparent close-packing. With lithium iodide this effect seems to be visible at smaller concentrations than with potassium iodide.

Another application of the same method has been made in studying organic compounds, especially those with long CH_2-chain (C_9-dibromide, C_{13}-dibromide[8] and C_{16}-mono-iodide were used). In this way evidence of their arrangement is obtained in a less ambiguous manner than usually.

Perhaps it is useful to add that with fatty acids, also studied, the results of Stewart and others[9] were confirmed and extended to C_{12}-, C_{14}-, and C_{16}-acids. A full account is to appear in *Zeitschr. f. Phys.*

My thanks are due to Prof. Coster for his helpful criticism.

J. A. PRINS.

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der Rijks-Universiteit,
Groningen.

[1] C. V. Raman and K. R. Ramanathan, *Proc. Ind. Assoc. for Cultiv. Science*, 8, II, 127; 1923.
[2] P. Debye, *Jour. of Math. and Phys. Massachusetts*, 4, 133; 1925; and *Phys. Zeitschrift*, 28, 135; 1927.
[3] F. Zernike und J. A. Prins, *Zeitschr. f. Phys.*, 41, 184; 1927.
[4] W. H. Keesom and J. de Smedt, *Proc. Amsterdam*, 25, 118; 1922; W. H. Keesom, *Proc. Amsterdam*, 30, 341; 1927.
[5] J. A. Prins, *Physica*, 6, 315; 1926.
[6] D. Coster et J. A. Prins, *Jour. de Phys.*, 9, 153; 1928.
[7] Solutions have been studied from another point of view by R. W. G. Wyckoff ("The Structure of Crystals," New York, 383; 1924) and W. H. Keesom (*Proc. Amsterdam*, 30, 341; 1927).
[8] Kindly put at our disposition by Prof. L. Ruzicka in Utrecht.
[9] G. W. Stewart and others, Several articles; *Phys. Rev.*, 31, 32; 1927 and 1928; J. R. Katz, *Chemiker-Ztg.*, 51, 384; 1927.

Population Problems.

THE article by A. M. C.-S. in NATURE of Dec. 29 shows convincingly how urgent are the population problems confronting the British community, and how inadequate is the knowledge at present at our disposal to solve them. These problems are by no means exclusively British, and they are much more acutely realised in many countries than here. It is therefore appropriate that, with the Editor's permission, I should remind readers of NATURE that an organisation has recently been established to deal with precisely such questions as are raised in the article, namely, the "International Union for the Scientific Investigation of Population Problems," with its constituent bodies, the national committees which are now being set up in each of the countries represented in the Union.

I cannot ask for space to describe the plans for developing research, both internationally and within the various national units, from which the founders of the Union, men eminent in many branches of science in many countries, confidently expect a great advance in the elucidation of population problems, and I must confine myself to the question of the financial provision on which the success of their efforts will depend.

Sufficient resources are already in great part assured to the International Union itself, and to certain of the national committees, notably those of the United States and Italy ; but they are at present almost non-existent in the case of the British section. It will not do for Great Britain, with her vast and varied responsibility for human populations, to fall behind in this enterprise, and it is with the object of trying to enlist support for the British National Committee which has been formed under the title of the "British Population Society" in connexion with the Union that I am asking the Editor to publish this appeal.

The only way in which we can hope to raise the very moderate income required for current expenditure is by way of subscriptions both from institutions and from individuals, which we propose to fix at a minimum of £1 per annum, giving the right to attend meetings, receive publications, etc. The primary object of the Society is to focus and co-ordinate research, and we are therefore specially anxious that all institutions of scientific or sociological character, universities, and other learned bodies interested in one or other branch of the population question, should join the new Society. We are encouraged to hope that they may do so by the fact that two or three important institutions of this character have already consented to be represented on the council and to support our work by quite substantial subscriptions, but we should hope that individuals interested or qualified in any particular branch of population research may also be induced to join us. I need scarcely add that if we are to take a worthy share in assisting and promoting research, both by the Union and at home, much more will be needed, but for this we shall have to look in the future to the generosity of donors inspired by a conviction of the great importance of this work to the welfare of human population.

The original members of the council, which will be added to as time goes on, are Sir William Beveridge, Sir Charles Close, Sir Arthur Keith, Sir Humphry Rolleston, the Dean of St. Paul's, Mr. Maynard Keynes, Capt. Pitt-Rivers, Dr. R. A. Fisher, Dr. David Heron, Mr. M. Pease, and Profs. A. M. Bowley, F. A. E. Crew, A. M. Carr-Saunders, B. Malinowski, J. S. Huxley, and J. W. Gregory.

May I add that I shall be glad to answer any inquiries on the subject either of the International Union or the British Society, and that communications may be addressed either to me as chariman of the council, or the honorary secretary, Mr. Eldon Moore, c/o The Eugenics Society, 20 Grosvenor Gardens, London, S.W.1. BERNARD MALLET.

8 Eccleston Square, S.W.1.

Magnetic Properties in Relation to Chemical Constitution.

THROUGH the kindness of Dr. Kapitza and Dr. Webster, we have had the opportunity of examining in the Cambridge Magnetic Laboratory a number of compounds to which formulæ with single-electron bonds have been assigned. These compounds are of two principal types: (1) *Pervalent salts*, including PCl_5, $SbCl_5$, $SbMe_3Cl_2$, $SbMe_3Br_2$, $SbMe_3I_2$, the α and β forms of $TeMe_2Cl_2$, $TeMe_2Br_2$ and $TeEt_2I_2$, α-$TeMe_2I_2$ and α-$TeMe_2I_4$, and a number of analogous compounds such as PCl_3, $POCl_3$, $AlCl_3$, TlI_3, BiI_3, CsI_3. (2) *Co-ordination compounds*, including the $Li^{\cdot}$, $Be^{\cdot\cdot}$, $Al^{\cdot\cdot\cdot}$, $Co^{\cdot\cdot}$, $Ni^{\cdot\cdot}$, and $Fe^{\cdot\cdot\cdot}$ derivatives of benzoylcamphor. Except in the case of substances containing a metal of the transition series, these compounds have all proved to be diamagnetic. We therefore conclude that all the electrons are magnetically paired, just as they are in compounds in which the valency-electrons are present as pairs of shared electrons or as 'lone pairs' of unshared electrons. The numerical results of these experiments will be published later.

We have also examined some cuprous and mercurous salts for which no magnetic data appear to have been given previously. We find that mercurous chloride and cuprous iodide are both diamagnetic, whereas mercuric chloride is diamagnetic and cupric chloride is strongly paramagnetic. The diamagnetism of mercurous chloride can be accounted for readily, since physico-chemical measurements with dissolved mercurous salts point to the existence of a diatomic ion derived from bivalent mercury, for example, $Hg_2(NO_3)_2 \rightleftharpoons Hg_2^{++} + 2NO_3^-$. Moreover, X-ray analysis of crystals of calomel has disclosed the existence of chain-molecules containing bivalent mercury, as shown by the formula Cl-Hg-Hg-Cl. The metallic atoms in the mercurous salts therefore contain completed shells of 18 unshared *O*-electrons, with an outer shell of 2 or 4 shared electrons, and are diamagnetic like the free metal. On the other hand, the copper atoms in a bivalent cuprous salt would contain an incomplete shell of 17 unshared *M*-electrons, with an outer shell of 2 or 4 shared electrons, and would therefore be paramagnetic like the cupric salts.

The fact that cuprous iodide is diamagnetic, shows that the cuprous salts, unlike the mercurous salts, contain only univalent ions or atoms of the metal. This result also is in agreement with X-ray analysis, which has shown that the structure of cuprous iodide is similar to that of silver iodide, $\overset{+}{Ag}\overset{-}{I}$. Conversely, however, the fact that cupric sulphide, CuS, is diamagnetic like cuprous sulphide, Cu_2S, suggests that it may really be a cuprous disulphide $\overset{+}{Cu}\ \overset{-}{S}\text{-}\overset{-}{S}\ \overset{+}{Cu}$, just as iron pyrites has been shown by X-ray analysis to be a ferrous disulphide, $\overset{++}{Fe}\ \overset{-}{S}\text{-}\overset{-}{S}$. This conclusion can be justified by comparison with the polysulphides of the formula Cu_2S_x; but it is also confirmed by X-ray analysis, which shows that the crystal structure of cupric sulphide is different from, and more complex than, that of all other binary monosulphides.

T. M. LOWRY.
F. L. GILBERT.

University Chemical Laboratory,
Cambridge.

A New Method of Recording Ciliary Movement.

THE rate of vibration of cilia is usually too great to permit of accurate observation with an ordinary microscope unless the light be interrupted at a suitable frequency and for suitable periods of time. If the frequency of vibration be approximately fourteen or more beats per second, the form of each cilium during the two phases of its beat, and the nature of the metachronal waves which pass over the epithelium, can be readily observed by means of a suitable stroboscope. If, however, the frequency of vibration is lower than ten per second, accurate observations of this type are impossible owing to the low intensity of illumination which is necessary to reduce 'flicker' to a convenient level. In such cases permanent records of individual cilia or of the metachronal waves can be made by synchronising, with a variable speed stroboscope, the shutter of an ordinary cinematograph camera; in this way 'slow motion' records of rapidly vibrating cilia can be obtained, and the frequency and velocity of beat can be determined with accuracy.

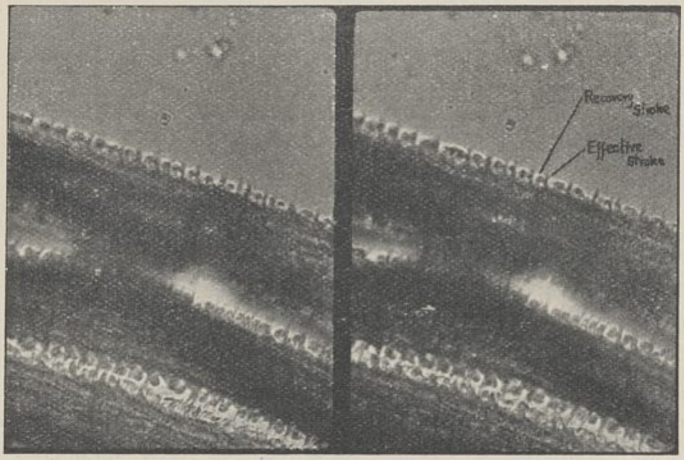

FIG. 1.—Two successive photographs of the metachronal waves passing over a ciliated epithelium. The cilia are seen in side view with their beat at right angles to the plane of the paper. Each wave has two components. (i) The dark finger-like processes representing cilia in the effective phase of their beat. (ii) Semicircular waves outlined by an illuminated edge, representing cilia in the recovery phase of their beat. The waves are travelling from right to left.

The lateral cilia on the gills of *Mytilus edulis* have been examined by these methods. The frequency of vibration of individual cilia varies, in different samples of tissue, from 5 to 16 vibrations per second at 22° C., whilst the metachronal waves move over the epithelium with an average velocity of 100 μ per second. The wave-length of the wave varies with the frequency of its constituent cilia, and the form of the wave may vary from time to time at any given point without interfering with the continuity of the whole wave system.

So far as is known, this constitutes the first successful attempt to establish a permanent record of ciliary activity. With the data thus available it is possible to analyse ciliary movement with accuracy, and we are no longer restricted to observations of the velocity at which particles move over the epithelium or to the behaviour of relatively inactive cilia.

It is interesting to note that the new methods illustrate very clearly the difference in the form of a cilium during the two phases of its beat, and that the nature and propagation of a metachronal wave is closely associated with the individual properties of the constituent cilia and do not appear to be the result of an extraneous timing mechanism. J. GRAY.

Zoological Dept., Columbia University,
New York City.

Horsetail Choking Field Drains.

FIELD drains are commonly blocked by the roots of trees growing in their vicinity. Sycamore, ash, elm, and naturally willow, are offenders in this respect; oak and beech rarely cause such trouble, at any rate in my experience. To find such mischief resulting from the rhizomes (underground stems) of the horsetail (*Equisetum*) was a revelation to me.

A wet patch developed recently in a pasture field here. The drains have just been examined and found to be stopped up in places by the matted rhizomes of *Equisetum*, presumably the common species, *E. arvense*. My man reported the matter to me, and said the stuff he had pulled out of the drain-pipes could not be tree roots, as there were no trees near, and besides the strands were soft and easily broken. He thought they might be the roots of 'sieves'—the local name for rushes (*Juncus communis*)—these weeds being now in evidence on the wet area. I greatly doubted this, and on investigation found the strands to be the underground stems of the horsetail. Hitherto I was unaware that *Equisetum* grew in this field, but my man informs me that it was quite noticeable when the ground was last ploughed towards the end of the War; and evidently it still persists to some extent.

The rhizomes have great penetrating power, for they were found in the pipes at a depth of three and a half feet. In the cuttings made down to the drainage level, the rhizomes can be seen running here and there in the subsoil, but in no great abundance. In the pipes, however, they increase greatly, giving off at each node a number of roots which branch copiously, effectually blocking the drain. The rhizome is about the thickness of a straw and the root much finer. They are both almost black in colour.

Farmers in this district are well acquainted with the plant, knowing it by the name of 'paddock pipes.' It has an evil reputation of scouring cattle.

JOHN PARKIN.

Blaithwaite,
Wigton, Cumberland,
Dec. 11.

Band Spectrum of Chlorine or Hydrogen Chloride.

IN the *Zeitschrift für Physik* for August, Kondratjew and Leipunsky describe the emission spectrum of chlorine heated in a silica tube to about 1000° C. I compared their photograph with one taken by W. West and myself in 1924 of the flame of chlorine burning in hydrogen, which shows a continuous spectrum with a maximum at 480 $\mu\mu$. I could find no record of the brand of plate used, so asked two honours students, Messrs. Reid and Soutar, to obtain a new photograph and compare it with the one obtained by simply heating chlorine. To my surprise a beautifully clear band spectrum was obtained.

The only difference in method I can recollect was that a silica jet was used for the chlorine instead of the platinum jet used in 1924. The continuous light is visible enough using a direct vision spectroscope, but is apparently of much less actinic intensity than the band spectrum in the apparatus now used. The flame is started by a spark from platinum wires connected to a small induction coil; if the sparks are maintained while the photograph is being taken, the continuous emission spectrum at 260 $\mu\mu$ is obtained as well (Fig. 1), ascribed by Oldenberg (rather doubtfully) to the union of Cl^+ and Cl^-. The arrows indicate the approximate positions of the middle band of the new spectrum about 385 $\mu\mu$; about a dozen of these bands can be made out on the photographs, the interval being about 10 $\mu\mu$; they fade off in intensity about equally on either side of the brightest band, but on the ultra-violet side they begin to exhibit a structure, which, however, cannot be studied with the low dispersion at our disposal.

The new spectrum appears to resemble somewhat, but not to be identical with, one described by L. and E.

FIG. 1.

Bloch (*Comptes rendus*, **184**, 744; 1927) obtained by passing an oscillatory electrodeless discharge through a tube containing sodium chloride.

The explanation first considered was that the heat of the flame produces chlorine atoms inside the zone of combustion and hydrogen atoms outside. The union of these atoms produces sufficient energy to give rise to radiation in the ultra-violet region, and if this is absorbed by the chlorine molecule might give rise to a resonance spectrum. But the bands are produced in the outer zone of the flame, which points to the molecule of hydrogen chloride as the emitter. The fine structure is being examined with the help of Prof. Curtis of Newcastle.

E. B. LUDLAM.

University Chemical Laboratory,
Edinburgh.

Changes in Nitrocellulose when Exposed to Light.

LORD RAYLEIGH mentions (NATURE, Oct. 27) that celluloid containing malachite green changes to a red colour when exposed to sunlight. He rightly remarks that this change is caused by the nitrocellulose and not by the camphor present in the celluloid. Bertholet and Gaudechon (*C.R.* **153**, p. 1220; 1911) found that oxides of nitrogen are liberated when nitrocellulose is exposed to ultra-violet light. It has also been known for some time that 'solarised' nitrocellulose becomes acid.

The production of the deep red colour is apparently due to the nitrogen oxides liberated, since it can be shown that malachite green (= Victoria green) acquires a deep red coloration with nitrous acid. Nitric acid produces a greenish-yellow colour in dilute solutions. Both colours fade on standing.

It may be of interest to mention that the wavelength most effective (per quantum absorbed) in causing acid decomposition of nitrocellulose is about $\lambda = 3100$ A., and does *not* correspond to the greatest absorption power of nitrocellulose. A more detailed account of the photochemical decomposition of nitrocellulose was given in a recent paper by DeVore, Pfund, and Cofman at the last meeting of the American Chemical Society, and will be published in the near future.

V. COFMAN.
H. B. DEVORE.

E. I. Du Pont de Nemours and Company,
Experimental Station, Wilmington, Del.,
Dec. 5.

The Average Life Period of an Atom.

THE unwary reader of Dr. J. H. J. Poole's letter (NATURE, Dec. 22, 1928, p. 960) would not gather that I had suggested any explanation of the heat conducted out of the earth that is not of radioactive origin. On the theory I have given at various times it is original heat, a relic of the earth's primitive fluid state. When Dr. Poole says, "We can only attribute the remaining 13 per cent to the apparently stable elements," he indicates that he has not read the theory that he appears to be quoting. Allowance for heat due to other sub-atomic changes would decrease the amount due to radioactivity more than that due to original heat.

Dr. Poole also says that "it is only by assuming a rather arbitrary distribution of radioactivity with depth that we can ensure that the earth as a whole is cooling." The upward concentration of radioactive matter is not assumed in order to ensure that the earth as a whole is cooling, but in order to co-ordinate the facts of the temperature gradient in the earth's crust, the radioactivity of surface rocks, and the law of heat conduction. When this is done, the cooling of the earth follows as a consequence: it is not a hypothesis. The alternative hypothesis mentioned by Dr. Poole begins by rejecting the law of heat conduction.

HAROLD JEFFREYS.

St. John's College,
Cambridge.

Ultra-Violet Raman Spectrum of Water.

So far, the study of the Raman effect has been confined to the visible region of the spectrum only. By the use of an all-quartz apparatus similar to that of glass used by Prof. Wood (*Phil. Mag.*, Oct. 1928), I was able to obtain the effect in the ultra-violet region for water in two hours. Fig. 1 shows that for every bright line in the mercury arc spectrum, there is a

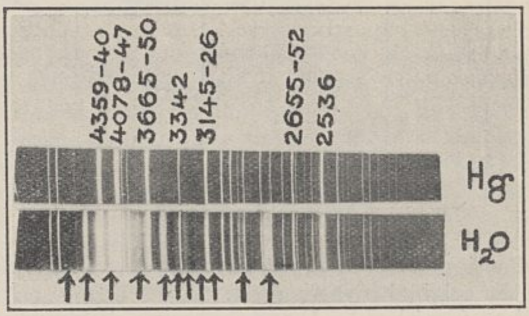

FIG. 1.

Raman band in the spectrum of the light scattered by water. There are altogether eleven bands clearly noticeable in the spectrum, which are marked with arrows. Measurements of the wave-lengths of these Raman bands have shown that water has an absorption band at $2{\cdot}97 \pm 0{\cdot}05\ \mu$, in close agreement with the values ranging from $2{\cdot}95\ \mu$ to $3{\cdot}06\ \mu$ from previous infra-red absorption measurements.

I. RAMAKRISHNA RAO.

Wheatstone Laboratory,
King's College,
Dec. 10.

Repetition of the Michelson-Morley Experiment.

By Prof. A. A. Michelson, For. Mem. R.S. (Research Associate, Carnegie Institution), Dr. F. G. Pease, and F. Pearson.

This investigation was undertaken with the view of making a more accurate test than had hitherto been obtained, and may be divided into three parts as follows :

The first preliminary observations were begun in June 1926. The principle employed was not essentially different from that in the original Michelson-Morley experiment, with the exception that in this investigation the observer was mounted on the apparatus, revolving with it while making observations. Several hundred observations were made, all indicating the same negative result as was obtained in the original investigation. According to calculations furnished by Dr. Strömberg, a displacement of 0·017 of the distance between fringes should have been observed at the proper sidereal times. No displacement of this order was observed.

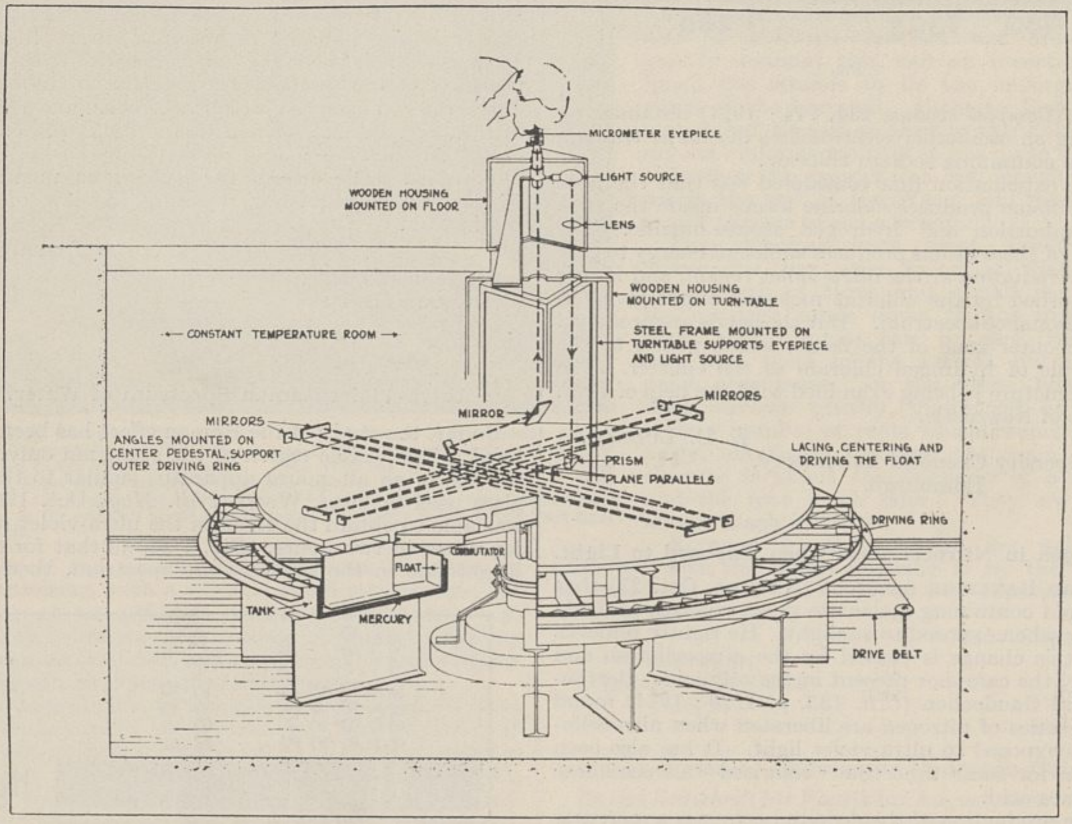

Fig. 1.

The second preliminary investigation was begun in the autumn of 1927. In this, the optical parts were supported on a heavy disc of cast iron, floating on a circular mercury trough as in the original experiments. The chief modification, however, consisted in the fact that the light source was placed vertically over the centre of the revolving disc and rotated with it. The return image, by a simple system of reflections, was rendered stationary, thus avoiding the necessity of mounting the observer on the apparatus. The stationary interferometer fringes could therefore be measured in the usual way by means of a micrometer eye-piece, the observer being at rest above the centre of the rotating disc. The length of the light path in this experiment was fifty-three feet.

In consequence of inadequate temperature provision (and probably unsymmetrical strains in the apparatus) the results, while not so consistent as could be desired, still show clearly that no displacement of the order anticipated was obtained.

In the final series of experiments, the apparatus was transferred to a well-sheltered basement room of the Mount Wilson Laboratory. The length of the light path was increased to eighty-five feet, and the results showed that the precautions taken to eliminate effects of temperature and flexure disturbances were effective. The results gave no displacement as great as one-fifteenth of that to be expected on the supposition of an effect due to a motion of the solar system of three hundred kilometres per second.

These results are differences between the displacements observed at maximum and minimum at sidereal times, the directions corresponding to Dr. Strömberg's calculations of the supposed velocity of the solar system. A supplementary series of observations made in directions half-way between gave similar results.

Progress of the Great Barrier Reef Expedition.

By Dr. C. M. YONGE, Balfour Student, University of Cambridge.

AFTER four months at its headquarters on Low Island, forty miles north-north-east of Cairns, North Queensland, the expedition is now (Nov. 21) well advanced with its extensive programme of research. Excellent living accommodation, and what is in effect a well-equipped marine laboratory, have been erected and fully established. The island has been well chosen as the site of work. Situated midway between the Barrier and the mainland, here only fourteen miles apart, it possesses a fauna characteristic of both these regions ; there is a mangrove swamp with the usual associated fauna and flora, while, exposed on the reef flat at low tides and all around the island beneath low water, there is an abundant growth of corals comprising many genera. There is thus ample material for experimental and observational work, while the island is so small—although thoroughly characteristic of the inner islands or ' cays ' which are numerous in the northern portions of the Barrier — that a very detailed ecological survey is possible. The ecological work has been greatly helped by the preparation of a mosaic of the island from a complete series of aerial photographs taken at a height of 2000 feet over the island and reef by an amphibian flying boat belonging to the Royal Australian Air Force. The services of this machine were kindly provided by the Ministry of Defence.

Plankton and hydrographic stations have been taken weekly within the Barrier, at a position three miles east of the island. This work, under the entire charge of Mr. F. S. Russell, who is assisted in his work on zooplankton by Mr. J. S. Colman, is carried out in the *Luana*, a ketch-rigged yacht with a powerful motor, the property of Mr. A. C. Wishart of Brisbane, who is personally in charge of her and is assisted by Mr. C. Vidgen, also of Brisbane. Half-hour oblique hauls are made with the stramin and the coarse and fine silk tow-nets, while vertical hauls are made with the Nansen net. Two similar stations have been taken outside the Barrier, but work there is dependent on the weather; on one occasion a powerful motor launch was hired from Cairns and deep ocean water (150-400 fathoms) was visited. Weekly plankton samples are also taken over the Low Island Reef. A series of hauls, taken in daylight to study the vertical distribution of the zooplankton, showed that, while the surface layers were avoided by most species, there was already a marked increase at 9 metres, the total number of animals rising from 2035 at the surface to 67,822 at 11 metres. A station has also been taken at night to study diurnal changes in distribution.

To date, there have been fluctuations in the zooplankton, but no great changes such as are experienced in temperate waters. It must be remembered, however, that seasons here are far less marked. Similar work on phytoplankton has been carried out by Miss S. M. Marshall, samples of sea water being taken at various depths by means of the water bottle, while vertical hauls with the Apstein net have been taken to compare with work elsewhere. Here, again, the results so far show no startling variations, and the numbers, as compared with British waters, are low. The reason for this paucity in the phytoplankton is revealed by the results of the chemical and hydrographic work carried out by Mr. A. P. Orr. Nutrient salts have been consistently low at all depths, although pH value and oxygen saturation have shown a slight rise throughout since the work was commenced.

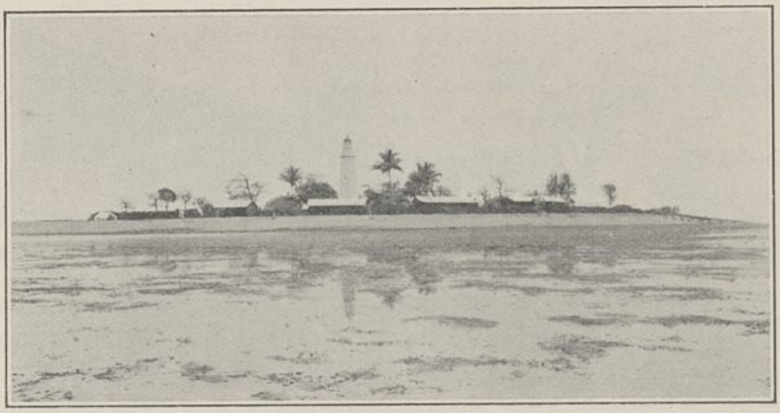

FIG. 1.—View of Low Island from south, taken at low tide. Four huts belonging to expedition are seen immediately behind the beach.

There has also been a gradual rise in temperature and salinity. Outside the Barrier similar results have been found for the upper layers, but, instead of mixing taking place throughout as in the inner station (32 metres), there is a well-marked discontinuity layer between 50 and 100 metres over the 100 fathom line. Temperature, pH value, and oxygen saturation all show a marked fall below 50 metres, but nutrient salts are present in appreciable amounts. Farther out, in deeper water, about 400 fathoms, this was still more marked, at 500 metres the phosphate content being 42 mgm. per cubic metre as compared with between 5 mgm. and 10 mgm. above 50 metres.

A series of samples taken at frequent intervals over a twenty-four hour period from over the reef flat, where there is much living coral, have yielded results of great interest. As soon as the tide leaves the flat at night, there is a rapid fall in pH value and in oxygen saturation, the latter dropping so low as 25 per cent. Open sea conditions are quickly restored when the tide returns. During the day, both pH value and oxygen saturation rise considerably in the pools left by the tide, open sea conditions again prevailing after the tide has risen. When left by the tide, the temperature of the coral pools rises considerably by day and falls by night, the salinity rising slightly by night and more by day. At a depth of two fathoms in the lagoon among rich coral, the tide has little effect, and the changes are related to light and darkness chiefly.

The work of the reef party under Dr. Stephenson has been varied. He has spent the majority of the first three months in the preparation of an elaborate experiment on the growth rate of corals. One hundred square blocks of concrete have been made, and to each has been fixed one or more living corals of many different genera. The blocks, after being photographed with the corals *in situ* by means of an apparatus which ensures that they can be photographed later at exactly the same angle and distance, have been spiked down firmly in two specially chosen areas. To test the effect of different environments on growth, ten further blocks have been provided with the halves of divided colonies and the halves planted out in different habitats. Dr. Stephenson has examined at regular intervals the gonads of the corals *Favia*, *Symphyllia*, and *Lobophyllia*. All are hermaphrodite, and at present have well-developed ova and less-developed testes. Weekly gonad samples of eight common reef animals, and examinations of the spawn and breeding habits of reef animals, have been made by Mrs. Stephenson. It is interesting to record that the common chiton (*Acanthozostera gemmata*) has twice spawned on the night of full moon. Mr. F. W. Moorhouse, of the University of Queensland, has assisted Dr. Stephenson, and has also carried out intensive work on two species of oyster, two of bêche-de-mer, and on the commercial *Trochus* (*Trochus niloticus*). He is making regular gonad samples of all, while the last named is being farmed for observations on the growth rate, which is remarkably rapid. He is also working on a commercial sponge of fair quality common on this and neighbouring reefs.

FIG. 2.—Outside of laboratory on Low Island.

Mr. G. Tandy, the botanist, has collaborated with the other members of the reef party in the general ecological survey now being carried out, and has also done extensive collecting of marine algæ. He has studied in the greatest detail possible the conditions of plant life on the Low Island Reef, illustrating this with as complete a series of photographs as possible. He has also collected some data on the rate of growth of algæ. There is no *Lithothamnion* reef here or in the neighbourhood, but the ubiquity of encrusting corallines is extraordinary, especially on the lower branches of the common staghorn coral.

While the time of the leader of the expedition has been chiefly occupied with details of administration and matters concerning its efficient running, a good beginning has been made on the intensive study of the feeding mechanisms of corals. The extent to which even corals with the least developed polyps can capture actively swimming planktonic organisms of frequently relatively enormous size is remarkable, while the reversal of the direction of ciliary beat appears to be undoubtedly of common occurrence in corals. Symbiotic algæ in vast numbers have been found in every individual of every genus examined. It is hoped to extend our knowledge of the function of these in the metabolism of the corals. They certainly produce an abundant supply of oxygen; elaborate experiments in which cleaned coral colonies in sealed glass jars have been placed in the sea for periods of nine hours, first in the light and then in the dark, have shown that, whereas in the light the oxygen content of the water may increase by so much as 100 per cent, in the darkness it may decrease almost to zero. The phosphate content decreases to zero usually under both conditions, protein metabolism not being dependent on light. The oxygen and phosphate determinations have been carried out with great accuracy by Mrs. Yonge.

The extent to which the corals with their symbiotic algæ form a closed cycle is revealed by the fact that corals have been kept in sealed glass jars for fourteen days in the sea and have not only lived but the water in some of the jars also contained a higher percentage of oxygen than at the beginning of the experiment. Investigations are proceeding into the part played by the algæ which crowd the exposed mantle surface of the giant clams *Tridacna* and *Hippopus* in the metabolism of these animals.

The effect of starvation and deprivation of light upon the corals and their contained algæ is being studied in the small aquarium attached to the laboratory, a special apparatus having been constructed for this purpose. Investigations of the digestive enzymes of corals show that corals are

(*Continued on p.* 99.)

Supplement to NATURE

No. 3090 JANUARY 19, 1929

The Transition from Live to Dead: the Nature of Filtrable Viruses.[1]

By Prof. A. E. BOYCOTT, F.R.S.,
Graham Professor of Pathology in the University of London.

RUTHERFORD was an example of the danger and folly of cultivating thoughts and reading books to which he was not equal. It is all very well that remarkable persons should occupy themselves with exalted subjects which are out of the ordinary road, but we who are not remarkable make a very great mistake if we have anything to do with them. —W. HALE WHITE, preface to the second edition of "The Autobiography of Mark Rutherford."

I do not propose to enter at length on the old controversy between vitalism and mechanism. Pathologists might with advantage have taken a greater share in it than they have, for it would take a hardened mechanician to maintain his faith in face of our daily experience of repair adaptation and all the other purposive compensations for injury of which the body is so abundantly capable. Unfortunately, our facts have not been widely known to those who have felt inclined to discuss the question. So far as I can see, the attempt to 'explain life by chemistry and physics' has completely failed. It was thought at one time that if only the microscope could be made to magnify enough, we should see life going on. Hope was then transferred to biochemistry, which has done just what the microscope did—it has helped us enormously to understand the mechanisms of live things and not at all to explain life. But if vitalism has had the best of the argument, it has not led to a very profitable or a very satisfactory position. Vitalism is often mysticism, and (which is why mechanism has been so popular) any dualistic interpretation of the world is always repugnant to natural human instincts.

It is possible to escape dualism in another way, and I suggest that the vitalistic controversy in anything like the form it has taken during the last forty years is out-of-date, that instead of emphasising the differences between live and dead things we should make as much as we can of their similarities, and that instead of dividing the world into two distinct categories we should regard it as being made up of one series of units with properties which differ more in degree than in kind. This is not the mechanistic view, for we come to it, not by explaining live things by dead things, but by realising that the characteristics of live organisms appear also in dead matter. While we have been waiting for life to be explained in terms of chemistry and physics, a good deal has been done towards stating chemistry and physics in terms of life. Of course, no 'explanation' of either live or dead has been given; the behaviour of an atom is just as mysterious as the behaviour of a wasp, and neither 'explains' the other any more than a trypanosome explains a whale. But it is something of a comfort if we can believe that at bottom they both behave in much the same way.

ATOMS AND ORGANISMS.

Picking up such rumours as he might of what is going on in other lines than his own, every biologist must have been struck by the curious familiarity of several of the conceptions which in this century have gone to start the revolution in atomic physics which has pulled the universe in pieces and has perhaps not yet quite succeeded in putting it together again. The ideas are familiar because they were originally biological—derived from the study of live things and applied to their explanation. Let me illustrate what I mean by some examples.

(*a*) It is one of the characteristics of life that it is exhibited by discrete units which we know as organisms. As Powell White says, there is no such thing as living matter, there are only live organisms, and in so far as they are alive 0·1 cow or 1·35 cabbage are impossibilities. The live world is made up of such discontinuous pieces: so, we now learn, is the dead world. Fractional atomic numbers are as impossible as fractional animals: the quantum theory tells us that energy is also parcelled out in bits; light consists of particles and, though the ether dies hard, the belief that there is anywhere a continuum—something without a grained structure—has been almost entirely abandoned. Discontinuities—in the

[1] Abridged and revised from the presidential address to the Section of Pathology of the Royal Society of Medicine, delivered on Oct. 16, 1928.

structure of atoms and in the sizes of the stars—are now as characteristic of the dead world as of the live.

(*b*) When Rutherford and Soddy made people believe that one element really could be derived from another, they did for dead things what Darwin had done for live things : indeed they did rather more, for they backed their proposal with experimental proof which neither Darwin nor anyone else had produced in the biological sphere. Now, neglecting the time factor, chemical elements are not necessarily more stable than zoological species. For practical purposes lead is lead and a dog is a dog, but now we have to apply to both the reservation that they have not always been so, and cannot be trusted to be so indefinitely in the future.

The disintegration of the radioactive elements takes place automatically : it cannot be started, stopped, controlled, or modified : its progress is simply a question of the lapse of time. The modes by which organic evolution has been supposed to take place are beyond our discussion, but it is not impossible that it follows the same plan. Osborn and other experts hold that the course of any evolutionary sequence of animals is predetermined from the beginning : this ' orthogenesis ' may be interfered with by circumstances and opportunities, for live organisms are obviously liable to meet conditions in this world which they cannot resist, and which may deflect them from a predestined track or bring them to an end altogether : dead elements meet their difficulties elsewhere in the universe.

(*c*) The classification of the elements which has developed by this evolutionary process recalls the familiar schemes of botanists and zoologists which show at once the affinities of animals and plants to one another and (though here there is of course a certain amount of guess work) their phylogenetic relationships. Animals were originally classified by characters which we now believe to be largely immaterial—whales were fishes and bats birds. About 150 years ago comparative anatomy began to get them into more natural groups, and evolution added the criterion of descent in determining the system which prevails at present.

Much the same has happened in classifying the elements into something better than a series of arbitrary pigeon-holes. Their discovery was the first step, much more difficult than the apprehension of animal species. The progress of chemistry then showed that they fell into groups akin to vital genera or families or phyla (we cannot guess at what level the analogy is closest), and the discovery of inorganic evolution and isotopes has brought their relationships to a suggestively biological position. Atomic weights are no longer of any great importance : what matters in classifying an element is its atomic number, which determines its position in the periodic table and is a summary of its comparative anatomy and a clue to its history. An element, for example lead, may arise by more than one line of descent, which is what a biologist would call 'evolution by convergence.' The isotopes into which Aston has dissected many of the elements correspond to the groups of closely allied species which embarrass the systematist and with which bacteriologists are familiar enough.

(*d*) If a man and a bicycle are smashed up together in a common catastrophe, the man mends himself, the bicycle does not. This capacity of self-repair is one of the greatest characteristics of live organisms : indeed, if one wishes to define shortly the subject matter of pathology, I doubt if one can do it better than by saying that it is the study of how organisms resist and repair injury. In the larger, more complicated animals we find very highly developed a capacity for individual repair which we see daily in the post-mortem room and experience continually in our own persons : it is so common that we are not impressed by it as much as we should be. Simpler things, such as bacteria, have little power of personal repair, but they achieve the same ends by other means, and owing to their numerical abundance and their high capacity for reproduction they can allow the injured individual to perish and readily replace him with a new one. Individually or racially, therefore, organisms repair themselves.

Atoms seem to be able to do the same. Each has a definite structure according to its species : as nucleus there are so many hydrogen atoms with their attendant electrons and outside are so many planetary electrons. Electrons are continually being detached from atoms by various means, for example, whenever electrical energy is manifested. Presumably an atom of, say, iron which has lost an electron is no longer of its normal nature and substance, and such a process would in the end lead to the iron becoming manifestly something which was not iron unless some restorative process was at work. It seems clear that injured atoms must be able to pick up electrons from somewhere to replace those which have been lost, a method of individual repair which appears to be efficient enough.

(*e*) Another of the great characteristics of live things is their variability. Any measurable quantity of any organism varies, and the values are distributed in some mode akin to the normal curve. Crookes suggested long ago that atoms vary in a similar way, Karl Pearson has imagined a world where contingency replaces cause and effect, and Donnan has emphasised that our chemical and physical constants are statistical, derived from the measurement of an infinite number of individuals, and summarising, perhaps, the average values of a variable population: but whether atoms and molecules vary like organisms we do not know—nor is it easy to imagine how we could find out.

(*f*) Cane-sugar boiled with dilute hydrochloric acid is progressively hydrolysed until practically none of it is left. Analysis of the course of the reaction shows that (say) one-fifth of the original quantity is decomposed in the first five minutes, one-fifth of what remains in the next five minutes, one-fifth of what remains in the next five minutes, and so on until the amount left is inappreciable. This strange behaviour is accounted for by assuming that the molecules of cane-sugar go through some sort of regular rhythmical change, so that at any moment only a certain proportion of them are susceptible to the action of the water at the instigation of the acid: there is, I believe, no other justification for the assumption than that it fits the facts, and it cannot fail to remind us of the rhythmical alternations of rest and activity which are common, perhaps universal, in live organisms.

If, as Chick has shown, bacteria sometimes succumb to heat or disinfectants on the same kind of plan, it is legitimate to say that they behave like the molecules of cane-sugar. But it is equally correct to say that the molecules of cane-sugar behave like bacteria. We cannot tell which is imitating the other: all we see is that the behaviour of both is similar. The conduct of the bacilli could scarcely have been predicted from a knowledge of what happened to the cane-sugar. The natural supposition would have been that the molecules of which each bacillus was made up would have been destroyed logarithmically, so that the death point of all the bacilli would have been reached simultaneously—a reflection which illustrates particularly clearly the considerable truth that the discrete unit which is comparable with the molecule of cane-sugar is the whole bacillus and not one of its constituent molecules.

Reproduction.

These analogies between atoms and organisms are suggestive to an imagination which is not afraid to have its wilder moments. There are two general objections which will probably occur at once to most biologists: (1) that dead elements do not show the multiplying reproduction characteristic of organisms; (2) that organic evolution, on the whole, progresses from the simple towards the complex, whereas what I have called the evolution of the elements proceeds uniformly in the opposite direction. The two difficulties are rather closely related.

Organic reproduction does two things: it produces a fresh version of the old organism and it gives an opportunity for numerical increase: its final effect is to leave organisms very much where they were. Each foxglove plant in my garden goes to immense trouble to produce about 500,000 seeds, and the wasps toil earnestly all the summer to increase from one to about 1000. But next year there will be just about as many wasps' nests as this and just about as many self-sown foxglove plants. Darwin taught us the qualitative importance of this superabundance, but, quantitatively, it is made use of only if conditions alter: it then enables organisms to fill up any gap in the environment.

There may be a tendency for a few large organisms to be replaced by many small ones, but on the whole the capacity for reproduction does not result in more organisms than there were before: it merely enables them to adapt themselves to varying conditions. If organisms were less complicated, more stable and enduring, less easily injured and less susceptible to their environment, reproduction might be a less important feature of their activities: an elephant does not bother about it until it is forty years old or thereabouts, a bacillus does it at an age of about twenty-five minutes.

With increasing complexity we get diminishing stability, which is presumably why there is no known element with a more elaborate structure than uranium. Units which are more complex cannot maintain themselves without the periodical remaking which we call reproduction: those which are less complex do not reproduce, because they have no need to do so.

There is no reason to suppose that anything so like organisms as to deserve the same name exists anywhere in the universe except on the earth. But we cannot confine our speculations about dead things within the same limits. The stars are made of much the same elements as the earth, and material transfers take place in both directions: meteorites come and nearly all the hydrogen and methane which arises from the decomposition of cellulose by bacteria and *Streptothrix* flies off to celestial bodies which are dense enough to secure its permanent adherence. The relevant habitat of the elements is therefore the universe and, taking this into consideration, it is not altogether clear that something like reproduction does not go on in dead things.

Though the elements seem inert and stable enough here and nothing much happens to them except the slow decomposition of those which are, in our environment, radioactive, in the immense heat of the stars atoms not only come to pieces and are dissociated into protons and electrons, but also their basic structure is destroyed, positive and negative electrons fall into one another, and matter is converted into radiation. In the heavens the elements disintegrate more completely than a dead cat does on earth, and unless there is somewhere some reconstruction the cosmos is coming to a material end. Lodge and Millikan think that in the depths of interstellar space, under conditions of intense cold, energy may once again become matter, radiation be reconverted into electrons which in their turn are recombined again into atoms, and so the various elements are reproduced ; Jeans doubts any such regeneration.

The duty of a pathologist does not call upon him to interpose his private judgment in so nice and important a controversy, and it would be impudent to say more than that some such process would enable us to have a comfortable faith in the maintenance of the material universe.

If the elements do go through such a cycle, it is possible that what we call their ' evolution ' is more analogous to the death and reproduction of organisms than to the progressive appearance of more complex forms. Very little of the cycle takes place in our own particular corner of the universe, to which the organismal cycle is limited, and it is conditioned by very different circumstances of time and space, but it has much the same result in that it leaves things where they were.

Such are some of the ideas familiar in biology which have appeared in the explanations of our experience of what is not alive. They lead to no certain conclusion ; they furnish, however, an assemblage of concurring and converging probabilities which encourage one to think it possible that things which are alive and things which are not alive constitute in effect one series, beginning with hydrogen atoms and reaching up to man, and perhaps on to angels, not arranged in a continuous linear succession but on a scheme resembling the phylogenetic line of the animal kingdom. The units (or ' wholes ' as Smuts would call them) which make up the series are of progressively increasing complexity, structural and functional, and must be compared against one another as they stand, irrespective of their composition. A hydrogen atom, a molecule of albumin, a bacillus, a dog are comparable as such, and it is not necessarily of any moment that hydrogen is the basic stuff of all matter, that proteids are essentials of all live organisms, or that a mammal is made up of many bits, each of which is more or less like a unicellular organism ; in no case is the behaviour of the more complex whole simply the sum of the behaviour of its constituents.

Such a view satisfies our natural antipathy to a dualistic explanation of the universe and makes the old controversy about vitalism and mechanism largely unnecessary.[2] It tells us nothing about the nature of life ; by indicating that organisms are analogous to elements, it encourages us to think of life as being as insoluble as gravitation, give up the attempt to make out what it is, and, as Lovatt Evans recommends, spend our time more fruitfully in studying its phenomena. If we like to be paradoxical, we can say that live things are dead, or if we prefer it, that dead things are alive. Both at bottom have much the same characters, and it is unlikely that any sharp distinction between them can be drawn.

Filterable Viruses.

Our general notion of the structure of the universe leads us therefore to expect that we might well meet with things which are not so live as a sunflower and not so dead as a brick, and the phenomena which we study under the heading ' filtrable viruses '[3] suggest that we now have sight of some of this intermediate group. The fluid from a blister in labial herpes, the spleen of a dog with distemper, the blood of a human case of measles or yellow fever, the juice of a tomato plant with mosaic disease, the body fluids of a caterpillar with polyhedral disease, all contain a something which will pass through a fine-grained porcelain filter, is invisible, is destroyed by boiling or strong antiseptics, and will in each case reproduce the disease from which it was derived when it is inoculated into a susceptible animal or plant. Smallpox, vaccinia, rabies, infantile paralysis, foot-and-mouth disease, hog cholera, fowl-pox, and other diseases show the same phenomenon. The bacteriophage is a similar something which dissolves the bacteria with which it is associated : the Rous cancer in fowls yields another invisible agent which will reproduce the same tumour in other fowls.

[2] See J. Needham, *Jour. Philosoph. Studies*, 1928, vol. 3, p. 29.

[3] For a recent survey, including bacteriophage, see "Filterable Viruses," edited by T. M. Rivers (1928) ; for the Rous virus, *Cancer Review, passim.* As Rivers points out, *filterable* for *filtrable* seems to be unauthorised ; on the horrid plural *viruses* see S.P.E. Tract, xix. (1925), p. 36.

If we put the question, Is such-and-such a virus alive or dead ? in the belief that we are asking a crucial question to which there is a definite obtainable answer which would solve our troubles, we put up one of those false antitheses which so often lead us astray. The difficulty in most scientific work lies in framing the questions rather than in finding the answers, and by the time we are in a position to know what the crucial question really is, we have generally pretty well got the answer. In this case 'live or dead' is a stupid question because it does not exhaust the possibilities. Let us see how far viruses conform with what are, in ordinary language, admittably 'live' and 'dead.'

Size.—There is no mammal, fish, mollusc, or insect which is not perceptible bare eye any more than there is any bacillus which can be seen without a magnifying glass. It is also in a general way true that there is nothing with the properties which we commonly associate with bacteria which is not at some stage in its life visible with the highest powers of the ordinary microscope.

The rules seem strangely anthropomorphic. Viruses are at or below the limits of microscopic vision (0·2 μ), though just how small they are it is impossible to say. In some phases some of them verge on visibility. They must be ultimately particulate because all matter is so arranged, and from the readiness with which they are adsorbed on to appropriate surfaces the particles are presumably much larger than the molecules of simple salts. Passage through filters with pores of different sizes turns out to be a complicated and dubious method of measurement, and the effects of centrifugalisation may depend more on the specific gravity than the size of the particles : it is possible to concentrate solutions of hæmoglobin in the centrifuge. Taking one thing with another, and reckoning that some viruses are doubtless larger than others, an average diameter of about 25 $\mu\mu$ (0·025 μ) for the smaller ones seems a reasonable assumption, about $\frac{1}{10}$ the diameter of the smallest bacillus, about the same size as the colloidal aggregates of dissolved hæmoglobin and with room for 200 to 400 proteid molecules.

Composition.—A diameter of 0·025 μ does not give much room or many facilities for complicated vital actions. We do not know what occupies that tiny bulk ; we do not even know that viruses are mainly proteid. There would be room for a larger number of simpler molecules, though it is doubtful whether in any simulacrum of life this would compensate for the absence of the unique combination of chemical flexibility and physical stability which proteids possess and without which, so far as we know, 'life' does not exist. The antigenic quality of viruses (*i.e.* their power to stimulate animals to produce antibodies) is our only evidence that they contain proteid : clinically and experimentally they confer an intense and durable resistance to reinfection which is associated with antiviral properties in the blood-serum.

Metabolism.—The attempts which have been made to demonstrate the production of carbon dioxide by viruses have failed, but the quantities involved are small and the technical difficulties large, so that we cannot regard the evidence as conclusive.

Stability and resistance to harmful agents.—Some viruses at any rate can retain their activity *in vitro* for several years. Some bacteriophages endure for a long time in bacteria-free filtrates ; the Rous tumour virus can be kept almost indefinitely in dried tumour tissue. Others are more labile and are difficult to keep over a period of days. There is much the same variability as there is with bacteria and bacterial toxins : viruses as a class are not characteristically unstable, evanescent things.

A good deal has been made from time to time of their resistance to heat and protoplasmic poisons. Here, again, the results are very various and differ with the sort of virus and the conditions of experiment ; there are no general rules. But there are a remarkable number of instances of viruses which have resisted temperatures up to 75° C., and treatment with chloroform, alcohol, ether, toluol, phenol, acids, alkalis, and so forth. As a whole, they are certainly more resistant than vegetative bacteria, but it is not certain that they differ markedly from bacterial spores. In several particulars their resistance recalls that of enzymes. There is nothing in their size *per se* which should protect them.

Capacity for independent life and multiplication.—No virus has ever been found wild, that is, apart from the animal or plant in which it usually operates, and there is no convincing evidence that any virus has grown and multiplied in artificial culture. Living cells are in all cases necessary, which may be supplied by living bacteria, living animals or plants, or tissue cultures. That they really do multiply under these conditions seems beyond question : foot-and-mouth disease can be passed on from one guinea-pig to another *ad infinitum* by filtrates of blister fluid, the bacteriophage can be transferred indefinitely from one culture of bacteria to another, vaccinia from one calf to another, and so on. All the evidence we have is conclusive on that point. Viruses are certainly not enzymes. Apart from living cells they may for a long time survive, that is, remain in such a state that, on altering the conditions, they can give rise to their characteristic effect—vaccinia, a sarcoma, bacteriolysis, etc., but there is no evidence that they multiply, and multiplication at the expense of the environment is probably regarded by most of us as the most important criterion of life. For their multiplication, young growing cells are especially suitable, and it may be quite necessary. The bacteriophage multiplies only with the multiplication of the associated bacteria, and vaccinia, herpes, Rous sarcoma, etc., develop and multiply especially in connexion with the growth of cells which results from local injury. Cell injury and cell growth are so intimately related that I know of no case where cell growth can certainly be excluded, but at present we cannot be quite certain that it is necessary. It seems also to be true that viruses multiply only in the course of the production of their specific effect.

Though the fact of multiplication is plain, it is by no means proved that it is effected in the way which is familiar in bacteria and living organisms generally. We put in so much virus and we get out more : we have no evidence, nor, I think, the right to assume, that the particles which we get out are the direct descendants of those we put in.

It may be that these facts are best explained by supposing that viruses are obligatory intracellular parasites, and that the difficulty of cultivating them on artificial media will be solved when we can imitate sufficiently closely the essential features of the intracellular environment.

The Cancer Agent.

Such an explanation would do quite well for the viruses that accompany infectious diseases and would cover the facts for the bacteriophage. But phenomena are known, surely more or less analogous, which it is scarcely possible to regard as due to parasites of any kind.

There is, for example, the agent which induces cells to become malignant, indicated years ago by Haaland and Russell,[4] when they showed that close contiguity with malignant epithelial cells might cause normal connective tissue to grow into a transplantable sarcoma—one of the great discoveries of pathology. Unless we suppose that tumour cells pervert neighbouring normal cells by argument, persuasion, example, or some other sort of immaterial communication, we naturally assume that some substance passes out from the one to affect the other. All attempts to demonstrate this substance in dead tumour cells or in extracts of them uniformly failed until Rous came across his fowl sarcoma and showed that it could be transmitted indefinitely from bird to bird by dried dead cells or by filtrates which contained nothing that could be seen or cultivated. This particular tumour produces the substance in a form so stable that it can be examined and played with when it is detached from live cells. With most transplantable tumours it is present in such small amounts, or more likely in such a labile unstable form, that its clear demonstration is not possible : the carcinoma-sarcoma experiment comes off only with a minority of mouse carcinomas. Gye has shown that its activity may be modified, enhanced, or depressed by various conditions, which helps to explain the difficulties and apparent inconsistencies which are met with in its experimental investigation.

A fair number of tumours have now been transmitted by filtrates, and there is, I think, no reason to doubt that the production of this carcinogenic substance is a common property of all malignant growths. We believe that all pathogenic bacteria, or at any rate all the larger ones, produce extracellular toxins : there is no other way in which they can injure the tissues. But in many instances they are so unstable that it is difficult or impossible to demonstrate their presence apart from the bodies of the bacilli. Nor should we, I think, be too shy of drawing general conclusions from such specially easy and demonstrative examples as Providence has provided for our learning and pushes under our noses, until even our stupidity is bound to take notice : diphtheria and tetanus for toxins, the guinea-pig's peculiar bronchial musculature for anaphylaxis, mice and tar for tumours, and radium are such sign-posts ; the Rous tumour is another.

Another analogous phenomenon takes us, I think, a step further. The products of autolysis of dead cells in the body, in suitable concentration, stimulate tissue growth. It is a beautiful self-regulating mechanism in which the amount of stimulus is proportionate to the amount of cell destruction, and therefore to the amount of cell growth required, and it is obviously of the highest importance for survival. As it normally operates in healing our cut fingers, the final result is simply the restoration of the cells which were destroyed.

If the normal restraint exercised by neighbouring tissues is evaded and use made of tissue cultures, the products of autolysis or metabolism (in the form of extracts of tissues, tumours or embryos) stimulate growth indefinitely and a much larger

[4] Third Scientific Report of the Imperial Cancer Research Fund, p. 175, 1908 : *Jour. Path. Bact.*, vol. 14, p. 344 ; 1910.

quantity of tissue may be obtained than we started with. From the autolysis of this a larger amount of stimulating substance may be obtained, and there seems no reason why this process of multiplication should have any limit: normal tissues in the physical isolation of tissue cultures are as immortal as malignant tissues in their physiological isolation from the rest of the body.

No one would, I think, pretend that these products of autolysis are alive in any ordinary sense of the word. They have not received nearly so much attention as they deserve, but they are probably of relatively simple and discoverable constitutions. Yet applied to cells they cause growth, and in so doing potentially increase their own quantity; this is very much what the Rous agent does.

If we agree to put the products of autolysis in the category 'dead,' by what difference are we to separate the Rous virus as being 'alive'? It cannot be cultivated apart from live cells; it multiplies only under conditions where its specific activity is displayed; its inactivation by chloroform and other protoplasmic poisons does not take it nearer life than are toxins or enzymes, or indeed simple metallic catalysts; and its retention of activity after the drastic methods of purification recently described by Murphy seems definitely to exclude it from 'live.' As to its origin, all the evidence seems to concur in indicating that the Rous virus arises *de novo* in each tumour. There is no epidemiological evidence that cancer comes into the body from outside; everything we know supports the classical view that it is a local autochthonous disease.

Most of the experimental work with the virus has started with an actual tumour, and it is therefore just possible that an agent might be carried along through the whole series which originated somewhere else than in a tumour. But experimental sarcomas produced by embryo extract and indol, arsenic or tar have been transmitted by filtrates, and if others have failed to reproduce Carrel's results, I would only remark that, in a question like this, one positive experiment is worth more than a great many negative ones. Epitheliomas are easily produced in mice by tar and in men by chronic irritation, and if we believe that all malignant tumours contain more or less of a carcinogenic agent akin to the Rous virus, it follows that we can with a considerable degree of certainty stimulate normal tissues to produce virus. It is therefore not very remarkable that Murphy, Leitch, and Brebner have at any rate occasionally demonstrated a carcinogenic agent in preparations of normal tissues (testes, pancreas, and embryo *plus* placental extract).

Infectious Diseases.

It is difficult to escape the conclusion that the Rous virus arises in the tumour. There is no doubt that it is a means by which a tumour may be experimentally dispersed through any number of available animals, and it is apparently responsible for some at any rate of the metastases which occur in the course of the natural disease. But there is no evidence that such a virus ever naturally causes a fresh tumour, and we learn the important lesson that the means by which a disease is propagated may not be the same as that by which it was originally started.

The chief way in which the virus of, say, foot-and-mouth disease differs from the Rous agent, and, going a step further back, from the products of autolysis (or metabolism) which stimulate growth, is that it seems to spread about fairly easily from one individual to another: chiefly, I think, from the parallel of bacteria, we take this to imply the possibility of independent life and probably independent multiplication. But we have no direct evidence of this: all we know is that, like the Rous agent, it can be deliberately dispersed through any number of individuals indefinitely, and that it multiplies only when and where it produces its specific effect. The blister which is determined on the foot of an inoculated guinea-pig by slight local injury is pre-eminently the place in the body where the virus is found in the largest amount, and, trying to be as open-minded as we can, we must allow that this may be due either to the lesion being produced where the agent is present in greatest quantity, or to the agent being produced in greatest quantity where the lesion is.

Putting aside all bacteriological analogy, we have no proof that the particles of virus which we get out of the lesion are directly descended from those we put in. In other words, we have to reopen the question which most of us regard as settled: Is the agent the cause of the disease or is the disease the cause of the agent? Another stupid antithesis, for the alternatives are not mutually exclusive: both might be true.

It might well be said—and I think with a good deal of justification—that it is contrary to all common sense to suggest seriously that the viruses of diseases like smallpox, measles, or rabies arise anew in each infected person. It may indeed be nonsense. It is evidently more conformable with our general experience and with the epidemiological dogma to which we subscribe to lay stress on the definite way in which each case can be traced to a preceding case, and that to another, and so on, explaining such examples of apparently spontaneous origin as we meet with by carriers (who harbour the virus without showing any symptoms) and the imperfections of our data rather than by the concurrence of a favourable epidemic constitution of the atmosphere. With that point of view I quite agree : the evidence that in an epidemic something is passed on from one case to the next seems extremely strong. But at the same time I cannot altogether get rid of the uneasy suspicions which intrude when I think of, say, foot-and-mouth disease, distemper, or labial herpes.

Distemper seems to be everywhere where there are susceptible animals, and if the stock of dogs at Mill Hill can be kept free from it indefinitely, it will be a point of much more than technical interest. As to foot-and-mouth disease, in which no material connexion between one outbreak and another can be discovered, I think that the unbiassed man in the street would say that the facts showed either that the virus was universally dispersed, possibly in some common animal (such as the hedgehog [5]) other than the cow, or that the disease was continually beginning afresh. Labial herpes seems in much the same position. Epidemics may be found by ransacking the literature, but they are certainly not common. Not only has herpes no connexion with itself but also it has a definite association with other diseases —pneumonia and severe catarrhs.

I daresay, however, that some simple explanation will be found for these epidemiological difficulties, and that any suspicions that we may have about the origin of these viruses will be allayed. Viruses can remain dormant in live animals for a long time, and carriers might be activated by a variety of incidents. But what are we to make of such a phenomenon as virus III ? Virus III is made manifest by inoculating a filtrate of an emulsion of a rabbit's testis into the testis of another rabbit. This procedure is sometimes followed by an inflammatory reaction and the production of intranuclear ' bodies,' and if this inflamed testis is emulsified and the filtrate inoculated into another fresh rabbit the inflammatory condition is reproduced : thereafter the ' disease ' can be carried on indefinitely. It is not fatal, and after its attack has subsided, a rabbit is refractory to further inoculations and his blood-serum can prevent infection with active virus.

[5] Mr. Charles Oldham tells me that at the end of the eighteenth and beginning of the nineteenth century churchwardens in Hertfordshire put as high a price (4*d.*) on the head of a hedgehog as on that of a polecat. ' Urchins ' were supposed to do something to cows which diminished the yield of milk, and this was translated into a belief, still extant, that they sucked the cow's udders when they were lying down. Such expenses were not lightly incurred in those days.

If we knew nothing of bacteriology, should we not conclude that this virus had been generated by our procedures from the tissues of the normal testis ? The only evidence to the contrary is analogy, and the slender fact that the phenomenon happens more easily in New York than in London rabbits. I do not know how many people have tried similar experiments with other apparently normal tissues : if they had been positive we should certainly have heard about them ; Leitch's, Brebner's, and Murphy's successes with sarcoma have already been mentioned and bacteriolysins transmissible in series have been extracted from normal organs.

Whatever filtrable virus we think of, we meet with the same difficulties. A good many people are willing to believe that the bacteriophage is generated by its bacillus—which is probably the truth. They would explain the way in which each bacteriophage more or less fits its own bacillus by its having originated from that bacillus. Others see in their multiplicity evidence that bacteriophages are really live organisms with the characteristic variability and adaptability. It is perhaps more than a coincidence that it is in another group of plants that the same difficulty has arisen : the agents of plant mosaic diseases have never been found apart from affected plants ; they have not been cultivated ; no one can be sure whether there is one virus or many viruses.

If viruses do originate in tissue cells, what are we to imagine that they are ? Béchamp's ghost would answer ' microzymes, as I told you seventy years ago.' Altmann would say bioblasts, others micellæ and even mitochondria, and all the people who have imagined that cells are made up of much smaller essential elementary live particles would see in the present development the fulfilment of their prophecies. They cannot all have been exactly right ; bioblasts are quite big, and mitochondria (which some have supposed to be symbiotic organisms) are also visible, and not only to the elect. But it may well be that they were making as shrewd guesses at the truth as Prout did when he suggested that all elements were ultimately compounded of hydrogen. Until Harrison did it, we had not suspected that the cells of warm-blooded animals could be cultivated *in vitro*. If they can live and multiply, divorced from their proper community, is it altogether impossible that parts of cells might have something of a separate existence also, just as electrons may operate apart from atoms ?

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specialised carnivores, and the manner—if any—whereby the algæ are digested is yet to be ascertained.

Mr. A. G. Nicholls, of the University of Perth, besides rendering great assistance to the leader of the expedition with his work on corals and beginning work on the calcium content of sea water, has taken charge of the work on the life history of the 'black-lip pearl oyster' (*Meleagrina margaritifera*). An area on the reef flat has been marked off with a stout fence of mangrove wood, ample settling surface for spat being provided not only by the mangrove stakes, but also by numerous empty clean clam shells. Some 450 oysters have been placed in this enclosure. Gonad samples are taken fortnightly, and one breeding period, during the first week in November, so far noted. Mr. G. W. Otter is carrying out a survey of the varieties, numbers, distribution, and powers of destruction of the rock borers, especially the lamellibranchs, and is obtaining results of interest. He is also working on the wood-boring Teredinidæ.

Collecting both on the reef and from the bottom near reefs by dredges and the Agassiz trawl—the latter from a 20-foot whale-boat with a 6 h.p. engine purchased locally—has proceeded apace, but intensive collecting is being held over until after the summer, when it is hoped that an additional boat will be chartered, and excursions can be made far afield. For the time being, the expedition is doing its best work by concentrating on the intensive study of the conditions on and around this small reef, and from the various lines of research so vigorously being prosecuted there is every indication that, at the end of the year here, there will be available for publication the most complete account to date of the conditions under which this type of coral reef exists.

Mr. J. A. Steers, assisted by Mr. M. Spender and Mr. C. Marchant, who constitute the geographical section, have cruised northward from Townsville in a launch chartered there, to Flinders Islands (north of Cooktown) and back, calling at Low Islands for several days on both outward and return trips. They have examined many reefs and coral cays in this long stretch, and have been able to form a very clear idea of the vastness of the problem confronting geographers in this region. Mr. Steers is now on his way back to England, but Mr. Spender and Mr. Marchant are to arrive at the Island shortly, the latter for two months only, the former, with periods of surveying on selected cays and on the mainland opposite the island, for the remaining period of the expedition.

Obituary.

PROF. BASHFORD DEAN.

DR. BASHFORD DEAN, who died at Battle Creek, Michigan, U.S.A., on Dec. 6, 1928, was equally eminent as an ichthyologist and as a student of medieval armour. He acquired both interests in early boyhood in circumstances which fostered them, and he continued to pursue both until the end. For several years he was the active curator of fishes in the American Museum of Natural History, New York, where he planned the public exhibition of fossil and existing fishes. For a still longer period he was curator of arms and armour in the Metropolitan Museum of Art, New York, and likewise planned the installation of the collection. In each case he largely added to the collection by the acquisitions he obtained during his numerous and extensive journeys in the Old World.

Dean was born in New York on Oct. 28, 1867, and was educated first at the College of the City of New York, where he made good progress in zoology. Next, in 1886, he entered Columbia College, where he studied geology and fossil fishes under Prof. J. S. Newberry, whose researches on Devonian fishes he afterwards continued. In 1890 he graduated as Ph.D. with a thesis entitled "Pineal Fontanelle of Placoderm and Catfish," which was published by the New York State Commission of Fisheries. Meanwhile, he had already become tutor in natural history in the College of the City of New York, and had also been appointed assistant on the Fisheries Commission. He thus had early experience both of teaching and of research. In later years he was for a time one of the professors of zoology in Columbia University, where he had some brilliant pupils; but most of his energies were devoted to research and the enlargement of the collections of which he had charge.

Dean's training led him to take the widest view of ichthyology, and he was equally well versed in the methods of embryology and of palæontology. His outlook is well shown in his useful handbook on "Fishes, Living and Fossil," which was published in the Columbia University Biological Series in 1895. It deals mainly with the lower and older groups of fishes, which are of the greatest interest from the evolutionist's point of view. It regards them in all aspects, and facilitates comparisons by adequate synoptical tables and pages of clear figures drawn by himself. It summarises the knowledge and ideas of the time, expressing several opinions which Dean's own researches afterwards caused him to modify. His latest and most important volume, on "Chimæroid Fishes and their Development," published by the Carnegie Institution of Washington in 1906, displays the same wide scope. It combines embryological observations on specimens which he collected in Japanese seas with extensive anatomical research and numerous descriptions of important fossils. It reaches the conclusion now generally accepted, that the chimæroids are highly specialised sharks.

Among Dean's papers on fossil fishes may be specially mentioned those on the Devonian shark which he named *Cladoselache*, and those on the armoured Devonian fishes commonly known as Arthrodira. He showed that the fins of *Cladoselache* could only be explained on the theory that the fins of fishes had been derived from continuous fin-folds. He also proved that the body-cavity of this primitive shark extended backwards almost as far as the tail fin, by examining microscope sections of the fossil which revealed the structures of the kidney. His researches on the Arthrodira led him to the conclusion that they were not Dipnoi, but while recognising them as much more primitive fishes, he failed to discover their connexion with ancestral sharks which Stensiö has lately demonstrated. Dean also devoted much attention to the supposed Devonian lamprey *Palæospondylus*, which he regarded as wrongly interpreted: he thought it might be the larva of some larger fish.

Dean made many observations on the embryos of all the existing ganoid fishes, the Port Jackson shark, and certain hag fishes, besides the chimæroid fishes already mentioned. He prepared series of beautiful drawings, but many still remain unpublished. His memoir on the embryology of *Bdellostoma stouti*, contributed to Carl von Kupffer's "Festschrift" in 1899, may be specially mentioned as illustrated by some of his finest drawings.

Dean also took every opportunity of studying living fishes, and he made many important observations on the specimens of *Ceratodus* living in the London Zoological Gardens, which were published in the *Proceedings of the Zoological Society* in 1906 and 1912.

From the beginning of his career, Dean realised the difficulty of becoming acquainted with existing knowledge of his subject, and devoted much time to the preparation of an adequate bibliography. By 1910 this had become so unwieldy that he felt he could not complete it himself, and he then succeeded in obtaining the co-operation of the American Museum of Natural History for the final preparation and publication of the work. Under his general direction, the two volumes of the index to authors and titles were extended and edited by the late Dr. C. R. Eastman, and published in 1916–17. The third and final volume, extended and edited by Dr. E. W. Gudger with the co-operation of Mr. A. W. Henn, includes an exhaustive subject index, and was published in 1923. This great work of reference, which extends to the year 1914, is of inestimable service to ichthyology, and gained for Dr. Dean the D. G. Elliot medal of the United States National Academy of Sciences, immediately on its completion.

In 1893 Bashford Dean married Miss Alice Dyckman, who belonged to one of the oldest Dutch families of Manhattan Island, and his wife not only furthered his life-work by her sympathy and help, but also accompanied him on his numerous and extensive travels. He was as well known among the zoologists of Europe as among those of North America, and he had a large circle of friends in Britain. He was a corresponding member of the Zoological Society of London. His always delicate health handicapped him in his activities, but his enthusiasm never flagged, and his old-world courtesy and friendliness endeared him to all who were associated with him. A. S. W.

Prof. E. H. L. Schwarz.

The death of Prof. Ernest H. L. Schwarz, professor of geology in the Rhodes University College, Grahamstown, leaves South African geology much poorer owing to the loss of his enthusiasm, originality, and ability as a teacher and lecturer. Prof. Schwarz was born in London on Feb. 27, 1873, and educated at Westminster School and the Royal College of Science. His father was a London merchant engaged in the South American trade, but he went to South Africa, being attracted by its mining development, and in 1895 settled in Johannesburg, where he became editor of the *Scientific African*.

Prof. Schwarz was more interested in academic than in applied geology, and in 1896 joined the Geological Survey of Cape Colony and spent nine years in its service under Dr. A. W. Rogers. He investigated the older rocks of Cape Colony, and in co-operation with Dr. Rogers correlated them with those of the Transvaal. During his surveys of the Cape Devonian beds he described the complex folds in the Bokkeveld Series, the glacial beds in the Table Mountain Sandstone, and in an account of a collection of rocks from Tristan da Cunha founded his Flabellites Land for a Devonian continent occupying the South Atlantic and extending northward into the Mississippi Valley. In an account of some Karroo beds he suggested that certain tuffs had been formed by the deep-seated shattering of the granite basement. He made important contributions to the Cretaceous and Kainozoic geology of the eastern Cape Colony, and described Baviaan's Kloof (1903), with the series of tectonic basins which he called 'fault-pits'; he gave the name of the Alexandria Formation to a succession of beds which have been recorded as ranging from the Upper Cretaceous to the Pliocene. He also urged the great influence of marine planation in forming the plateau of the same part of Cape Colony.

In 1905 Prof. Schwarz was appointed to the chair of geology at Grahamstown, and had the opportunity to give play to his interests in the speculative sides of geology and cosmogony, and in his "Causal Geology" (1910) he applied some of the natural corollaries of T. C. Chamberlin's planetesimal theory to later geological history. In connexion with his educational work he prepared an excellent summary of the geology of South Africa and a small work on African geography.

While working in the backblocks of the Cape, Prof. Schwarz had been impressed with the diminution of the agricultural population and attributed it to growing desiccation of the country. The reduction of Lake Ngami from a great lake to a swamp, and later to a bare plain, seemed to Schwarz one effect of a process that was doing widespread injury throughout South Africa. He published his conclusions in 1920 in "The Kalahari, or Thirstland Redemption," in which he advocated the diversion from the Upper Zambezi of some of the flood waters that now rush wasted to the sea. He held that much of the water could be turned back into the dry valleys and lake basins of the Kalahari and the climate of the interior of South Africa materially improved. The scheme has been set aside as too costly; but Schwarz was probably correct in his views that the Kalahari has suffered by the capture by the Zambezi of some of its rivers and that some of the water could be restored to the ancient channels. He, however, probably exaggerated the effects that would follow from this expensive undertaking.

Prof. Schwarz's book on the Kalahari and its natives, published in 1928, recorded his observations during a canoe voyage across that country when wet seasons had refilled its lakes and rivers and thereby thrown doubt on his theory of the progressive desiccation of South Africa. He also described the natives of the Kalahari, and advanced views which, as usual, were of daring unconventionality. His interest in irrigation projects led to his study of the river system of Africa as a whole, and it was probably in connexion with its problems that he was visiting St. Louis in Senegal, where he died on Dec. 19.

Schwarz's conclusions were often highly speculative, and his great scheme for the irrigation of the Kalahari has been rejected as impracticable; but he has left many contributions of permanent value to the geology of Cape Colony, and his death will be widely regretted owing to his gifts of friendship and the stimulating originality of his views.

J. W. G.

Dr. W. G. Smith.

Science has lost a distinguished agricultural botanist in the death of Dr. W. G. Smith, who died in Edinburgh on Dec. 8, 1928. Dr. Smith was born in Dundee on Mar. 20, 1866. He graduated in pure science in the University of St. Andrews, and after a short period of teaching in the Morgan Academy, Dundee, became a lecturer in agriculture under the Forfarshire County Council. Later he acted as a demonstrator in botany in the University of Edinburgh under the late Sir Isaac Bayley Balfour. Proceeding to Munich, he took a two years' course of study, gaining there in 1894 his doctorate of philosophy for a thesis entitled "Untersuchung der Morphologie und Anatomie der durch Exoasceen verursachten Spross- und Blatt-Deformationen." This thesis was afterwards translated into Italian. Another result of his sojourn in Munich was his translation of von Tubeuf's standard work on the "Diseases of Plants by Cryptogamic Parasites," which appeared in 1897. On his return from Germany, Dr. Smith became lecturer in botany in the University of Leeds, where he remained for eleven years. In 1908 he was appointed chief of the biology department of the Edinburgh and East of Scotland College of Agriculture. For the last twenty years the College was his headquarters. Recently, under the scheme for the development of research work in agricultural problems, Dr. Smith was appointed advisory officer in agricultural botany to the Board of Agriculture for Scotland.

Three fields in botany attracted Dr. Smith's particular interest, and in each of these he was acknowledged an expert. His earlier training under von Tubeuf gave him a keen interest in researches on the diseases of plants, especially those of concern to agriculture and horticulture. Along with his brother, Robert Smith, who died young, he instituted the first detailed botanical surveys in Britain. Numerous papers dealing with ecological botany appeared from his pen. Amongst these were botanical surveys of Forfar and Fife and of various areas in Yorkshire and Teesdale. He was always in close touch with Warming and other distinguished Continental ecologists. The third field in which Dr. Smith distinguished himself was the study of grassland, especially of hill pastures, including the utilisation of heathland and the eradication of bracken.

These three phases of his work were combined into one harmonious whole, and no one was better fitted from his experience and patient research to act as advisory officer on matters concerning agricultural botany. Throughout most of his career he was engaged in the instruction of students, by whom he was held in the highest regard. Teaching duties, onerous as they were, did not hinder him from pursuing a continuous series of investigations, and the record of his published papers extends from 1894 until 1928.

In 1903, Dr. Smith received the award of the Back Grant by the Royal Geographical Society for research in the geographical distribution of vegetation in England. It is of interest to record that of his four children, two pairs of twins (boy and girl), three have had distinguished university careers, each taking first-class honours, while one is still an undergraduate. The elder son is professor of botany in Grahamstown University, South Africa.

We regret to announce the following deaths:

Mr. R. H. Cambage, C.B.E., president of the Australian Association for the Advancement of Science and of the Australian National Research Council, and a past president of the Royal Society of New South Wales, on Nov. 28, aged sixty-nine years.

Prof. H. B. Fine, professor of mathematics and dean of the departments of science at Princeton University, distinguished for his work in pure mathematics, on Dec. 21, aged seventy years.

Mr. W. T. Gauss, a grandson of the illustrious German mathematician, Carl Friedrich Gauss, and through his mother a nephew of the noted German astronomer, Friedrich Wilhelm Bessel, on Nov. 14, aged seventy-seven years.

Major-General Sir Gerard Heath, a former chairman of the Building Research Board of the Department of Scientific and Industrial Research, on Jan. 9, aged sixty-five years.

Prof. M. J. M. Hill, F.R.S., emeritus professor of mathematics in the University of London and president of the Mathematical Association, on Jan. 11, aged seventy-two years.

Dr. Alexander A. Maximow, professor of anatomy in the University of Chicago and formerly professor of histology and embryology in the Russian Imperial Military Academy of Medicine, on Dec. 3, aged fifty-four years.

News and Views.

THE Gold Medal of the Royal Astronomical Society has been awarded to Prof. Ejnar Hertzsprung, of Leyden Observatory, for his determination of the distance of the Magellanic Clouds and other pioneering work in stellar astronomy. Prof. Hertzsprung's work is characterised by definiteness and originality; it includes researches in photometry; study of change of period in variable stars; investigations of the spacial distribution of Cepheids and other bodies; special studies of clusters; and researches in celestial spectroscopy. He was the first (1906) to emphasise the evidence for distinction between giant and dwarf stars. His work on the relation between colour, proper motion, and apparent magnitudes of stars has been a noteworthy contribution. His early application (1906) of the theory of radiation to considerations of stellar temperatures led him to be among the first to estimate the angular diameters of stars. He found the key by which Cepheid variables can be used to determine stellar distances. Miss Leavitt at Harvard had found a relationship between the apparent magnitude and period of Cepheid variables in the lesser Magellanic Cloud. Hertzsprung saw that this implied a relationship between actual luminosity and period. He then by means of solar motion deduced the parallax of thirteen bright Cepheids and thus their absolute luminosity, and the constant of the period luminosity relation. He derived the distance of the lesser Magellanic Cloud as 10,000 parsecs. This work was published in 1913, and the method has since been extensively employed by Shapley, Hubble, and others in the determination of the distances of remote clusters and nebulæ.

SCOTLAND has been slow in developing the bird-sanctuary movement. Apart from the fine enclosure of some 40 acres at Duddingston Loch, near Edinburgh, there is no considerable reserve in the country, although the vast areas of the deer-forests have acted in many ways as real reservations. A welcome announcement, therefore, is contained in a leading article in the *Scottish Naturalist* (p. 166, 1928), that a new sanctuary of 70 acres is to be created at Possil Loch, in the neighbourhood of Glasgow. The area is well known to naturalists on account of its wealth of plant and insect life, and the use made of the Loch by birds as a resting-place on their migrations. The extension of Glasgow and the increasing presence of irresponsible marauders, egg-collectors, and bird-nesters has threatened the existence of the marsh as a nature-lover's paradise, so that the natural history societies of Glasgow and related bodies have been compelled to acquire the ground in order to preserve its amenity. They have been generously met by the owners of the estate, and propose to administer the area so that its natural beauty and wild life may best be preserved, while reasonable access will be secured to the public for all time. It is estimated that a sum of £2000 will be required for the purchase and maintenance of this bird and botanical sanctuary, and the Committee appeals for donations, which should be sent to Mr. J. M. Crosthwaite at 207 West George Street, Glasgow.

WE are informed that the appeal for subscriptions to a memorial to the late Sir William M. Bayliss and Prof. Ernest H. Starling has up to the present resulted in a sum which, with interest, and apart from subscriptions which are still arriving, will amount to above £2600. The sum has been contributed principally by personal friends, relations, and pupils of these distinguished physiologists, but very liberal subscriptions have also been received from their admirers in America, various European countries, chiefly Germany, from learned societies, and from various physiologists and members of the medical profession from all parts of the world. A small part of the fund has been employed for the provision of a simple memorial tablet designed by Prof. A. E. Richardson, F.R.I.B.A., bearing their names, which will be erected in the entrance hall of the department of physiology and biochemistry, where it will occupy a suitable place over the bust of Sharpey. A material memorial or an annual lecture would, however, have seemed a smaller thing to Bayliss and Starling than the provision of means whereby young workers of suitable training and ability might be attracted into their chosen subject. The bulk of the sum, therefore, will be used for the creation at University College, London, of a Bayliss and Starling Studentship, which will be open to any graduate in science of any university, or any graduate or undergraduate in medicine of suitable standing, to enable him to spend a year or more in such training in physiology and biochemistry as would fit him for research. For this purpose the sum of £2500 will shortly be transferred to the University of London to be held in trust for the creation of such a studentship. The governing body of University College has agreed to assist this scholarship in a very material way by remitting all fees for instruction and ordinary expenses payable by the selected candidate. It is hoped to make the first award of the scholarship in June of the present year.

THE Zoological Society of London has for a hundred years been a force working for the diffusion of Nature knowledge amongst the people, and during the last quarter of a century its progress has been extraordinary. It is fitting, therefore, that the centenary of the granting of its Royal Charter, which followed three years after the founding of the Society in 1826, should be properly commemorated. It will be celebrated during the present year by a representative gathering of fellows and of delegates of other societies at the annual general meeting on April 29, by an evening reception for the 8000 fellows and their guests in the Gardens during the summer, and by the publication of two interesting memoirs. The first of these is a historical account of the origin and development of the Society and of its general and scientific work, written by Dr. P. Chalmers Mitchell; the second, a list of every species of mammal, bird, reptile, batrachian, and fish that has been exhibited alive in the Gardens since their foundation. The list will include popular and scientific names, as well as a certain amount of synonymy and references to descriptions and figures. Anyone who has regularly used P. L.

Slater's "List" of 1896 will appreciate the labour involved in the new venture, and its potential value for the creation of a common standard of English specific nomenclature.

BOUVET Island and Thompson Island, in the South Atlantic, have been much discussed lately owing to rival political claims and the uncertainty as to the existence of Thompson Island. This island has been searched for several times unsuccessfully since Capt. Norris reported it in 1825. Com. R. T. Gould recently showed that to the north-east of Bouvet Island, centring about lat. 54° S., long. 4° 35′ E., there is an unexplored area of the ocean in which Thompson Island probably lies. The whole problem is reviewed in an editorial article in the *Geographical Journal* for December, which is accompanied by reproductions of Norris's sketches, or copies of his original sketches, now preserved in the Admiralty Library. From the evidence available, the suggestion is made that the land first sighted in 1739 by Captain Lozièr-Bouvet and named by him Cap de la Circoncision was not the Bouvet Island of to-day but Thompson Island. Bouvet placed his cape in lat. 54° 6′ S. and he cruised so far as 54° 40′ S. These positions agree reasonably well with the probable position of the two islands. Bouvet estimated that the extent of land which he saw was forty-five miles, but his sight was continually hampered by mist and ice. It is therefore possible that Bouvet really sighted both islands. Furthermore, it is now clear, as has been previously supposed, that the Liverpool Island of Norris is the same as Bouvet Island. Lindsay Island of Lindsay (1808) is the same island. The problem of Thompson Island is further complicated by the failure of the *Norvegia* to find the island in a recent lengthy search in the area of sea indicated above.

DURING the War, when coal was scarce and its price very high, surplus electrical energy was used to heat boilers. It was found that this not only effected savings in the coal bill but also could be used economically in working electric plant. Two applications of the principle have come into practical use. Small thermal accumulators are used for domestic purposes and boilers are regulated electrically so that they can supply a sudden demand for steam. For heavy loads and voltages exceeding 500, the water itself is used as the resistance when alternating current is available. If the frequency of the supply exceed 15, there is no risk of explosive gases being generated in appreciable quantity. In *Engineering* for Jan. 4, a complete description is given of the electrically heated plant which is made by Messrs. Sulzer Bros. of Winterthur. Pressures up to 16,000 volts can be utilised and so the expense of transformers can be saved. Water containing salts conducts electricity much better than soft water. Water at 59° F. has an average resistance of from 1800 to 6000 ohms per cubic centimetre. At 212° F. its resistance varies from about 500 to 2000 ohms per c.c. and it is about 15 per cent. less at 400° F. Boilers should be constructed with their electrodes completely immersed and connected with the top of the boiler by an insulating tube. If this is not done, sparking occurs to the surface of the water when the voltage exceeds 1000, and this causes the load on the boiler to fluctuate and the electrodes to wear away rapidly. Tests prove that the efficiency of large electric boilers is exceedingly high. For domestic purposes, electric thermal storage presents many advantages. The whole of the heat supply in spring and autumn can be supplied by electrical energy, the coal fire being used only during periods of severe cold.

A FEW years ago broadcast listeners were greatly interested in the technical side of the service, and so were not very critical of its quality. The more one listens the less tolerant one becomes of interruptions and of poor quality service. In continental areas the number of available wave-lengths is rapidly diminishing. The number of high-power stations is being reduced, and the other stations are using wave-lengths which are continually getting shorter in order to prevent being interfered with by other waves. In some countries the broadcasting is being carried out in a haphazard way, and their listeners therefore have not been educated to expect a good service. Hence their broadcast radiations interfere with the high-quality reception demanded by residents in other countries. In a paper read to the Institution of Electrical Engineers by P. P. Eckersley, T. L. Eckersley, and H. L. Kirke, on Jan. 2, this aspect of the broadcasting problem was emphasised. They consider it most unfortunate that the broadcasting problem should be discussed by many as if it were a political and not a scientific problem. In their opinion, the best way of attacking it is to attempt to design an aerial so as to make it a radiator which practically emits only rays which are initially parallel to the surface of the earth. It is the existence of the other rays that are so detrimental to a good broadcasting service. These rays interfere with the service from very distant stations and intensify fading and bad service in the local service area. To obtain horizontal radiation high aerials are necessary. Radio engineers in the past have been chary about using wave-lengths less than 300 metres, as they were afraid that this would in practice seriously limit the service area. As the authors point out, however, it has to be remembered that limitations are inevitable, and it is far better to have a limited service than one which suffers continually from interference.

TRINITY COLLEGE, Hartford, Connecticut, does an interesting thing in the way of encouraging good general reading among its students, who are, one may suppose, roughly of what we call 'university status' in England. A list of recommended books is drawn up in ten classes, ranging from natural science, which is put first, through various types of history, on to various types of literature. These books are actually grouped in one bookcase in the College Library. "Students are expected to do one hundred points of reading in a year, and write up each point on at least half a typewritten page. . . . One hundred pages of ordinary novel reading is credited as one point," and extra credit is allowed for more difficult subject matter. They must select at least one title from each of eight of the ten classes of book mentioned. Not more that a fifth may be fiction. One would like to know how the plan really works, what the students think of it, and how much they retain of the books thus read. Independent reports from the professorial and the student side would be welcome before we embark on the experiment on any large scale in England, where undergraduates are more mature, less *in statu pupillari* than they are in the United States. For the list itself, one can have nothing but praise. It is admirable alike for what it includes and what it leaves out. It is clearly the work of humane and philosophically minded persons who agree with Comte in putting first in their library 'les œuvres de synthèse,' books on the history and the philosophy of science. But when they mention by name in their preface some of the 'muck-raking' novels which they refuse to include in their list, one might be afraid that they would increase the circulation of the proscribed books in any less well-ordered institution than Trinity College, Hartford.

Operations at Ur were resumed by the British Museum Expedition in November. The results of the first month's excavation, which were described by Mr. Leonard Woolley in the *Times* of Jan. 11, if less spectacular than those which opened the season last year, are none the less remarkable for the fresh light they throw on the funerary customs of the early Sumerians and the promise they hold out for the immediate future. Last year's work recovered the plan of a king's grave. Now a similar grave has been seen in section, which, as Mr. Woolley points out, is scarcely less illuminating. The first indication of the nature of the evidence which was being brought to light was a layer of reeds extending up to the walls of what appeared to be a small room of mud bricks. Under the reeds were innumerable fragments of clay pots, animal bones, and several human skeletons which lay on a floor of beaten clay. This was clearly a subterranean building, of which the contents were in the nature of a votive deposit. Further examination showed that it lay in a vertical shaft, and was an element in a new form of ritual in which, after the burial of the king and the slaughter of his retainers, votive offerings were placed in the earth at intervals as the shaft was filled in, until finally it was stopped with a subterranean chamber containing offerings. This in turn was covered with earth, and perhaps the whole completed with a funerary chapel as a superstructure.

In another shaft at Ur, which appears to be that of a queen's tomb, a remarkable series of offerings included a coffin burial, and concluded after a considerable interval in the remains of a funeral feast immediately above the dome-shaped roof of a burial chamber in which were six bodies, four men servants, a maid servant, and the queen in whose honour the tomb had been built. Beside the conventional gold head-dress, the funerary appointments included a pin of unusual type and a gold enamel cylinder seal with scenes of feasting and musicians. The tomb of a small girl had a miniature replica of the conventional gold head-dress.

Mr. L. S. B. Leakey, who returned to Africa in September last to resume excavations in Kenya with the assistance of a grant from the Royal Society, has made a discovery relating to early man which, if the conditions are as reported in the *Times* of Jan. 12, is of great importance. Mr. Leakey is excavating in a cave known as 'the Gambles' in the Elmenteita district, one of the districts in which his discoveries of previous seasons were made (see Nature, July 16, 1927, p. 85). This cave shows a stratification of fourteen chronological layers extending from the earliest times down to its modern occupation by the N'dorobo. In the stratum of the second of the African pluvial periods into which the early deposits have been classified, Mr. Leakey has found a complete human skeleton, which is said to have been removed undamaged except for a pickaxe hole in the skull. The skeleton, which was associated with a rich industrial development of tools, was found with the knees under the chin. The type is definitely that of *Homo sapiens*. It is stated that Mr. Leakey believes that this is the earliest predecessor of Aurignacian man yet found, his opinion being based upon the view that the various pluvial periods of East Africa are to be equated with the glacial epochs of Europe. In the stratification of the cave a relatively brief Mousterian occupation follows the second pluvial period, and in the third pluvial period the cave was occupied by a people of an Aurignacian culture, who, however, made pottery. The occurrence of pottery with early types of culture in Kenya had already been recorded by Mr. Leakey; but it suggests caution in accepting a high dating. Nowhere else does pottery occur at so remote a period. Neither here nor in any other area do known conditions suggest why East Africa should be exceptional in this respect.

On Jan. 15, Dr. F. A. Freeth delivered the first of a course of two lectures which he is giving at the Royal Institution on "Critical Phenomena in Saturated Solutions." Dr. Freeth pointed out that the ordinary 'commonsense' view of solutions is apt to be disturbed at high temperatures and pressures near the critical state. For example, it is generally assumed that pressure will cause a vapour to condense; the reverse phenomenon, namely, the turning of a liquid into a vapour by means of increased pressure, is, however, almost a universal phenomenon, although the conditions under which it occurs are sufficiently remote from those of ordinary life to make it appear singular. If we take a saturated solution of a substance and heat it in a closed space, it may just boil, as does a solution of common salt in water; and it is possible to have two solutions which boil at ordinary temperature, one a solution of, say, sodium nitrate and water, the other a solution of water and the salt. There may be a considerable range of temperature, however, in which it is impossible to obtain a solution of any kind, the best known example being that of anthraquinone in ether. This state of affairs holds for a very large number of salts and water. It has not received much experimental attention on account of the great practical difficulties of realising the conditions. Finally, it was pointed out that just as a liquid should be caused to vaporise by increase of pressure, so in certain circumstances could a solid.

AT a meeting held in New York on Dec. 27, a new scientific society, the Acoustical Society of America, was formed, to bring together workers in all branches of pure and applied acoustics. Among its activities will be the provision of a medium of publication for papers on acoustics, for which there is acute need; such papers have hitherto been widely scattered. Elected to temporary office were: *President*, Dr. Harvey Fletcher, of Bell Telephone Laboratories; *Vice-President*, Prof. V. O. Knudsen, of the University of California; *Secretary*, Mr. Wallace Waterfall, of the Celotex Company; *Treasurer*, Mr. C. F. Stoddard, of the American Piano Company. A committee was appointed by Dr. Fletcher to consider the details of organisation, and the first regular meeting was arranged for some time in April at Bell Telephone Laboratories.

SIR HUBERT WILKINS, in a dispatch to the *Times* announces that he made a second flight from Deception Island on Jan. 10. He passed southward for about 250 miles looking for an advanced base that would be more favourable than Deception Island. Fog, however, prevented him finding one and forced him to return without adding to his discoveries. He has decided to postpone further efforts until next season, when he hopes to find a base on the continent to the south of the group of islands of which he has proved Graham Land forms part. If he is successful in reaching such a base by ship, Sir Hubert Wilkins will be in a position to try a flight along the edge of the continent towards South Victoria Land. Continuity of land below his line of flight will ensure some possibility of return to his base if engine trouble or other causes should force him to descend.

OWING to various developments which have taken place in connexion with the fertiliser interests of Imperial Chemical Industries, Limited (particularly the formation of Scottish Agricultural Industries, Limited), and to the inauguration by the Government of the agricultural credits scheme, the project which the company had in mind for the inauguration and support of a special Imperial Grassland Association has proved unnecessary and incapable of complete realisation without duplication and overlapping of effort. Lord Bledisloe, who had been invited to become the chief of this new organisation (and who, it will be remembered, relinquished his membership of the Government with that object in view) has retired from his association with the project. While acknowledging Lord Bledisloe's willingness and ability to undertake the work which would have been entailed had the scheme been proceeded with, Imperial Chemical Industries, Limited, realised that it had no alternative but to release Lord Bledisloe, who will continue, however, to act in an advisory and consultative capacity on agricultural questions generally.

AN admirable account of the proceedings of the ninth annual conference of the Apis Club, which was held at Geneva and Berne on Aug. 12–16 last, under the presidency of Dr. Otto Morgenthaler, appears in the *Bee World* for November and December last. The meetings were attended by a number of distinguished workers, of several nations, representing both the practical and research sides of apiculture. Among the various papers read at the conference and published in this journal, Dr. E. Elser's account of the micro-technique involved in investigating the brood food over the last forty years is of special interest to biologists. After discussing the now well-known remarkable work of von Planta, modern methods of determining the constituents of the larval food are described. The next conference will be held in Berlin in 1929, under the presidency of Prof. Ambruster.

THE Council of the Geological Society has this year made the following awards: Wollaston Medal to Prof. F. J. Becke, of Vienna, in recognition of the value of his researches in petrology; Murchison Medal to Dr. C. A. Matley, in recognition of the value of his researches on stratigraphical geology in various parts of the British Empire; Lyell Medal to Dr. A. Morley Davies, in recognition of the value of his researches in invertebrate palæontology; Bigsby Medal to Prof. P. G. H. Boswell, for his valuable researches in sedimentary petrology and stratigraphy; Wollaston Donation Fund to Dr. R. Campbell, in recognition of the value of his researches in Scottish petrology and stratigraphy; Murchison Geological Fund to Mr. L. R. Cox, for his valuable researches in invertebrate palæontology, especially in connexion with the Lamellibranchiata; a Lyell Geological Fund to Mr. C. Edmonds, in recognition of the value of his researches on the Lower Carboniferous rocks of the Whitehaven district; a second Lyell Geological Fund to Dr. E. O. Teale, for his contributions to the geology of Victoria and of Africa.

AT the meeting of the London Mathematical Society, to be held on Feb. 14, at 5 P.M., at Burlington House, Prof. O. Veblen, of Princeton University, will deliver a lecture on "Generalised Projective Geometry." Members of other scientific societies who may be interested are invited to attend.

A VIOLENT earthquake was registered at seismological observatories on Sunday, Jan. 13. The record at Kew Observatory, where the first tremors were received at 0 hr. 14 min. 49 sec. G.M.T., indicates that the epicentre was near the Kurile Islands, Lat. 50° N., Long. 150° E. This location is confirmed by the information received from Bombay, Helwan, and Stonyhurst.

THE Annual Report for the year 1927 of the South African Institute for Medical Research, Johannesburg, by the Director, Sir Spencer Lister, has recently been issued. The work of the Institute comprises routine examinations of material for medical practitioners, as aids to diagnosis, and research work. The last-named included during the year field-work on plague, determination of the types of the tubercle bacillus among

South African natives, investigations on pneumonia, cerebro-spinal fever, effects of dust inhalation, and the estimation and elimination of dust in 'dusty' occupations, and a mosquito survey in Zululand.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant in the technical education branch of the department of the West Riding Education Committee—The Education Department, County Hall, Wakefield (Jan 28). A public analyst and agricultural analyst for the City of Cardiff—The Medical Officer of Health, City Hall, Cardiff (Jan. 31). An agricultural economist at the West of Scotland Agricultural College—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (Jan. 31). A technician in the department of zoology of the University of Edinburgh, for assistance in research and the preparation of microscopic slides for class use; also a museum curator in the same department—The Secretary, The University, Edinburgh (Feb. 1). A research assistant in the Leather Industries Department of the University of Leeds—The Registrar, The University, Leeds (Feb. 4). A bio-chemist at the antitoxin establishment of the Metropolitan Asylums Board—The Clerk, Metropolitan Asylums Board, Victoria Embankment, E.C.4 (Feb. 6). A principal of the Dundee Technical College and School of Art—The Secretary, Technical College, Bell Street, Dundee (Feb. 8). A head of the mechanical and civil engineering department of the Sunderland Technical College—The Chief Education Officer, 15 John Street, Sunderland (Feb. 9). Two appointments in the Forest Service of Burma—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (April 6). A full-time teacher of engineering at the Verdin Technical School, Northwick—TheDirector of Education, Dept. 'C,' County Education Offices, City Road, Chester. Two junior assistants (male) under the directorate of ballistics research, Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18. A secretary to the Pharmacopœia Commission of the General Medical Council—The Acting Secretary, British Pharmacopœia Commission, General Medical Council, 44 Hallam Street, W.1. A junior professional assistant in the Meteorological Office—The Secretary (S.1), Air Ministry, Adastral House, Kingsway, W.C.2. An assistant physicist in the experimental department of the Fine Cotton Spinners' and Doublers' Association, Ltd.—The Chief of the Experimental Department of the Association, Rock Bank, Bollington, near Macclesfield. A physicist for research work in the laboratories of the British Boot, Shoe, and Allied Trades Research Association—The Secretary of the Association, 19 Bedford Square, W.C.1.

Our Astronomical Column.

FORBES'S COMET.—The following observations of this comet were obtained by Dr. H. E. Wood at the Union Observatory, Johannesburg:

U.T.	R.A. 1928·0.	S. Decl. 1928·0.
Nov. 21·07734	$12^h\ 8^m\ 29{\cdot}31^s$	21° 43′ 44·5″
26·07167	12 22 3·48	25 12 47·4
30·07286	12 32 45·00	27 38 48·3
Dec. 1·06356	12 35 22·30	28 12 20·4

Using these in combination with positions obtained at Algiers, Lick, and Yerkes Observatories, Dr. A. C. D. Crommelin has deduced the following elliptical elements:

T	1928 Nov. 5·02378 U.T.	
ω	196° 0′ 13·6″	1928·0
Ω	250 5 19·1	1928·0
i	28 54 6·1	1928·0
ϕ	67 48 54·2	
log q	9·8723448	
Period	31·9448 years.	

The identity with comets 1818 I. (Pons) and 1873 VII. (Coggia-Winnecke) may now be looked on as established. The identity of these two was already considered probable by Weiss and Schulhof, but the observed arcs in 1818 and 1873 were only 4 and 5 days, so the matter remained conjectural. The fact that the period found is much closer to 27½ than to 55 years makes it likely that the comet has made four revolutions since 1818, which would give a mean period of 27·69 years. If this is correct, then the comet 1457 I. (observed by Toscanelli and also in China) is probably the same comet, there being thirteen revolutions between 1457 and 1818, with a mean duration of each of 27·77 years. The following are the elements of this comet, necessarily somewhat uncertain owing to the want of precision of observations at that date:

T 1457 Jan. 18·0, ω 194·9°, Ω 249·7°, i 13·3°, log q 9·847.

The discoverer of the comet at this apparition is Mr. A. F. J. Forbes, of Rosebank, Cape Town, who is an architect by profession, and treasurer and librarian of the Cape centre of the Astronomical Society of South Africa. He has been engaged for some months in sweeping for comets, using an 8-inch reflector which he constructed himself.

The comet is now in south declination 42°, so it is out of reach of most northern observatories. It is to be hoped that it will be observed over a sufficiently long arc to determine the elements, especially the period, with great precision.

ARGON IN THE SOLAR CORONA.—In NATURE for Feb. 4, 1928, a letter by I. M. Freeman appeared, stating that a number of hitherto unidentified lines in the coronal spectrum had been attributed to argon, and promising further details in a forthcoming paper. This paper has now appeared in the *Astrophysical Journal*, vol. 68, p. 177. The investigation of argon was suggested by the fact that three recurring differences of wave-number between pairs of coronal lines agreed with the three chief term differences in the argon spectrum as investigated by Meissner. Twenty-two unknown lines of the corona are attributed with great plausibility to well-known argon lines, while combination lines of argon account for a further ten. Transitions from metastable states are not involved in these identifications, which is in accord with Eddington's theories. A possible test of these results lies in the fact that two different combinations give a line very close to the bright green coronal line, the separation being about 0·1 A., so that it should be possible at future eclipses to detect the doublet structure of this line.

Research Items.

EXCAVATIONS AT KISH.—Reports on the work of the various archæological expeditions in the field at the opening of the new season are now beginning to come to hand. Among the more interesting of these is Prof. Langdon's letter to the *Times* of Jan. 4, which deals with the work of the University of Oxford Expedition at Kish, which resumed work in November. The first undertaking was to continue the attempt to secure an accurate and complete series of archæological stratifications, which last year had reached modern water level. This has now been carried farther by hydraulic methods down to virgin soil through three metres of wet earth. A scientific classification of the various periods from the beginning of civilisation to the neo-Babylonian period has thus been established. The cavity extends to 14 metres below the pavement of the temple of Nabunidus, dating to the end of the sixth century. The water level has risen nine feet since the foundation of Kish. The lowest stratum, now below water level, shows the monochrome and polychrome painted ware and the deep red ware, with some fine black ware and beautifully made incised black pottery. The first two classes correspond to that found at Jemdet Nasr, 17 miles to the north-east, which has been dated at 3500 B.C. According to Prof. Langdon, it is clear that the proto-Sumerian people, who are the real founders of Kish and the proto-Sumerian cities of Mesopotamia, are really Elamites, and from the evidence now being obtained the foundation of these cities should be placed before 4000 B.C. Seven stages of human history are to be observed in the stratification now laid bare at Kish.

BIRDS AND ENVIRONMENT.—An intensive study of the vertebrate fauna of a small area adjacent to the Missouri River in Kansas, has enabled Jean M. Linsdale to reach some general conclusions regarding the relationship of birds to their environment (*Wilson Bulletin*, September 1928). She discusses the dangers to which birds in the area are subjected, the influence of culture upon birds, and of birds upon culture, seasonal responses, relationship between species, and the changes which result from alteration in the environment. The interrelationships of the birds themselves are sketched in brief, and apart from these it is apparent that at almost every point a weighty factor is the presence of man, whether his interference be directly for or against the birds, or be reflected indirectly in changes in the avifauna due to the spread of civilisation and consequent changes in the character of the country-side. Her conclusions, which are similar to those reached by Ritchie in his study of the Scottish fauna, are, finally, that " the area under discussion probably has a larger bird population than it had when it was entirely in primitive conditions. A few large and conspicuous species are extinct, but many more are found now that were probably not present when the country was settled." It is difficult to reconcile this conclusion with the one prophecy made by the author : " with a greater utility of waste land and other resources, a point may finally be reached when the effect of man's work in this vicinity will be to eliminate nearly all the bird species." Surely this is in direct contradiction with the observed premises, unless it be foreseen that the whole area is to be built over.

ORIGIN OF THE FAUNA OF THE WEST INDIES.—The origin of the West Indian fauna has been a subject of controversy, the alternative views being that the fauna has been derived from the mainland by migration over one-time land bridges, or that the fauna is a chance assemblage which has found its way thither by different methods across the existing seas. Karl Patterson Schmidt, in discussing the " Amphibians and Land Reptiles of Porto Rico," in a detailed monograph, comes down upon both sides of the fence (New York Academy of Sciences—Scientific Survey of Porto Rico and the Virgin Islands, vol. 10, Pt. I, 1928). He considers that the Greater Antilles received their fauna from Central America, probably in Eocene or even pre-Tertiary times, and that the uniformity of the faunas of the larger islands suggests that these were united for a time. On the other hand, he thinks that the Lesser Antillean fauna is derived from South America, that it is a genuinely fortuitous one, and that no land bridge has existed through this chain in Tertiary times. The Porto Rico fauna in particular is simply an impoverished Greater Antillean fauna, and its peculiar characters are due to a process of extinction still continuing, to the isolated position of Porto Rico at the eastern end of the land mass, and to the differentiation of the Porto Rican forms, partly through isolation during post-Pliocene times, and partly to the influence of the mountains of Porto Rico as a centre of differentiation throughout Tertiary times, before island conditions began.

YOLK-ABSORPTION IN A SQUID.—Dr. A. Portmann and Miss A. M. Bidder (*Quart. Jour. Micr. Sci.*, Oct. 1928) describe observations on yolk absorption in the squid, *Loligo*. The yolk, large in amount, is contained in a closed yolk-sac which has no communication with any other organ of the body. The sac is divided, like an hour-glass, into an external and internal part, both almost surrounded by blood spaces, and there is a blood-circulation between the embryo and the external yolk-sac by which nutritive material is transferred from the sac to the organs of the body. Growth of the arm-musculature cuts off the circulation to the external yolk-sac, and at this time the yolk is passed from the outer to the inner sac by regular contractions of circum-oral muscles, so that the internal yolk-sac occupies almost the whole of the body cavity. During these changes the vitelline membrane of the internal yolk-sac, hitherto extremely thin, thickens rapidly, and apparently is actively concerned in the transformation of the yolk. The increase in size of the internal yolk-sac gradually brings the vitelline membrane into close relations with the liver and causes the suppression of the intervening blood sinus (except at the posterior end of the yolk-sac), which for a time has transferred nutritive material from the yolk-sac to the organs. The part of the vitelline membrane in contact with the liver is different from the rest, and here transformed yolk passes into the liver. Absorption of the yolk results in decrease of the internal yolk-sac, which finally is almost surrounded by liver. During this stage the liver has rapidly increased in size, and that part in contact with the active vitelline membrane is clearly different from the rest; and the authors suggest the liver is performing two functions,—that common to the whole organ, as in the adult liver, and another—confined to the cells in contact with the yolk-sac—the transformation of the yolk. They suggest that the transformed yolk, mixed with the digestive secretion of the liver, passes to the pancreas, where it is absorbed into the blood stream.

NOMENCLATURE OF GENES.—Breeding work with the domestic fowl at the Anikovo Genetic Station, near

Moscow, of which N. K. Koltzoff is director, led to the publication in 1926 of an extensive monograph in Russian with an English summary, on the genetics of fowls, written by Serebrovsky, Shivago, and others. The results of this work are abstracted by Dr. L. C. Dunn in *Jour. Hered.*, vol. 19, No. 11. The work aims at an analysis of the different breeds of hens in terms of their genes. Particular chapters are devoted to inheritance of the size of the red blood corpuscles and the catalase content, the genetics of growth and size, and of egg-laying. Another is concerned with the chromosome complexes. In this work, Serebrovsky introduces a new system of symbols (first proposed in 1921), which aims at producing an international method of naming genes, by which the same symbols will be used for the different groups of animals and also for plants. The scheme is to subject every gene to a decimal system of classification, by which it receives a number based on its most characteristic phenotypic character. Genes are first divided into ten classes according to whether they are histological, physiological, colour characters, etc. These are each divided into ten groups, such as intensifiers, inhibitors, modifiers, etc. The numbers so obtained are translated into letters according to an arbitrary table, so that a pronouncable word of four or five letters will result. Thus *tifa* refers to the gene for melanin pigment, and *trage* to the barring factor. When the same system of naming is applied to other groups, such as mammals or flowering plants, difficulties may arise, but there is certainly much need for uniformity in the nomenclature of each group.

FORESTRY IN SWEDEN.—In view of the importance of the world's resources of soft timber and the tendency for the supplies to decrease, it is of interest to note that in an address on forestry in Sweden printed in the *Journal of the Royal Society of Arts* for Dec. 7, Prof. E. P. Stebbing stated that the annual cut does not exceed the increment in that country although fifteen to twenty per cent of the areas felled annually are reforested by direct sowing or planting : the remainder are naturally regenerated. At the same time, he pointed out that, while timber cutting on a large scale is in the forests favourably situated for access and transport, the increment is in young woods which will not be available for timber for many years. In the interior of Norrland and in Svealand, the exploitation of mature and over-mature timber exceeds the increment. In southern Sweden there is a shortage of older timber, but young forest is much in evidence. Considerable progress is being made in reclaiming marsh, heath, and bog for forest land. This is done mainly by the State and the large timber companies, but small proprietors are following the example thus set. More than three thousand miles of forest drains were cut throughout the country in 1925, which gives some idea of the scale on which the problems of the forest lands is being faced. Other aspects of Prof. Stebbing's paper are of value in application to the forest lands of Great Britain.

EXPERIMENTS IN MOUNTAIN BUILDING.—The problem of *échelon* folds and the closely related phenomena of accurate folded mountains have been investigated by T. A. Link in a series of experiments carried out in the geophysical laboratories of the University of Chicago (*Jour. Geol.*, pp. 526-538 ; 1928). It was found that differential stress transmission in the horizontal plane, through rigid materials bordering incompetent beds, gave rise to *en échelon* folds and arcuate systems, even though non-rotational compression was applied. The same effects were produced in homogeneous materials by applying rotational compression. That is to say, differential stress transmission in geological formations may result from lateral variation in plasticity, rigidity, or competency in general. It is shown that some of the experiments gave results comparable in tectonic structure with that of the Jura mountains. The latter are interpreted as an arcuate system in relatively incompetent beds bordering the outer edge of the competent Nägelfluh conglomerate through which the stresses from the Alps were transmitted.

ORE DEPOSITS OF JAPAN.—For many years Prof. Takeo Kato, of the Tokyo Imperial University, has been occupied with an intensive study of the late Tertiary vulcanism and associated ore deposits of Japan. He has usefully summarised the results of these researches in a contribution to the *Jap. Jour. Geol. and Geog.*, 1928. Volcanic activity is represented by the characteristic succession: (1) Rhyolite and associated tuffs ; (2) pyroxene-andesite and associated tuffs ; (3) minor intrusive dykes of andesite, porphyrite, etc. Mineralisation took place repeatedly in (1) and (2), and the ores are generally, though not always, cut by (3). Certain basalt dykes cut the whole series and are of the post-Tertiary age. The late Tertiary rocks are regarded as the derivatives of a parent magma cooling under plutonic conditions at a comparatively shallow depth, the mineralising solutions being the residual liquors expelled during a late stage of solidification. The volcanic rocks and the ores are thus consanguineous, the parent of each being concealed in the depths, except locally, where crustal disturbances and erosion have been unusually active.

SEMINOLE OILFIELD, OKLAHOMA.—This oilfield, one of the greatest the world has ever known, has attracted attention not only on account of a prodigious production—200,000,000 barrels to the end of June 1928—but also for many important technical reasons. Recent developments prove that no less than five separate oil-pools occur in this field, known as Seabright, Seminole City, Bowlegs, Little River, and Earlsboro. A geological feature of note is that the main producing horizon, the Wilcox Sand, is of Ordovician age, not younger Palæozoic, the case with the majority of oil-fields in the Mid-Continent region. Some production is also obtained from the Hunter Lime, of Silurian-Devonian age, principally in the Seabright unit. The Wilcox Sand lies at depths ranging from 4000 ft. to 4300 ft., according to well-location ; it yields an oil of gravity varying between 0·814 and 0·840. Drilling and production technique in this field have recently been described by Mr. G. Heseldin to the Institution of Petroleum Technologists, and, as might be anticipated, provided much interesting data, having regard particularly to the size of the pools, rock conditions, oil and gas pressures, and general rapidity of development. Much of the drilling is by rotary drill down to depths of 3700-3800 ft., when 8¼-inch casing is set and drilling continued with cable tools, this being practicable owing to the comparatively low pressure of the oil in the sand. Some idea of the intensity of development can be gleaned from an example of one well quoted by the author : this took four days to complete the rig ; five days later drilling commenced ; in less than fifteen weeks drilling was completed to 4485 ft., 4100 ft. of this being made in 50 days. The drillers work in what are known as 'twelve hour towers' and for seven days per week. The greatest footage made in one 'tower' was 220 feet.

SUPERCONDUCTIVITY.—The September issue of the *Journal de Physique* contains the address on this subject which Prof. de Haas, of Leyden, gave to the French Physical Society in May last. When a metal such as mercury has its temperature reduced, its electrical conductivity increases in the usual way until the temperature is within a few degrees of the absolute zero—4·2° absolute in the case of mercury—when the conductivity becomes very large. Without any change of temperature, the conductivity may be reduced by the application of a magnetic field in the direction of the current, and on withdrawal of the field the metal becomes again a superconductor. If the field be withdrawn gradually, the superconductivity is acquired in steps, and the steps occur at different fields in different parts of the conductor. The author ascribes this to the formation of filaments of atoms along which the electrons move freely, and not to the presence of free electrons in the spaces between the atoms. Superconductivity is brought about by the facility with which the 2, 3, or 4 electrons of the outer layer of an atom can pass from atom to atom when the irregular movements due to temperature have been reduced.

Lightning and Overhead Electric Power Lines.—The high-pressure overhead systems which electricians are now using to convey electric power from their generating stations to their distributing stations have to be protected against the effects of lightning strokes by safety devices. In the *Westinghouse International Journal* for January, E. Beck describes the methods being adopted and the apparatus used by the Westinghouse Company to find out the exact nature of the disturbance caused by a lightning flash in the immediate neighbourhood of an overhead high-pressure power system. The experiments are being made in the Smoky Mountains of Tennessee, U.S.A. A special research staff is employed and elaborate instruments are used. The disturbance of the voltage of the overhead system when a flash occurs acts on a Dufour cathode ray oscillograph and a photograph of the transient disturbance is obtained. Radio receiving sets and a special form of relay which rings a bell are used for signalling the approach of a storm. The photographic film moves with a velocity of 12,000 feet per minute. It is found, however, that this is only suitable for the measurement of slow lightning transients. In order to get a record of the more rapid effects, a rapid oscillatory motion is given to the electron beam. Another instrument used to locate the position of the stroke is called the 'osiso.' It is used to measure accurately the time between the beginning of the oscillograph transient and the arrival of the noise of the thunder as recorded on a film. Two of these instruments enable the accurate position of the stroke to be found by triangulation. A special form of camera is also used, which enables a photograph of the entire horizon to be obtained. It is hoped in this way to find out the connexion between lightning strokes and the ensuing disturbances on overhead systems.

Circuit Breaking with Heavy Currents.—The difficulties that have been experienced in switching off very large electric currents in circuits which contain an appreciable amount of inductance have led manufacturers to make many careful experimental researches on the subject. Since 1922 the British Electrical Research Association has been experimenting on 'circuit breaking' with special reference to the rupture of the arc. A paper giving an introduction to these researches, by E. B. Wedmore, W. B. Whitney, and C. E. R. Bruce, was read to the Institution of Electrical Engineers on Dec. 20. The experiments were carried out at the Carville power station at Newcastle. Three special cases were considered when the separating contact pieces were immersed in oil. In the first case, the arc goes out in a bubble of gas separating the contacts. In the second case both oil and gas are present together; and in the third case the whole path is filled with oil. The last case is an exceedingly rare occurrence, and the second case presents great difficulties, as it is almost impossible to determine the relative amounts of oil and gas present in the path of the arc. Hydrogen is the principal constituent of the gases produced by arcing in oil. It was found that a relatively large proportion of acetylene was produced—in some cases it was as large as 30 per cent. This is much larger than that found by previous investigators, due possibly to neglect of the fact that acetylene is soluble in water. The breaking of an alternating current circuit simplifies the problem of how to prevent the arc restarting once the current has attained zero value. Some interference with the arc is necessary during the flow of current. Merely to increase the speed of separation of the contact pieces or to use magnetic 'blow-outs' is not necessarily a satisfactory solution. It has been shown to be possible to rupture arcs in air, the current in which is approximately 7000 amperes in value and the potential difference across which is 5500 volts, with a single air gap only ⅜ inch in length.

Ignition of Firedamp.—The Safety in Mines Research Board has just issued *Paper* No. 46 on the ignition of firedamp by the heat of impact of rocks, written by M. J. Burgess and R. V. Wheeler. The subject is an important one, because there are a number of examples on record in which the heat or the sparks evolved by falling rocks appeared to be the only possible explanation of certain mysterious colliery explosions. The difficulty has been that hitherto there has been no definite proof that firedamp could be ignited in this way. That proof is supplied in the present paper, in which experiments are described in which a block of siliceous rock was pressed against a revolving wheel made of the same rock, and it was found that ignitions of firedamp could be produced comparatively easily under these conditions and that weak mixtures of methane and air could be ignited more easily than rich mixtures. It was shown that an expenditure of energy of less than 200 ft.-lb. was sufficient in some cases to produce ignition, and that a duration of contact between the rock surfaces of between ⅜ths and ⅝ths of a second was sufficient for ignition. The paper is a record of a very valuable piece of work, which will no doubt tend to throw light upon one of the possible causes of colliery explosions.

New Method for Measuring Osmotic Pressure.—The experimental study of osmotic pressure is a matter of considerable difficulty. Apart from its importance in biology, a convenient method of measuring osmotic pressure would be of great value in the investigation of dilute solutions, and hence it is interesting to note that a new method is described by R. V. Townend in the *Journal of the American Chemical Society* for November. It can be applied to any non-volatile solute in a volatile solvent, the solution and pure solvent being separated by the vapour phase, which acts as a diaphragm permeable to solvent molecules only. The pure solvent is located within the capillaries of a porous plate and the liquid at the surface of the plate is placed under a tension so that the normal curvature is altered and the vapour pressure reduced. The rates of distillation from solvent to solution are measured under different tensions, and the osmotic pressure, *i.e.* the tension for zero distillation, is obtained by extrapolation of the resulting curve.

Annual Exhibition of the Physical and Optical Societies.

THE Imperial College of Science and Technology, London, was once more the scene of the annual exhibition (the nineteenth) of the Physical and Optical Societies on Jan. 8, 9, and 10. The large number of visitors again testified to the widespread interest in the Exhibition on all sides, and its usefulness to trade and industry was evident by the exhibits, bewildering in their number and variety, of the various sections. The general arrangements were similar to those of last year, and congratulations must once more be offered to Mr. T. Martin as secretary, on the success which attended the Exhibition and to all those responsible in various ways for their unfailing courtesy and helpfulness.

It is impossible in a short description to do justice to every part of the Exhibition, and the only plan that can be followed, therefore, is to mention, so far as possible, some of the exhibits typical of recent developments in research and industry.

In the Trade Section there were eighty-two exhibiting firms. Among their exhibits the following may be mentioned : Messrs. Baird and Tatlock, Ltd., the Sutton photometer bench and a pump with double-acting pistons for aerating aquaria tanks, etc., its special attributes being its silent action and economy in use. Bakelite, Ltd., a new flaked fabric moulding material, particularly resistant to shock. The British Metallising Company, Ltd., had an exhibit illustrating the present and possible uses to scientific instrument manufacturers of their process of producing a metal film or coating firmly adherent to a non-metallic base, on which in turn a large range of non-ferrous metals may afterwards be plated to any desired thickness. The Cambridge Instrument Company, Ltd., the Campbell A.C. Potentiometer (Larsen type) ; a modified form of the photoelectric microphotometer originally developed by Dr. G. M. B. Dobson, a new portable form of electrocardiograph, and other novelties. The Edison Swan Electric Company, Ltd., various Ediswan battery eliminating devices for wireless receivers and other devices for wireless outfits, and a gas-filled rectifier for heavy currents for charging car batteries. The Foster Instrument Company, the intrascope, a new instrument for internal examination of tubes, bores, and other enclosures in which, by means of a novel optical system, examination of industrial structures can be made in the same way as with the cystoscope on the human body. The Research Laboratories of the Gramophone Company, Ltd., a logarithmic recording galvanometer, by means of which the electrical response curve characteristic of a gramophone pick-up can be obtained photographically and plotted automatically with a logarithmic scale ; a demonstration of the vibrations of a membrane type loud speaker by means of lycopodium powder aroused much interest. Messrs. Hilger, Ltd., Dr. Jean Thibaud's grating spectrograph for the study of soft X-rays and of the extreme ultra-violet, in which the ruled grating is so placed that the incident rays fall almost tangentially upon its surface ; some samples of pure earths—spectroscopically standardised substances. The Igranic Electric Company, Ltd., the transverse current microphone, the Phonovox electrical reproducing equipment. Messrs. E. Leitz, London, a new pattern ultra-microscope for the investigation of elements in colloids. Marconi's Wireless Telegraph Company, Ltd., a signal strength measuring set with a wave range of 14-5000 metres ; a tuning-fork and thermostat unit for maintaining constant frequency in facsimile transmission. The M. L. Magneto Syndicate, Ltd., Coventry, the M-L noise comparator—an instrument designed to give a quantitative measure for noises in industrial mechanism, a direct-reading apparatus which requires no aural observation, and can be operated by an unskilled observer. The National Glass Industry, Dewar's flasks for liquid air, etc., and various experimental glassware. Negretti and Zambra, a new industrial type of ventilated hygrometer, a new recording rain gauge to overcome the difficulties of the self-syphoning type. Siemens Brothers and Co., Ltd., distance thermometers of various types, the substantial construction of these being of particular note. H. Tinsley and Company, a portable electric harmoniser under the patent of Prof. Miles Walker. Messrs. Beck, various new microscopes, including the No. 22 metallurgical microscope. Messrs. Carl Zeiss, London, Ltd., a hand sugar refractometer, and refractometer for the oil and sugar industries. Messrs. Bellingham and Stanley, Ltd., showed a new model critical angle refractometer, quartz spectrographs, etc.

In the Research and Experimental Section there were sixteen groups of exhibits illustrating recent physical research. The Brown Firth Research Laboratories had an interesting demonstration of dyed fabrics, showing in a striking manner the different tints of colour obtained when using container vessels of enamelled iron (taken as standard), copper, iron, nickel, lead, and Firth 'staybrite' steel. Among other examples of the applications of photoelectric cells, the Research Laboratories of the General Electric Company showed an apparatus for the detection of dust or smoke in air or gases. The National Physical Laboratory supplied eleven exhibits, among which may be mentioned Dr. D. W. Dye's interferometer for the examination of the modes of vibration of piezo-electric quartz plates ; by means of this apparatus the interference fringes are disturbed by the vibration of the quartz plates and the whole area can be mapped into its nodal and antinodal parts ; and a beat tone oscillator as a low and telephonic frequency source of good wave form and constant output for testing purposes ; a high temperature resistance furnace and electric radiator by Dr. W. Rosenhain and Mr. W. E. Prytherch, in which the heater elements are of particular note ; a method of measuring flame temperature by spectrum reversal by Dr. Ezer Griffiths and Mr. J. H. Awbery. The Air Ministry Section of the Meteorological Office had five exhibits, including a sky-photometer and an electrical wind-direction recorder. Prof. E. W. Scripture, of Vienna, showed a graphic apparatus for the registration of speech, and the strobilion, an apparatus for rendering the frequency of the voice tone visible. Dr. J. H. Vincent showed some experiments in magnetostrictive oscillations at audio and radio frequencies.

In the section devoted to lecture and instructional experiments in physics, Mr. S. R. Humby gave some beautiful demonstrations of experiments by means of a modified Tyndall apparatus, showing that the laws of reflection of light hold accurately for sound—illustrating Lloyd's single mirror fringes, Lippmann's stationary light waves and other effects. Messrs. W. and T. Avery, Ltd., Research Department, had a number of exhibits illustrating the mechanics of the freely suspended beam and of linked weighing mechanisms. Other exhibitors in this section were Mr. J. E. Calthrop, Dr. R. S. Clay, Mr. C. W. Hansell, Dr. L. F. Richardson and others of Westminster Training College, Dr. G. D. West, and the Physics Department of the Wigan and District Mining and Technical College.

The Historical Section again provided an opportunity for a survey of past development in science, all the more striking for being placed near the exhibits of such modern developments as those of the Igranic and Gramophone and other companies. The exhibits included some examples of scientific instruments to illustrate the work of a series of London instrument makers in direct succession from Christopher Cock (seventeenth century) to Elliott (nineteenth century), contributed by Mr. T. H. Court, among which may be noted Robert Hooke's own microscope; photographs of the original apparatus used by Alessandro Volta in his researches of 1763–1819, exhibited by Mr. Robert W. Paul; and some early and primitive time-measuring devices contributed by the Science Museum, from early Egyptian water clocks to a seventeenth-century turret clock from St. Giles' Church, Cambridge.

The discourses once more attracted keenly interested audiences, whose appreciation was obvious. That on the first evening was delivered by Prof. F. Lloyd Hopwood, whose subject was "Experiments with High Frequency Sound Waves." He made use of a quartz piezo-electric oscillator, the crystals being cut in the form of circular discs with their plane faces parallel to the optical axis and at right angles to an electric or binary axis. This method of producing vibrations is due to Prof. Langevin, of Paris, and many practical applications of it have been made both in peace and war. The quartz discs were immersed in transformer oil contained in glass tanks, suitable arrangements being made for producing both horizontal and vertical beams of sound. The method used in connexion with a horizontal beam was due to Prof. R. W. Boyle, and exemplified stationary waves (obtained by reflection and rendered visible by the striæ formed in dust lying on a horizontal sheet of glass in the path of the beam), interference patterns, defraction effects; attenuation (observed by bringing into action the frictional dissipation of energy due to the viscosity of the oil vibrating in a confined space, achieved quite simply by supporting a second glass plate almost in contact with the fir s; pressure of sound radiation, shown by means o Langevin's acoustic radiometer. Some biological effects brought about by the agency of ultra-sonic sound waves were then described and illustrated by means of slides—a beautiful example being the segregating of the chloroplasts in the fresh-water plant *Nitella*. By making use of a vertical beam of ultra-sonic waves some experiments were shown illustrating phenomena not usually associated with sound. These depend on the effect of pressure due to radiation on the surface of oil, which is strikingly shown by the formation of a mound of oil which erupts drops like a miniature volcano. By plunging vessels of appropriate form into this mound, vibrations of great intensity are communicated to the walls of the vessel, or through the walls to liquids contained in them. By these means it is possible to show cavitation in water; the vaporisation of benzene; transverse vibrations of a solid by the pattern produced in a test tube dusted with lycopodium powder; and the calorific effect by melting a wax ball, which can be made to simulate the descent of a time ball.

On the second evening, Mr. Conrad Beck discoursed on "Lenses." The Greeks, he said, at least as early as 430 B.C., learnt that a piece of glass with curved surfaces could be used as a burning glass, and the derivation of the word 'focus' is from the word meaning 'altar' or place of fire. Text-books treat the focus as a geometric point formed by light entering the lens as a parallel beam. This is incorrect and leads to misconception. The focus of the ancients was a finite spot and not a point. Mr. Beck said that the way to understand the action of a lens is to study how it produces an image, for which three processes are necessary: the production of an image of a spot in the centre of the object on the axis; the direction of the axial rays from spots on the object away from the axis; and the examination of a complete bundle of rays from the marginal spot on the object. The Gallilean field glass, telescopes, periscopes, photographic and projecting lenses were discussed, and the study of the Gauss theory for the invention of new and original types of instruments was advocated. Mr. Beck considers that great attention should be paid to the more elementary principles of image formation before the questions of the correction of aberrations or the considerations of diffraction are investigated.

The lecture on the third evening, entitled "Some Colour Problems in Photo-Engraving," was given by Mr. A. J. Bull, and dealt with the effects in three-colour printing of errors in the selective absorption of the three-colour 'filters' and printing inks. Experiments were shown in which white light was imitated by superposing the colours transmitted by three-colour 'filters,' and it was shown that to obtain a white a larger area of blue filter is required than green, and a larger area of green filter than red—blue, green, red being the order of their increasing transparency. The colours obtainable are, however, fairly pure and close to theoretical requirements, so that screen plate processes give colour photographs which are fairly accurate as to colour but much lower in tone. This was shown by examples with the Lumière Autochrome plate. The ideal double colours which are desirable for the purposes of printing were shown by optical superposition of red and green images to obtain a yellow printing colour, green and blue images to obtain a 'blue' printing colour, and blue and red images to obtain a magenta or 'red' printing colour. These were contrasted with the colours of inks actually obtainable and the inaccuracies introduced were shown. These take the form of darkening blues and greens and a loss of reflected blue light with purples and pinks. The methods used for retouching were indicated; in half-tone work the skill of the colour etchers is such that excellent colour prints can be obtained by them from monochrome originals.

KATHLEEN E. BINGHAM.

Annual Conference of the Geographical Association.

THE annual conference of the Geographical Association was held at the London School of Economics on Jan. 3–5. In addition to the usual business meetings, and some discussions on special problems of the teaching of geography, there were public lectures on some recent research work; and the chief part of the presidential address was also concerned with geographical investigation. The president, Sir H. G. Lyons, gave a concise review of the year's activities and then indicated the vast mass of material now available for geographical study in the reports and maps of the many national and other surveys now at work, and some of the difficulties of access to this material. He suggested that the Association should seek the co-operation of other interested societies in attempts to obtain some satisfactory classification of, and readier access to, this material.

Of the four main papers,[1] three dealt with human

[1] Geomorphological Problems of the Eastern Alps, by Prof. J. Sölch. Natural Environment related to Human Activity in the Corn Belt of North America, by Dr. P. W. Bryan. The Balance of Urban and Rural Populations, by Prof. C. B. Fawcett. On Linguistic Frontiers in the Borderlands of German Speech, by Dr. Vaughan Cornish.

geography and only one with a purely physical problem. This is a reversal of the proportions which held good in most geographical work even a few years ago; and it marks the extent to which geographers are now attempting to investigate their central problem of the relations of man to his environment and his modifications of the natural environment. Dr. Bryan gave a vivid account of the cultural landscape of rural central Illinois as it is to-day, after more than half a century's work by a population of skilled agriculturists, under favourable physical, political, and economic conditions, has made that area the heart of the Corn Belt. Here the first settlers, coming from the wooded regions of Western Europe or the Eastern States, chose the forested bottom lands as the most fertile and left the treeless prairie untouched; though their choice was also influenced by the fact that they were dependent on the rivers for bulk transport in the pre-railway period. But the soils of the open prairies, fertilised by the humus accumulated from the annual sod of many centuries and retaining their fertility better than the soils of steeper slopes and wetter bottoms, where also tree growth gave a less quantity of humus, are better than any of the other soils except annually renewed river alluvium; and so the prairies are now the richer farmland. The corn belt is by no means a one-crop area, like so much of the cotton belt and some newer parts of the wheat region to the north-west. The corn (maize) is usually grown for two years of a four-year rotation on the best soils and one year in three on other soils. The specialisation of farms in the use of the corn for sale as grain, or for feeding dairy or beef cattle, or swine, is determined mainly by the relative transport facilities for the more or less rapid disposal of their produce by rail to the cities.

A contrast to this account of a modern adjustment to a particular type of environment was furnished by Dr. Cornish's study of the borders of German speech. The author's thesis was that these borders were, for the most part, fixed at the time when Christianity was adopted by, or imposed on, the several peoples concerned; that the Church estimated carefully, and usually accurately, the territorial limits of the languages in use by its converts, and adapted its organisation of bishoprics and archiepiscopal provinces to those limits; and further, that through this organisation the Church did much to stabilise the boundaries which it had adopted and the languages which it recognised and helped to develop. Thus, on the whole, the boundaries established from the fifth century (in the west) to the thirteenth century (in the north-east) remain to-day. The thesis was illustrated by detailed studies of the linguistic borders in Belgium, Alsace-Lorraine, Switzerland, Tirol, Carinthia, Bohemia, Poland, and Slesvig.

The third paper, by Prof. C. B. Fawcett, was an examination of a particular problem of the distribution of population. The differences of classification in various censuses make it impossible to obtain close and trustworthy comparisons of the proportions of urban and rural populations in many countries. According to such census returns, the urban population ranges from 10 per cent of the total in India to 79 per cent in England, and from 3 per cent in Assam to more than 90 per cent in the southern states of New England. Such numerical comparisons are only possible for part of the last century and for the more advanced countries. The maximum numbers of the urban population are fixed by the surplus food produced by the rural population, in any self-contained region and in the world as a whole, and the possibility of transporting that food to the towns. As a result of the improvement of the tools and technique of agriculture, and of transport, during the last two centuries the urban population is now more than half of the total in most of the lands of western civilisation. These improvements act in two ways, first by reducing the number of workers required to cultivate a given quantity of any crop, and second by enabling almost all the industries other than agriculture to be concentrated in the towns. A study of the numbers of the agricultural workers and the proportions of home-grown foods in Great Britain led to the estimate that under the conditions of this country the rural population, not including therein urban workers resident in rural districts, should number at least 25 per cent of the whole population to make the country self-supporting in regard to its principal foodstuffs.

Prof. Sölch's lecture was accompanied by a number of magnificent photographs of Alpine scenery illustrating the existence of several comparatively plane, though much dissected, surfaces, which he termed 'flats,' at various altitudes in the Alps. He compared these with similar land forms in the British highlands, and appealed for comparative studies and co-operation in the task of investigating the ages of these 'flats' and their relations to different stages in the uplift of the Alps and to glacial and interglacial periods.

These papers will probably be published in full in early numbers of *Geography*, the magazine of the Geographical Association, which is to be issued as a quarterly from now on.

University and Educational Intelligence.

APPLICATIONS are invited by the committee of the Royal Society and the University of Sheffield appointed to administer the Sorby Research Fund, for the Sorby research fellowship, value £500 per annum and tenable for five years. Particulars may be obtained from the Assistant Secretary of the Royal Society, Burlington House, London, W.1.

IN the recent Report of the National Fuel and Power Committee it was stated that the most economic use of fuels is largely dependent on a highly trained personnel. With this in mind, the Governors of the Sir John Cass Technical Institute, Aldgate, E.C.3, are extending their existing courses in fuel technology by an advanced and post-graduate course on "Coal Carbonisation," and the inaugural lecture will be delivered by Dr. F. S. Sinnatt, of the Fuel Research Board, on Jan. 28 at 7 P.M. Admission to this lecture is free.

NEGRO universities and colleges in the United States of America have six times as many students as they had ten years ago. This very striking growth is one of the developments brought to light by a comprehensive survey of 79 institutions for the higher education of negroes recently completed by the United States Bureau of Education. It means that the negro universities and colleges have been growing three times as fast as the others. Their aggregate annual income increased in the same period nearly fourfold. Even now, however, their students constitute only one-sixtieth of the total number of university and college students in the United States, and their incomes amount to only one-fiftieth of the aggregate incomes of all such institutions. Although there has been a correspondingly rapid increase in the number of negroes entering the professions for which preparation can be had only in institutions for higher education, the number of negro doctors, dentists, architects, engineers, etc., is still wholly insufficient to provide all the professional service required by the negro population.

Calendar of Patent Records.

January 21, 1630.—The first patent to contain a direct proposal to raise water by fire was granted in England to David Ramsey, one of the grooms of the Privy Chamber, on Jan. 21, 1630. The patent recites a number of devices of which Ramsey claims to be the inventor, amongst which are "to raise water from lowe pitts by fire ; to make any sort of mills to go without the helpe of wind, waite, or horse ; to make boates, shippes, and barges to goe against strong winde and tyde ; to rayse water from low places and mynes and coale pitts by a new waie never yet in use." No record of the details of these inventions is, however, available.

January 23, 1798.—Chlorine was first suggested as a bleaching agent for cotton goods by the French chemist Berthollet, and was so used by James Watt and others, but the establishment of the industry is mainly due to Charles Tennant of Glasgow, who patented his process for absorbing the gas in lime on Jan. 23, 1798. The patent was revoked four years later on the ground that Tennant was not the true inventor, but a second patent granted to him in 1799 for the production of bleaching-powder by impregnating slaked lime in the dry state with chlorine was more successful, and Tennant's works at St. Rollox, Glasgow, became the largest in the world.

January 23, 1849.—From the middle of the eighteenth century onwards, many proposals were made for the coking and industrial utilisation of peat, but the first large peat distillation factory was started by the Irish Peat Company at Kilberry, Co. Kildare, Ireland, to work the process invented by Rees Reece, for which an English patent was granted to him on Jan. 23, 1849. The process created great interest, and a Government Commission was appointed to investigate its possibilities, but the factory was compelled to close down a few years later.

January 24, 1578.—London was given its first water supply by Peter Morris, who was granted a patent for 21 years for his engine for raising water, on Jan. 24, 1578, and later obtained permission from the City Corporation to pump water from the Thames into the City by means of water-wheels placed in the arches of London Bridge and driven by the tide. The installation, completed in 1582, and enlarged from time to time by the addition of further water-wheels, furnished the City with water for 240 years, and only came to an end with the demolition of the old bridge in 1822.

January 24, 1730.—An important event in the history of chocolate-making was the patent granted to Walter Churchman of Bristol on Jan. 24, 1730, for an invention described as "a new invention and method for the expeditious, fine, and clean making of chocolate by an engine driven by a water wheel." The exact process was kept secret, but on Churchman's death the business was purchased by Joseph Fry, and thus became the starting-point of the well-known firm of J. S. Fry and Sons. The water-wheel was replaced by a Watt steam-engine before 1798.

January 26, 1796.—E. T. Jones, accountant of Bristol, was granted a patent on Jan. 26, 1796, for his "new-invented speedy and effectual method or plan for detecting errors in accounts of all kinds, and whereby such accounts will be kept and adjusted in a much more regular and concise manner than by any other method hitherto known." The patent would not presumably have stood the test of an action in the courts, but it no doubt served as an excellent advertisement for the pamphlet explaining his system, which Jones issued, with a licence to use it, at the price of one guinea.

Societies and Academies.

PARIS.

Academy of Sciences, Dec. 10.—Maurice Hamy : A consequence of a property of diffraction by a circular aperture.—Charles Moureu, Charles Dufraisse, and Marius Badoche : Autoxidation and antioxygen action. (33) The catalytic properties of antimony, bismuth, and their derivatives, and of some vanadium derivatives. The experimental results are summarised in eight diagrams. The catalytic properties of vanadium compounds were very marked.—L. Cayeux : The existence of fresh-water spongoliths in the Gard coal basin. The 'silex' of Doulovy is composed of spongoliths, exceptionally rich in spicules, and proves the existence of fresh-water sponges at a very remote period.—Gabriel Bertrand and Boje Benzon : The proportions of zinc in plants used for food. The leaves of plants contain zinc in amounts which increase with the proportion of chlorophyll present. Bulbs (garlic, onion) and seeds contain the highest percentages of zinc.—Riquier : A problem relating to the partial differential equation $\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)^n u=f(x, y)$. — Jean Baptiste Senderens : The catalytic dehydration of alcohols by alkaline bisulphates. Several dehydrations hitherto carried out with potassium bisulphate can be effected with greater facility with sodium bisulphate. Details of the preparation of cyclohexene from cyclohexanol are given.—Charles Nicolle, Charles Anderson, and Jacques Colas-Belcour : The experimental adaptation of recurrent spirochætes to species of *Ornithodora* other than those which transmit them in Nature. The necessary conditions for success in these experiments are that nymphs must be used, since although adults can be infected they are incapable (with rare exceptions) of transmitting the spirochætes by their bites, and to utilise for the infecting meal an animal the blood of which is rich in spirochætes.—Serge Bernstein was elected *Correspondant* for the Section of Geometry.—Paul Delens : The calculus of spherical operations.—Marcel Vasseur : The deformation of a surface with a conical conjugated network.—Pierre Rivet : The contact of skew curves and of surfaces.—Mandelbrojt : A generalisation of a theorem of M. Hadamard.—Florin Vasilesco : The nature of irregular and regular points and their distribution on the frontier of a domain.—Belzecki : Some cases of equilibrium of elasticity of a rectangular prism.—D. Pompeiu : A formula generalising Cauchy's integral and its interpretation in hydrodynamics.—Henri Bénard : Alternate vortices and the law of dynamic similitude.—G. P. Arcay : The influence of vibrations on the rate of chronometers. Vibrations bring about a change in the rate of the chronometer, usually a retardation, and part of this change in rate is permanent. The results of the experiments are given in detail.—Josef Mikuláš Mohr : The law of frequencies of the velocities of stars and the relation between the absolute magnitude and absolute velocity for *G*-type stars. The distribution of the frequencies of the absolute velocities of these stars, found by the author for 519 stars, is in agreement with the law of Adams, Strömberg and Jay, resulting from the study of type *K*.—R. Jarry-Desloges : The period of the planet Venus. The figure deduced is 23 hours 53 minutes, but this result is approximate only, since it implies no change in the markings on the planet during a terrestrial day.—E. Pierret : Oscillators with very short waves.—G. Grenet : The Hughes induction balance for the determination of the susceptibility of rocks. By the use of the methods and apparatus of wireless telephony, the sensitiveness of the Hughes induction balance can be increased to a marked extent. The apparatus requires some tedious preliminary adjustments, but once set up, the determination of the magnetisation coefficient of a rock can be completed in five minutes.—**Paul Soleillet** : The theory of the polarisation of light emitted by fluorescence.—**Mlle. Jacqueline Zadoc-Kahn** : The refractive indices of a mesomorphic substance in the solid state. Details of the measurements of the three principal refractive indices of crystals of para-azoxyanisol. From the results, this is one of the most strongly doubly refractive substances known.—**R. Coustal** : The permanent luminescence of certain crystallised salts of uranium. Uranium salts have a faint permanent luminosity, visible only after the eye of the observer has been in complete darkness for thirty minutes or longer. The effect is shown most strongly by the sulphate, the nitrate rather less, acetate and other salts much less. The explanation is based on energy derived from the radioactivity of the uranium.—**Pierre Auger** : The directions of emission of the photoelectrons.—**A. Boutaric** and **M. Doladilhe** : The electrosmosis of mixtures of electrolytes.—**Pierre Jolibois** and **Pierre Montagne** : A rapid method of calculation of homogeneous dissociations. Application to carbon dioxide. A graphical method is described and illustrated.—**Lécorché** and **Jovinet** : Study of the mechanism of the stabilisation of nitroglycerol powders by diethyldiphenylurea. As soon as the powder becomes acid, the nitrous acid formed is absorbed, giving ethylphenylnitrosamine ; the latter can be readily determined by a colour method based on the reaction with α-naphthylamine and hydrochloric acid.—**Albert Portevin** : The action of sulphur dioxide at high temperatures on glasses and basic rocks and a probable origin of sulphate mineral springs. Sulphur dioxide, even when diluted with other gases, at high temperatures attacks basic rocks and glasses superficially, forming the sulphates of the alkalis and alkaline earths. The attack is selective, as in spite of the low proportion of sodium in the rocks attacked, the deposit consists mainly of sodium sulphate.—**J. Fallot** : The northern limit of the subbetic overthrusts between Sierra Sagra and Rio Segura.—**Léon Moret** : The extension of the strata containing *Hemithersitea* and phosphate in the southern slope of the Marrakech Atlas (Morocco).—**Aug. Chevalier** : The origin of the Imbuia wood (Brazilian walnut) of Brazil and the biology of the producing tree, *Phœbe porosa*, belonging to the Lauraceæ family.—**Pierre Dangeard** : The favourable action of potassium iodide on iodovolatilisation. The emission of free iodine by certain algæ is increased by treatment with sea water containing a small proportion of potassium iodide in solution.—**Paul Guérin** : Hydrocyanic acid in lotus. A discussion of the amount of hydrocyanic acid present in varieties of *Lotus*, with reference to possible danger as fodder.—**Serge Yourièvitch** : The energetics of the ocular movements.—**G. Hamel** and **J. Feldmann** : The geographical distribution of the Fucaceæ and *Laminaria* on the western coasts of the Iberian peninsula.—**A. Magnan** and **A. Sainte-Laguë** : The experimental determination of the resistance to the forward motion of fishes. The results of a kinematographic study giving true velocities.—**S. Posternak**: A new organic phosphorus compound in the red blood corpuscles. The new compound is probably a diphosphate of α-ketotrioxyadipic acid.—**Y. Manouelian** and **J. Viala** : The spinal marrow, the bulb, the protuberance, and the parasite of hydrophobia.—**Et. Burnet, P. Durand,** and **D. Olmer** : Marseilles exanthematic fever is absolutely distinct from exanthematic typhus fever. The Marseilles fever does not give immunity against typhus (in the ape), and acquired immunity against typhus does not prevent the development of Marseilles fever, thus proving that the two diseases are distinct.—**Camille Nachet** : A new arrangement for the simultaneous registration of three selected images for the production of photographs in colour.

GENEVA.

Society of Physics and Natural History, Nov. 8.—**Pierre Dive** : The existence of a permanent regime of rotation in a heterogeneous fluid with ellipsoidal stratification. The author completes as follows a proposition previously enunciated. Whatever may be the law of variation of the flattening of the layers, there exists a permanent regime of rotation which maintains the fluid in its initial stratification, except perhaps in two extreme cases. Except for this, none of the earlier conclusions requires modification.—**Rolin Wavre** : The lines of force of the field of gravity. Continuing his earlier work, the author deduces two new propositions. (1) If in a portion of a fluid the surfaces of equal density are parallel, they have also a mean constant curvature. (2) If the tangent to a line of force of the field of gravity is stationary at a point, the mean curvature of the surface of equal density passing through this point is equally stationary there.—**Fernand Chodat** : The rôle of plants in the atmometric equilibrium of their phyllospheres. New atmometric researches made at the Linnæus alpine garden show that each plant association creates for itself a specific atmosphere, the phyllosphere. It is the same for each plant. The author gives measurements which express the contribution of different plants in the phenomenon of inhibition of the transpiration of the soil by the herbaceous covering.

Nov. 22.—**A. Borloz** : The volumetric estimation of gold in electrolysis baths. During electrolysis, the concentration of the bath diminishes, and it is desirable to have a method of determination which is both rapid and of sufficient accuracy. The author has adapted Jüpner's method (reduction of the gold in solution by a ferrous salt and titration of the excess of the latter with 0·5 normal permanganate) to the case of baths containing impurities, such as salts of bismuth, antimony, etc.—**E. Joukowsky** : Some observations on the phreatic waters of the Genevan plateau. The author has proved for two points of the same phreatic sheet, situated at a depth of about 25 metres, that the level of this sheet is always comprised between that of the lake and that of its outlet. The curves traced during several months show that the precipitations have no influence on the level of the deep waters. Variations in the level of the lake and previously of the outlet, on the contrary, are felt after a lag of several days.—**Sw. Posternak** : A new organic phosphorus compound of the red blood corpuscles. Pursuing his researches on the blood corpuscles of the horse, the author has been able to isolate in addition to the di- and monophosphate of *l*-glyceric acid, a new dextrorotatory principle, the diphosphate of α-ketotrioxyadipic acid, reducing Fehling's solution. This product is certainly related to hexosediphosphoric acid and probably represents an intermediate stage in the course of the elaboration of lactic acid in the muscle and in other tissues.

SYDNEY.

Royal Society of New South Wales, Sept. 5.—**C. A. Sussmilch, W. Clark,** and **W. A. Greig** : Geology of Port Stephens. The area dealt with is situated immediately to the south of Port Stephens. The rocks occurring here belong to the Kuttung Series, a subdivision of the Carboniferous formation. Much of the Kuttung Series throughout the area is hidden under a mantle of recent alluvian and blown sand, but the outcrops which do occur consist mainly of igneous rocks (lava flows). These Kuttung lavas fall into three groups as follows: (a) Andesites; (b) toscanites; and (c) rhyolites. The andesites occur near the base of the series, and have associated with them coarse conglomerates; the toscanites form a very thick series of flows upwards of 1000 ft. in thickness. With the rhyolites is associated a thick series of sedimentary strata consisting mainly of tuffs and tuffaceous conglomerates, but containing also thin beds of cherty shales containing fossil plants (*Rhacopteris*, etc.). These facts indicate that the district suffered from intense volcanic activity during the Carboniferous period.—**R. H. Cambage**: The outbreak of springs in autumn. During drought times it is not uncommon to hear of the outbreak of springs in New South Wales between February and June; this has nothing to do with the droughty conditions, but is the result of diminishing evaporation. These springs usually come from swamps, and often stop running during the hot weather owing to the whole of the moisture on the surface of the swamp being evaporated. At Kosciusko there is a small roadside spring which regularly flows a distance of 252 yards during the afternoon while it is in shadow, and at night, but late in the forenoon, owing to evaporation while it is fully exposed to the sun, it can only reach a distance of 160 yards. The outbreak of springs has no bearing on the duration of a drought.

Oct. 3.—**W. F. Blakely**: Description of three new Eucalypts and one new Acacia. Two of the new species of *Eucalyptus* are stringybarks; the other belongs to the Hemiphloiæ group and is allied to the broad-leaved peppermints. The acacia is an interesting alpine species with affinities to *A. podalyriæfolia*.

Official Publications Received.

British.

Board of Trade. British Industries Fair, 1929, The White City, Shepherd's Bush, London, W.12, February 18th-March 1st. Organised by the Department of Overseas Trade. Special Overseas Advance edition. Pp. xvi+400+Ad. 250. (London: Board of Trade.) 1s.

Department of Agriculture, Trinidad and Tobago. Witch-Broom Disease of Cacao and its Control. By F. Stell; and Note by the Hon. A. B. Carr; Appendix: What is a Fungus? by F. Stell. Pp. 19+2 plates. (Trinidad. B.W.I.: Government Printing Office, Port-of-Spain.) 3d.

Publications of the Dominion Astrophysical Observatory, Victoria, B.C. Vol. 4, No. 5: The Spectroscopic Orbit of H.R. 5702 and Velocity and Light Curves of 12 Lacertae. By William H. Christie. Pp. 55-65. Vol. 4, No. 6: The Orbits of the Spectroscopic Components of the two Helium Stars H.D. 19820 and H.D. 176853. By J. A. Pearce. Pp. 67-79. Vol. 4, No. 7: Two A-type Binaries and the Radial Velocities of 50 Stars. By R. M. Petrie. Pp. 81-95. Vol. 4, No. 8: The Spectroscopic Orbit of H.D. 176819 and a Note on H.D. 185936. By P. M. Millman. Pp. 97-101. Vol. 4, No. 9: Two Spectroscopic Orbits and Notes on ν Sagittarii. By J. S. Plaskett. Pp. 103-118. (Victoria, B.C.)

Royal Society of Arts, John Street, Adelphi, London, W.C.2. Report on the Competition of Industrial Designs, 1928. Pp. 46. (London.)

Papers of the Society of Painters in Tempera. Edited by M. Sargant-Florence. Vol. 1: 1901-1907. Second edition, revised and brought up to date with Appendix by the Society of Mural Decorators and Painters in Tempera. Pp. ix+96. (Brighton: The Dolphin Press.) 10s. 6d.

Foreign.

Geology and Water Resources of Palestine. By G. S. Blake. Pp. 51. (Jerusalem: Department of Lands.) 100 mils.

Annual Report of the Board of Regents of the Smithsonian Institution showing the Operations, Expenditures and Condition of the Institution for the Year ending June 30, 1927. (Publication 2927.) Pp. xii+580+99 plates. (Washington, D.C.: Government Printing Office.) 1.75 dollars.

Stanford University Publications: University Series. Biological Sciences, Vol. 5, No. 2: The Fossil Fishes of the Miocene of Southern California, Contribution No. 9. By David Starr Jordan. Pp. 16+4 plates. (Stanford University, Calif.: Stanford University Press.) 50 cents.

Catalogues.

Catalogue of B.D.H. Fine Chemical Products. (January 1929.) Pp. 130. (London: The British Drug Houses, Ltd.)

The Photo-electrical Recording Photometer. Second edition. (Mess 469/II.) Pp. 7. Photograms taken with the Recording Photometer. (Mess 469b.) Pp. 4. (London and Jena: Carl Zeiss, Ltd.)

Diary of Societies.

FRIDAY, January 18.

Textile Institute (Lancashire Section) (at Manchester), at 1.15.—J. P. O'Callaghan: Water Softening for the Textile Industries.

British Institute of Radiology (Medical Members), at 5.—Informal Discussion on Gastro-intestinal Cases.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: The Anatomy and Evolution of the Human Brain.

Society of Chemical Industry (Liverpool Section) (at Liverpool University), at 6.—C. Gordon Smith: Common Salt.

Institution of Mechanical Engineers, at 6.—J. G. Weir: Modern Feed-Water Circuits.

Institution of Chemical Engineers, (at Institution of Civil Engineers), at 6.30.—Prof. J. W. Cobb: The Reactivities of Solid Carbon in Fuel Processes (Lecture).

Society of Dyers and Colourists (Manchester Section), at 7.—Dr. S. G. Barker: The Standardisation of Fastness of Dyestuffs on Dyed Fabrics.

Royal Photographic Society of Great Britain (Pictorial Group), at 7.—M. O. Dell: Some Recent Prints from the Pyrenees.

Glasgow Society of Dyers (at 7 Gordon Street, Glasgow), at 7.15.—A. J. Hall: The Action of Swelling Agents on Artificial Silk.

Junior Institution of Engineers, at 7.30.—J. F. Petree: Notes on the Fitting and Operation of Michell Bearings.

Oil and Colour Chemists' Association (Manchester Section) (at Milton Hall, Manchester), at 7.30.—Dr. J. J. Fox: The Examination of Paints.

Institution of Automobile Engineers (Scottish Graduates) (at 51 West Regent Street, Glasgow), at 8.—J. Swan: Dynamometers.

Royal Society of Medicine (Pathology, Surgery, and Obstetrics Sections), at 8.—Special Discussion on Post-operative Thrombosis. Openers: W. H. Evans (Pathology), D. H. Patey (Surgery), V. Bonney (Obstetrics).

Royal Society of Medicine (Electro-Therapeutics Section), at 8.30.—C. T. Holland: Epiphyseal Injuries of the Wrist Joint.—Dr. R. S. Patterson: Some Factors Influencing Epiphyseal Growth and Union.

Royal Institution of Great Britain, at 9.—Sir William Bragg: Further Progress in Crystal Analysis.

Todmorden Textile Society (at Todmorden).—H. P. Curtis: Cloth Testing and Examination from the Manchester Man's View.

SATURDAY, January 19.

Geologists' Association (at Museum of Practical Geology, Jermyn Street), at 2.30.—Dr. R. Crookall: Demonstration of Coals, their Composition and Origin.

Physiological Society (at National Institute for Medical Research, Mount Vernon, Hampstead), at 3.—Dr. H. H. Dale, H. W. Dudley, H. P. Marks, and J. H. Gaddum: A Choline Ester (?) in Extracts of Spleen.—Prof. L. Hill: Sphygmometry of the Vessels of the Frog's Leg.—J. A. Campbell and T. Angus: Water Evaporated from the Body in Relation to Work.—J. A. Campbell: Tensions of Gases in Tissues. (a) Effects of CO Poisoning; (b) Hydrogen in the Peritoneal Cavity.—F. M. Durham: Effect of Alcohol on Genetic Behaviour of Guinea Pigs.—H. V. Horton and W. Dulière: Reversible Loss of Excitability in Isolated Amphibian Voluntary Muscles.—W. Dulière: The Condition of Creatine in Amphibian Voluntary Muscle.—D. W. Bronk: The Energy Expended in Maintaining a Contraction.—Prof. A. V. Hill: The Restoration of Fatigued Muscle by Washing with Oxygen-free Ringer's Fluid.—H. E. Magee: Further Experiments on the Movements of Isolated Intestinal Loops.—A. N. Drury and A. Szent-Györgyi: The Influence upon the Heart of a Substance Present in Heart Muscle and other Tissues.—Demonstrations:—J. A. Campbell: (a) Effects of Prolonged Exposure to Low Tensions of Oxygen: (b) Gas Tensions at the Surface of the Skin of Man.—Prof. L. Hill: A Katathermometer Graduated for Warm Atmospheres.—Prof. L. Hill and J. McQueen: Capillary Circulation in Liver of Mouse.—R. B. Bourdillon and R. G. C. Jenkins: Methods of Measuring Absorption of Ultra-violet Rays.—A. Eidinow: Sensitisation to Fluorescent Radiation.—Dr. H. H. Dale: Complete Artificial Perfusion of the Liver.—J. H. Gaddum: (a) Use of Richards-Collison Metabolism Apparatus for Thyroxin, etc.; (b) An Outflow Recorder for Rapid Flows.—H. E. Magee and J. J. R. Macleod: Diffusion through the Wall of the Living and Dead Intestine.

Royal Institution of Great Britain, at 3.—Dr. E. Cammaerts: Flemish and Belgian Art (I.): The Portrait.

British Association of Managers of Textile Works (at Athenæum, Manchester), at 6.30.—W. A. Hanton: Recent Loom Design (Lecture).

Hull Association of Engineers (at Municipal Technical College, Hull).—J. Evans: Modern Steam Condensers and Feed Systems.

MONDAY, January 21.

Royal Society, Edinburgh, at 4.30.—R. B. Mooney and E. B. Ludlam: The Thermal Equilibrium between Ethylene, Iodine, and Ethylene Di-Iodide.—E. B. Ludlam, H. G. Reid, and G. S. Soutar: The Hydrogen-Chlorine Flame.—R. W. Armour and E. B. Ludlam: Photochemical Equilibrium between Hydrogen, Bromine, and Hydrogen Bromide.—W. W. Taylor: Demonstration of a New Method of Determining Free and Bound Water.—W. W. Taylor: The Lyotrope Effect and the Antagonistic Action of Ions.—W. O. Kermack, A. G. M'Kendrick, and Eric Ponder: The Stability of Suspensions: III. The Velocities of Sedimentation and of Cataphoresis of Suspensions in a Viscous Fluid.

Victoria Institute (at Central Hall, Westminster), at 4.30.—Rev. C. W. Cooper: Precious Stones of the Bible, with Special Reference to the High Priest's Breast Plate.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: The Anatomy and Evolution of the Human Brain.

Textile Institute (London Section) (at Clothworkers' Hall), at 6.—G. Garnett: Woollens and Worsteds Customs Designation (Lecture).

Institution of Mechanical Engineers (Graduates' Section, London) (jointly with Students' Sections of Institution of Civil Engineers and Institution of Electrical Engineers), at 6.30.—H. R. Sketch: Engineering Insurance.

INSTITUTION OF AUTOMOBILE ENGINEERS (jointly with Western Centre and West of England Branch of Institution of Mechanical Engineers) (at Merchant Venturers' Technical College, Bristol), at 6.45.—Dr. H. J. Gough: Recent Developments in the Study of the Fatigue of Materials.
INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—Capt. J. M. Donaldson, J. G. Hines, and others: Discussion on The Anticipation of Demand, and the Economic Selection, Provision, and Layout of Plants.
INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Capt. P. P. Eckersley: Lecture on Wireless.
SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (at Great Northern Hotel, Leeds), at 7.15.—Prof. R. D. Passey: Poisoning and Disease in Industry (II.). Industrial Cancers.
INSTITUTION OF AUTOMOBILE ENGINEERS (Glasgow Centre) (at Royal Technical College, Glasgow), at 7.30.—M. Platt: Safety in Four-Wheel Braking Systems.
BRADFORD TEXTILE SOCIETY (at Midland Hotel, Bradford), at 7.30.—W. O. R. Holton: The Uses of Laps, Wastes, Shoddy, etc. (Lecture).
HUDDERSFIELD TEXTILE SOCIETY (at Huddersfield Technical College), at 7.30.—D. R. H. Williams: Costings (Lecture).
ROYAL SOCIETY OF ARTS, at 8.—Dr. C. H. Lander: The Treatment of Coal (Cantor Lectures) (I.).
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—O. P. Milne: Criticism of Work submitted for Prizes and Studentships. Presentation of Prizes.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—J. R. Baker: The Northern New Hebrides.

TUESDAY, JANUARY 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. F. A. Freeth: Critical Phenomena in Saturated Solutions (II.).
INSTITUTION OF CIVIL ENGINEERS, at 6.—J. H. Hyde and H. R. Lintern: The Vibrations of Roads and Structures.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—Capt. J. M. Donaldson, J. G. Hines, and others: Discussion on The Anticipation of Demand, and the Economic Selection, Provision, and Layout of Plants.
ILLUMINATING ENGINEERING SOCIETY (at Home Office Industrial Museum, Horseferry Road), at 7.—Dr. L. C. Martin: Colour and its Applications.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—W. Bickerton: The Moods and Emotions of Birds.
INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates) (at Broadgate Café, Coventry), at 7.15.—Mr Wheeler: Jigs.
INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Informal Meeting) (at Watergate House), at 7.25.—J. F. Ward: The Training of Drivers.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Students' Section) (jointly with Newcastle and District Association of Institution of Civil Engineers) (at Mining Institute, Newcastle-on-Tyne), at 7.30.—A. Page: The Development of Generation and Distribution of Electrical Power in the British Isles.
SHEFFIELD METALLURGICAL ASSOCIATION (at Sheffield), at 7.30.—C. H. Faris: The Applications of Electro-deposited Metals to Engineering.
SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Cardiff).—Dr. T. Lewis: The Training of an Ophthalmic Optician.
MANCHESTER ATHENÆUM TEXTILE SOCIETY (at Manchester).—C. A. Harrington: Artificial Silk and its Application to Fabrics (Lecture).

WEDNESDAY, JANUARY 23.

ELECTRICAL ASSOCIATION FOR WOMEN (at 143 Knightsbridge), at 4.—A. B. Read: Modern Decorative Lighting of Interiors.
ROYAL SOCIETY OF MEDICINE (Comparative Medicine and Tropical Diseases Sections), at 5.—Prof. F. T. G. Hobday, Prof. G. H. Wooldridge, Dr. Minett, J. W. McIntosh, E. A. West, and others: Special Discussion on Glanders and Kindred Diseases.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Anatomy and Evolution of the Human Brain.
GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. A. Jowett and Prof. J. K. Charlesworth: The Glacial Geology of the Derbyshire Dome and the Western Slopes of the Southern Pennines.—Prof. J. K. Charlesworth: The South Wales End Moraine.
NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at Institution of Automobile Engineers, Watergate House, Adelphi), at 5.30.—Rhys Jenkins: A Chapter in the History of the Water Supply of London—A Thames-side Pumping Installation and Sir Edward Ford's Patent from Cromwell.
INSTITUTION OF AUTOMOBILE ENGINEERS (Manchester Centre) (at Engineers' Club, Manchester), at 7.—M. Platt: Safety in Four-Wheel Braking Systems.
ALCHEMISTS' SOCIETY (at Glasgow University), at 7.30.—Prof. H. E. Armstrong: The Future Alchemist.
ROYAL SOCIETY OF ARTS, at 8.—Sir Henry A. Miers: Museums and Education.
EUGENICS SOCIETY (at Royal Society), at 8.30.
HASLINGDEN AND DISTRICT TEXTILE SOCIETY (at Grammar School, Haslingden).—H. Bromiley: Processes from the Field to the Finished Yarn (Lecture).

THURSDAY, JANUARY 24.

ROYAL SOCIETY, at 4.30.—Dr. D. Denny Brown: (*a*) On the Nature of Postural Reflexes; (*b*) The Histological Features of Striped Muscle in Relation to its Functional Activity.—W. S. Stiles: The Effect of Glare on the Brightness Difference Threshold.—L. J. Harris: The Combination of Proteins, Amino-Acids, etc., with Acids and Alkalis. Part II. Titration Curves of Amino-Acids, in presence of Formol.—*Papers to be read in title only*:—Dr. F. W. R. Brambell and G. F. Marrian: Sex-reversal in a Pigeon (*Columba livia*).—Prof. J. B. Gatenby and Sylvia Wigoder: (*a*) The Effect of X-radiation on the Spermatogenesis of the Guinea Pig; (*b*) The Post-Nuclear Body in the Spermatogenesis of *Cavia corbaya* and other Animals.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15—Gordon Home: Roman London (II.).

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. Wright and C. W. Marshall: The Construction of the Grid Transmission System in Great Britain.
INSTITUTION OF THE RUBBER INDUSTRY (Manchester and District Section) (at St. Mary's Parsonage, Manchester), at 7.—Dr. E. G. Ritchie: Storage of Steam.
ROYAL AERONAUTICAL SOCIETY (at St. Ermin's Hotel, Caxton Street), at 7.30.—Informal Discussion on The Compression Ignition Engine for Aircraft.
ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Sir William de Courcy Wheeler: Traumatic Rupture of the Urethra.

FRIDAY, JANUARY 25.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Gaiety Theatre, Dublin), at 4.—Ll. B. Atkinson: How Electricity does Things (Faraday Lecture).
ASSOCIATION OF ECONOMIC BIOLOGISTS (Annual General Meeting) (in Botany Lecture Room, Imperial College of Science and Technology), at 5.—S. G. Tallents: The Work of the Empire Marketing Board.
PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Prof. C. V. Boys: A Fused Quartz Pendulum Rod for Clocks.—G. W. Sutton: A Method for the Determination of the Equivalent Resistance of Air-Condensers at High Frequencies.—L. Hartshorn: The Measurement of the Anode Circuit Impedances and Mutual Conductances of Thermionic Valves.
ROYAL SOCIETY OF MEDICINE (Children Section), at 5.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Anatomy and Evolution of the Human Brain.
SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Engineers' Club, Birmingham), at 7.—Prof. W. E. S. Turner: Communications from the Department of Glass Technology, The University, Sheffield.
MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.
INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. T. Usher: Bromoil.
WEST OF SCOTLAND IRON AND STEEL INSTITUTE (at Royal Technical College, Glasgow), at 7.—J. Mitchell: The Manufacture of Iron and Steel Tubes.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Students' Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.15.—S. Gibson: The City of Winnipeg Hydro-electric Power Station.
BLACKBURN TEXTILE SOCIETY (at Bradford Technical College), at 7.30.—W. Wilkinson: Power Loom Pickers and Picking (Lecture).
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—M. J. McCarthy: Notes on Winches, Derricks, and other Lifting Appliances used in Modern Building Construction.
ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. Ledingham, Dr. G. F. Buchan, and others: Discussion on Vaccination Against Smallpox in the Light of Recent Experience.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof A. C. Seward: The Vegetation of Greenland.

SATURDAY, JANUARY 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Cammaerts: Flemish and Belgian Art (II.): The Landscape.

PUBLIC LECTURES.

FRIDAY, JANUARY 18.

UNIVERSITY COLLEGE, at 5.—C. F. Pantin: Comparative Physiology. (Succeeding Lectures on Jan. 25, Feb. 1, 8, 15, 22, Mar. 1, 8, 15, and 22.)

SATURDAY, JANUARY 19.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—D. Martin Roberts: London through the Ages.

MONDAY, JANUARY 21.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—F. Rayns: The Cultivation of Sugar Beet.

WEDNESDAY, JANUARY 23.

IMPERIAL COLLEGE OF SCIENCE—ROYAL SCHOOL OF MINES, at 5.30.—Dr. A. McCance: Some Applications of Physical Chemistry to Steel Manufacture. (Succeeding Lectures on Jan. 24, 30, and 31).

THURSDAY, JANUARY 24.

UNIVERSITY COLLEGE, at 5.—Dr. R. J. Ludford: Cytology in Relation to Physiological Processes. (Succeeding Lectures on Jan. 31, Feb. 7, 14, 21, and 28).
BEDFORD COLLEGE FOR WOMEN, at 5.15.—W. P. Yetts: Chinese Architecture.

SATURDAY, JANUARY 26.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. Harcourt: The Lure of India.

CONFERENCE.

SATURDAY, JANUARY 19.

JOHN INNES HORTICULTURAL INSTITUTION (Merton), at 2.30.—Conference on Polyploidy in Relation to Species and Horticultural Varieties.
Dr. C. C. Hurst: Polyploidy in the Genus *Rosa*.
Prof. R. R. Gates: The Origin of Polyploids.
J. B. S. Haldane: Laws of Inheritance in Polyploids.
Dr. C. D. Darlington: The Importance of Chromosome Behaviour in Polyploids.
Dr. C. L. Huskins: Polyploidy in Cereals.
M. B. Crane: Polyploidy in Strawberries, *Rubus* and *Prunus*.
Miss Caroline Pellew: *Primula Kewensis* and Species Hybrids.
Dr. F. W. Sansome: Polyploidy in Tomatoes.