Nature

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" *To the solid ground*
Of Nature trusts the mind that builds for aye."—Wordsworth.

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NATURE

A WEEKLY JOURNAL OF SCIENCE

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SATURDAY, JANUARY 3, 1931.

CONTENTS.

The Ancient Monuments Bill.

RECENT events have demonstrated beyond all question that the revision of our Acts for the protection of ancient monuments is a vital necessity. Stonehenge, the greatest of all our relics of the past, but a national possession only by private benefaction, was within an ace of permanent disfigurement and vulgarisation. It was saved only by a national appeal for funds to purchase the adjacent land. The Roman Wall, a monument no less unique and equally dependent upon its surroundings for its full significance and its appeal to the historic imagination, was, and still is, in danger from an act of vandalism which would devastate one of the most characteristic stretches in its whole range. Happily, the proposals to exploit the natural resources of that area, which entailed the quarrying of some millions of tons of stone, with an illusory limitation that operations were to extend only over a brief period of years, were not allowed to pass unchallenged. The effect of the influential protest which followed the announcement of what was proposed is to be seen in the provisions of the Bill to amend the Ancient Monuments Acts which was introduced into the House of Lords by Lord Ponsonby on Dec. 3, and of which the text is now available.

In at least three directions the new Bill extends the principles of previous Acts. It enlarges the powers of the Commissioners of Works in the matter of schemes of preservation, in the range of their expenditure, and in enabling them to prohibit the exportation of ancient monuments from the country.

Under § 22 of the Act of 1913, the expression

" monument ", it is laid down, " includes . . . the site of any such monument, or of any remains thereof ; and any part of the adjoining land which may be required for the purpose of fencing, covering in, or otherwise preserving the monument from injury ; and also includes the means of access thereto ". To a certain extent this was a compromise with the rights of private property; and in fact, in reserving to the public the means of access, together with so much land as was necessary for the purposes of preservation, as well as the site of the monument, at the time it was framed it did represent a very considerable advance in the assertion of the claims of the community as against the rights of the individual. It did no more, however, than claim the minimum essential for the protection of the structure of the monument or what remained of it. No attempt was made to safeguard its character in so far as this was dependent upon historical or natural setting.

In the case of historic buildings in urban surroundings, any provision with such an end in view obviously would have been unpractical; while for other relics of antiquity, more especially, perhaps, prehistoric monuments, most of them situated in open land or isolated on moors and downs, such provision may have seemed unnecessary. It was not foreseen that a vast extension of motor traffic was at hand which would bring in its train an increase in the number of excursionists for whose entertainment and refreshment provision would be made, as well as a wider distribution of bungalow towns and suburban villadom. But the refreshment booth and the bungalow which, equally with the buildings for which the Government was responsible, menaced Stonehenge, are as nothing compared with the far graver danger from the demand for road metal, enormously increased by the provision of arterial roads and prepared surfaces for motor traffic. The quarrying at Malvern serves to show what might happen in any district which provided suitable material, and the inevitable disfigurement which threatens the countryside once guarded by the Roman Wall.

The gravity of the situation which has arisen from the development of modern social and commercial conditions cannot be too strongly emphasised. From one point of view it calls for, from another it justifies, the extension of the powers of the Commissioners of Works in dealing with ancient monuments. It is proposed to enact that the Commissioners may frame schemes for preserving the amenities of ancient monuments and that such schemes may provide for prohibiting or restricting building works, the felling of trees, quarrying and excavations, and for otherwise restricting the user of land within the controlled area. Further, in the definition of an ancient monument for this purpose and in so far as affects the acquisition, guardianship, receipt of voluntary contributions towards maintenance, and the transfer of ancient monuments, the term is extended to include any land comprising or adjacent to an ancient monument which, in the opinion of the Commissioners or the local authority, is " reasonably required for the purpose of maintaining the monument or its amenities, or for providing or facilitating access, or for the exercise of proper control or management ".

It will be seen that under the provisions of the Bill it is proposed to give the Commissioners wide powers. Not only may they prohibit any action of the owner or his representatives in the vicinity of the monument which would be likely to be injurious or unsightly, but according to their interpretation of what constitutes the amenities of the monument, they themselves may determine the area to which that prohibition extends. In view of the past record of the Commissioners in the action they have taken in relation to ancient monuments, it is improbable that their interpretation of their powers under these provisions will be such as to be regarded as unduly harsh. The rights of the owner, however, are now to be protected by the provision that a preservation scheme may provide for compensation to persons whose property is injured by the scheme. When no such provision for compensation is made, objection to the scheme may be raised, within three months of the date of the order confirming it, by any person so affected. In that event the scheme shall cease to have effect two years from the said date unless it is confirmed by Parliament. Thus the Act would ensure a period during which the monument would be fully protected while the case was argued on either side. Expert opinion would obtain a hearing, and it may be assumed the public would be informed through the Press of the merits of the case. The action of Parliament eventually would ensure that a weight of opinion in favour of the scheme would prevail. By a similar provision for objection in the case of a preservation order which places the monument under the protection of the Commissioners, the owner is placed in a more favourable position, as under the existing Act there is no opportunity for appeal until the Bill to confirm the order is before Parliament.

The Bill also proposes to enlarge the powers of the Commissioners in the matter of finance. Unlike the Ancient Monuments Acts of certain other countries, such, for example, as Switzerland, the British Acts have made no adequate provision for the maintenance of ancient monuments. At present the powers of the Commissioners in respect of preservation and upkeep are confined to those monuments of which they are owners by transfer or of which they have been constituted the guardians by a deed executed by the owners. The powers of local authorities are wider, for they may, if they think fit, bear the cost or contribute towards the cost of preserving, maintaining, and managing monuments of which they are not the owners and guardians, provided the monuments are in or near the area for which they are the authority. These powers, however, it will be noted, are permissive only. The responsibility for a monument which is the subject of a preservation order, but of which the Commissioners or the local authority have not been constituted owners or guardians by deed, falls upon the owner; but he is under no compulsion to maintain. The results in some cases have been disastrous.

To some extent the difficulty is met under the provisions of the new Bill. The powers of the Commissioners and local authorities are enlarged in the case of monuments of which they are guardians. It is proposed that they should now be empowered to incur expenditure on excavating and examining such monuments; while in the case of monuments of which the Commissioners are not owners or guardians, they will be empowered to undertake and pay for "work". While it may be presumed that such authorisation would not cover the cost of maintenance, it could be made to cover urgent work essential to preservation.

It will be noted that the work of excavation is here added to the permissive powers of both the Commissioners and local authorities. The Bill also gives the Commissioners power to enter upon any land believed to contain an ancient monument and excavate for purposes of examination, except that if that land be occupied in connexion with a dwelling-house, or in private ownership, the consent of the occupier or owner is required.

A further provision as regards finance would empower the Commissioners to bear the expense in whole or part incurred by an authority through preserving the amenities of an ancient monument in carrying out a scheme under the Town Planning Act, 1925.

As a final measure of protection, it is proposed that the Commissioners may by order prohibit the export from Great Britain of any monument or any part of it. This order will continue in force until any order is made revoking it. It shall also be open to a local authority to obtain an injunction against the exportation of an ancient monument by application in the county court of the area in which the monument or any part of it is situated.

The faulty definition of a monument, which specifically stated that it was a 'structure' or an 'erection', is changed. An amendment was desirable here in order to bring within the class of 'ancient monuments' remains of archæological interest which could not be regarded as either. "Monument" will now include "any building, structure, or other work, whether above or below the surface of the land . . . and any cave or excavation".

Our ancient monuments have suffered grievously in the past from lack of adequate attention, and many a priceless relic has vanished or has been mutilated, both before and since the passing of the Act of 1882, through public apathy or official indifference. There are signs that a healthier public opinion, more fully alive to the significance of the ancient monument, is on the increase. If the Bill now before Parliament becomes law, as it should, and with no undue restriction laid upon the authorities whose duty it will be to administer it, the nation will be one stage nearer the complete realisation that in relation to the material evidence of the past, to-day is at best the trustee of to-morrow.

The Twilight of Selenium.

The Selenium Cell: its Properties and Applications. By George P. Barnard. Pp. xxix + 331. (London: Constable and Co., Ltd., 1930.) 35*s*. net.

IT is a remarkable fact that in spite of the keen interest displayed in selenium ever since the discovery of its response to light fifty-eight years ago, no complete treatise on its properties has appeared in English until now. Students have had to rely on the small German handbooks of Ruhmer and of Ries, or the compendium, "Il Selenio", published by Bianchi in 1919. If Mr. Barnard had done no more than compile his 50 pages of excellent bibliography, he would have conferred a considerable benefit on the scientific public. But his book does much more than that.

The study of the properties of selenium has reached a peculiar position. The reaction following upon the earlier claims of inventors which failed to materialise has been so severe that the excellent work of more recent days has had to disguise itself, so to speak, under pseudonyms. Thus, television by means of infra-red rays and selenium is called 'noctovision', and a powerful London company for the manufacture and utilisation of selenium cells is known under the name of 'Radiovisor'. There has never been a time at which more selenium cells were constructed and used, or when such rapid and solid progress was made in the study of their properties. But few dare confess to it. It is the twilight of selenium, the eclipse of the 'moon-element'.

When, in 1872, the light-sensitiveness of selenium was discovered, Mr. Shelford Bidwell said at the Society of Telegraph Engineers: "Mr. Preece has told us that by the aid of the microphone the tramp of a fly can be heard, resembling that of a horse walking over a wooden bridge; but I can tell you something which, to my mind, is still more wonderful—that by the aid of the telephone, I have heard a ray of light fall on a bar of metal".

Everyone would have expected that after such an introduction the combined efforts of the scientific world would have sufficed to unravel the secrets of the marvellous substance which presented such a phenomenon. Yet, fifty-five years after, Prof. Gudden, who has spent a lifetime in studying photoelectric phenomena in crystals, says: "It is as hopeless to expect to understand what happens in selenium from the observation of selenium cells as it would be to determine the laws of vibration from the investigation of a creaking hinge".

Prof. F. C. Brown is one of those who spent many years investigating large single crystals of selenium, but his work has not yet reached a satisfactory conclusion. Gudden and Pohl have, at all events, established one basic fact, namely, that in the insulating red form of selenium the effect of light upon the conductivity is both instantaneous and linear, though reckoned in micro-micro-amperes. These red crystals have, according to Kyropoulos, a refractive index so high as 3·5 and obey Maxwell's law of refraction. Much of the work on selenium of the next fifty years will no doubt be done on red selenium.

When the D.C. conductivity of a substance is to be studied, we must, unfortunately, have electrodes, and selenium with electrodes constitutes a 'selenium cell'. It should not surpass the ingenuity of our physicists to make the monoclinic crystals of conducting selenium arrange themselves in a regular and reproducible order, and to find an electrode, say of carbon, which has no chemical effect upon the substance. We know that the square-root law of light-action is obeyed at faint illuminations down to very low values, and that is some foundation.

There used to be a slogan in the Cavendish Laboratory at Cambridge when anything difficult had to be undertaken: "Do it with selenium!" (pronounced, in defiance of Greek etymology, "selennium"); and Mr. Barnard certainly enumerates an imposing array of results achieved by the 'creaking hinge'. Fire and burglar alarms, automatic machines for counting stamp cancellations and even carcases, street lighting and train control, the mechanical estimation of fog and smoke density, and the control of camera shutters, are some of the successful applications of selenium. Cox's magnifier of cable signals is fully described, as is Symonds's ingenious device for counting interference fringes. This and the optophone could not possibly function with any form of photoelectric cell.

When we come to the applications of intermittent light, we are on less difficult ground, for all considerations of the zero in the dark can be eliminated or disregarded. The only element that matters is the amplitude of the response.

It has been found that selenium responds to notes of a frequency of 12,000 hertz. It is therefore capable, in spite of its 'lag', of following the whole gamut of the notes used in music. Theoretically, its response ought to vary inversely as the pitch, and a correction would have to be applied to make the higher notes stronger. This would be inconvenient but for the fact that every reproducer devised so far must be corrected in one sense or the other. Usually it is the lower notes that want strengthening. The correction is the easier for the fact that there is plenty of current to spare. Prof. Thirring showed recently that selenium gives from 1000 to 1,000,000 times as much response as any photoelectric cell.

A most valuable feature of this excellent book is the collection of chemical, optical, and electrical constants of selenium. Everyone will naturally turn to these tables for information as to the resistivity, only to be told that it lies somewhere between 10^5 and 10^{10} ohms/cm.^{3} The figure 10^6 given by Siemens might have been quoted as an approximate practical guide. E. E. F. D'A.

Immunisation of Plants.

L' immunità nelle piante. Per D. Carbone e C. Arnaudi. (Monografie dell' Istituto Sieroterapico Milanese.) Pp. xii + 274 + 3 tavole. (Milano: Istituto Sieroterapico Milanese, 1930.) 25 lire.

DISEASE in plants is a subject which sooner or later brings to the mind of initiated and uninitiated alike the possibility of assisting our crop and ornamental plants with some of the more recent discoveries in human and animal pathology which are in daily use for reducing the ravages of disease. Realising that the results of the simplest operations in animal and vegetable therapeutics are not exactly similar, and that the structure and functions of the body parts of animals and of plants have little in common, it is encouraging to find that the more complex application of serum and vaccine therapy to plants is being continuously and seriously studied in Italy by the joint work of Dr. D. Carbone and Dr. C. Arnaudi, who, in this latest monograph from the Institute of Serotherapy of Milan, have reviewed the whole subject of immunity in animals and plants and the practical applications of the knowledge gained by their work.

In England the published opinions of some of our prominent physiologists and plant pathologists show that there is little sympathy with the view that disease resistance can be secured in plants by methods which are successful in animal pathology, it being asserted that in plants a reaction to disease is localised and not found, as generally in animals, throughout the body; moreover, there is no blood-stream by which anti-bodies can be distributed throughout the plant. It is further pointed out that in plants—and this, of course, applies to agricultural crops—new organs (roots, branches, flowers, seeds) are being continually produced, necessitating the rapid spread of the immunising factor, and unless there is some prospect that acquired immunity will be transmitted to the freshly developing organs, the study of serum and vaccine therapy in plants is likely to receive meagre support. Scientific workers, however, are not daunted by difficulties, and certainly not by those which are only suggested. It is with a feeling of admiration, therefore, that we note these authors have 'nailed their colours to the mast', for on the cover of their work appear some words of Sir J. C. Bose: "Animal life finds an echo in the vast inarticulate life of plants. The vital processes of the one and of the other are guided by identical laws."

The title of the book conveys no indication that it is only slightly concerned with the natural immunity of plants and chiefly with the serotherapeutical aspect. Prof. S. Belfanti, in his preface, introduces this monograph as one result of a plea for unity and interchange of ideas which he made at the Perugia Congress of Italian Microbiology in 1929. He bewails the splitting of microbiology into autonomous branches, and suggests physiopathology as a science comprising the study of the conditions which determine the common pathological state of all living beings.

The terminology of animal immunity is dealt with in the first thirty pages, and examples are given when each definition of a term is discussed. A special section is devoted to the immunity reactions of certain of the lower animals, since these are not so far removed from plants as are the vertebrates.

An insight is next given of the congenital immunity naturally present in plants; touching on the subject of specialisation of parasitism, Dr. Arnaudi criticises adversely the modern tendency to multiply the number of biologic forms of a parasite. An attempt is not made to give a complete review of the literature, and discussion of certain work is avoided when this is highly specialised and does not, in the author's opinion, assist in obtaining a general view of the subject. It is somewhat surprising, however, that no mention is made of well-known investigations on the grafting of immune and susceptible plants, since the authors have been deeply concerned with the possibility of transportation of immunity factors in the sap. Very little original work is included in this first discussional part of the monograph; a method of technique, however, is given for the culture *in vitro* of plant tissues and the maintenance of botanical sections alive for about a month. Dr. Arnaudi thinks that eventually this will enable the phases of symbiosis or of infection and the corresponding cell reactions to be followed exactly.

Chap. iii., on acquired immunity in plants, begins Part 2 of the book. Some few facts are brought forward in an attempt to show that phenomena of plant and animal resistance to disease are not altogether dissimilar. Dr. Arnaudi describes the work of others and one of his own experiments with *Bacterium tumefaciens* on geraniums when dealing with resistance to superinfection. He summarises the results of eight experimenters with vaccination of plants and details two of his own vaccination studies. Complete immunity as a result of vaccination is claimed in begonia and kidney bean from *Botrytis cinerea*, in orchids from *Orcheomyces* spp. and *Rhizoctonia repens*, and in bean from *Bacillus carotovorus*. In other cases a degree of resistance is gained but the period of duration of the immunising effect is short, varying from one week to one month. The mechanism and technique of vaccination are discussed. A section on acquired passive immunity includes description of an experiment in which galls on geranium were made to shrivel up by keeping the cut stems in a liquid containing anti-*B. tumefaciens* serum obtained from a rabbit. By the same method a fresh infection by the parasite was made to fail.

In the ninety pages of Chap. iv., which delves deeply into the relation of animal immunity to that of plants, the whole subject of the presence or absence in plants of pseudo-antibodies and the various antibodies known to human bacteriologists is exhaustively dealt with by Dr. Carbone. Knowledge accumulated by other workers is given *in extenso*, and original experiments are detailed which must have required truly laborious technique. An example is that involved in adapting and performing the complement fixation test. It is not shown that plants do or do not produce antibodies.

The final chapter, entitled "Phyto-Immunity in Practice", is somewhat disappointing, as are also the conclusions arrived at. It appears that in our desire for crop plants resistant to disease, we are to rely rather on the work of geneticists than on being able to confer acquired immunity. Moreover, the reader is left with the idea that an enormous amount of arduous work has been performed and much has been written with insufficient results to warrant the inclusion of a chapter with this title. There can be no doubt of the great ability of these investigators, however, who are to be congratulated on having accomplished much in laying a foundation for future work. W. M. Ware.

Alchemical Manuscripts.

Union Académique Internationale. Catalogue of Latin and Vernacular Alchemical Manuscripts in Great Britain and Ireland dating from before the XVI. Century. By Dorothea Waley Singer, assisted by Annie Anderson and Robina Addis. Vol. 2. Pp. viii + 329-755. (Brussels: Maurice Lamertin, 1930.) 10 Belgas.

THE publication of a second part of Mrs. Singer's catalogue of alchemical manuscripts enables us to form some idea of its usefulness as a guide to the *Corpus Scriptorum Alchemistarum*, a usefulness which will be materially enhanced by a promised third part containing indexes of names, places, and first lines. It would be hard to exaggerate the importance of this work to the historian of scientific thought in western Europe; we are here put in possession of a key to the materials from which the story of the development of alchemical theory can be written. Up to now, no historian of chemistry except Kopp, and in a lesser degree Berthelot, has gone to the manuscript sources for his information; all of them, when they have not copied one from another, have aimlessly turned a few pages of the printed texts and extracted some sentences from them to small profit.

The literature of alchemy was collected in the seventeenth century by Zetzner in six closely printed volumes and later by Manget in two folios—mainly from printed sources. The earliest treatises have in the main escaped printing down to our own days, while those of the early texts reproduced are incredibly corrupt by the accretion of notes and interlineations and by accidental omissions. But no thorough revision of the classics of Latin alchemy will be possible until the scholars of France and Italy have followed the example here set. In the meantime, any student of philosophy, equipped with some knowledge of the medieval Aristotle, will find here a rich field open to him.

The catalogue is arranged in the order of the historic development of alchemical thought; first of treatises of Byzantine or Hellenic origin such as the "Turba Philosophorum", the "Emerald Table", and other treatises ascribed to Greek authors, real or apocryphal; then to Arabic authors, to Latin authors in prose, to anonymous treatises, to the large body of alchemical verse, to chemical crafts, and to receipts of all descriptions. The named treatises were included in the first part; the remainder are here given and their study throws an interesting light on the processes of chemical technology in the Middle Ages. One does not see how this arrangement can be improved upon, but it must not be allowed to mask the fact that alchemical theory in western Europe was entirely Arabist in its origin and growth. Chemical technology is purely Byzantine and Hellenic, but it was altogether divorced from theory, and the "Turba" is never quoted by any writer in the first century and a half of alchemical literature. But though Greek thought had no direct action on Latin writers, it was the ultimate source of Arabic alchemy as regards the theory of metals, the elixir of life being apparently of Chinese origin. No doubt a few Byzantine adepts found their way into the west—Roger Bacon mentions a Greek he had known, and there is the still earlier case of the Jew of Bremen.

The story of translation from the Arabic begins with Robert of Chester in 1144, Plato of Tivoli and Hugo Sanctallensis, and goes on to Gerard of Cremona, who before his death in 1187 translated three classics of alchemy—two of them only printed in our own time, by Berthelot and the writer. A number of treatises were translated before the middle of the thirteenth century, as shown by the quotations from them in the "Speculum Naturale" of Vincent of Beauvais (1245), the alchemical writings of Roger Bacon ending 1267, and the writings of Albertus Magnus on minerals and the "Speculum Astronomicum". St. Thomas also accepts the scientific possibility of alchemy. The series of philosophic writers on alchemy closes with Arnold of Villanova at the end of the thirteenth century. Two expository works of some value as accounts of current theory were written in the first half of the fourteenth century—the "Margarita Novella" of Petrus Bonus and the "Quintessence" of Johannes de Rupescissa—but no new ideas are to be found in them; the developments of the Aristotelian theory of matter had been exhausted and the pursuit of the transmutation of metals had been abandoned, not as impossible but as impracticable. The fifteenth century brings in a spate of tracts, all with high-sounding claims, reiterating the old formulæ and clothed in the old mystification of language.

It is impossible to rate too highly the unwearying industry of Mrs. Singer and her helpers; they have searched and almost re-catalogued not only the great collections of Sloane and Harley in the British Museum, of Digby and Ashmole at Oxford, but also every corner of every library, great or small, in Great Britain, and have revealed a scarcely suspected wealth of manuscripts. When their provenance is examined and tabulated some interesting results may appear. It would seem that the earliest centre of alchemical activity was in northern Italy, that from there it spread to the south of France, thence to Paris, becoming common in England in the fourteenth century, as witness the "Canon's Yeoman's Tale" of Chaucer. Its progress is marked by the Act of 1403 making it illegal—alchemy had become a shield for coiners of false money. The Act, however, was powerless to stay the flood of students and treatises—some of them voluminous like those ascribed to Ramon Lull, which first appear in 1443 (translated from a non-existent Catalan original). There are, too, a number of official licences to practise alchemy on record, and more remarkable still, three Royal Commissions to inquire into its possibilities as a means of paying the King's debts—the last a very strong one consisting of four bishops and a number of high officials. It would be interesting if Mrs. Singer, who has ferreted out of the Record Office some alchemical tracts, could come upon the reports of these Commissions. Licences and treatises come to an end in England at the last quarter of the fifteenth century; 1476 for the licences, 1471 and 1477 for the treatises of Ripley and Norton. Commerce was offering a more certain road to wealth than alchemy.

In the thousands of extracts of more or less barbarous Latin in badly written, badly spelled and contracted manuscripts here printed, it is not to be expected that there should be no doubtful readings; but speaking with no inconsiderable experience of medieval hands, I can say that the work as a whole would do credit to an expert palæographer and bibliographer. It is the sort of work that only an enthusiast would undertake, and it betrays the hand of an amateur only in the desire for completeness which has led Mrs. Singer to give us lists of the manuscripts of the "Canterbury Tales" and such-like works which have been made the subject of intensive study elsewhere. Mrs. Singer and her assistants have earned the hearty thanks of all who are interested in the history of scientific thought.

ROBERT STEELE.

Gumbotils and the Pleistocene Succession.

Iowa Geological Survey. Vol. 34: *The Pre-Illinoian Geology of Iowa.* By George F. Kay and Earl T. Apfel. Pp. 304 + 3 plates. (Iowa: Iowa Geological Survey, 1929.)

SINCE the middle of the last century, certain sands and gravels which occur embedded in glacial boulder-clays have been interpreted as accumulations of genial interglacial periods. A similar construction has been placed upon the peats and forest trees which over the same time have been derived at intervals and from widely separated localities in these layers in northern Europe and North America. In more recent times the importance of deeply weathered boulder-clays as indicators of interglacial conditions has been frequently stressed, as by A. Jentzsch and C. Gagel in Germany, and by A. Penck and E. Brueckner in the region of the Alpine glaciation. These weathered layers, however, have never had quite the same emphasis placed upon them in connexion with the recognition and extensive mapping of the interglacial horizons as by Dr. G. F. Kay and his colleagues on the Iowa Geological Survey during the last ten years or so. It has to be admitted that the effectiveness of the old methods is definitely limited, for the sands and gravels are impersistent and of diverse origin, while the peats and trees are few and fragmentary and of local occurrence only. The weathered clays or 'gumbotils', on the other hand, are of wide extent and considerable thickness and can be mapped as stratigraphical units.

The gumbotil, to use the term introduced by Dr. Kay, is a grey to dark-coloured clay, very sticky — 'gumbo' is a sticky clay — destitute of lamination and stratification. It is tenacious when dry and breaks with starch-like or polyhedral cracks when wet. It represents the thoroughly leached and oxidised boulder-clay resulting from the chemical weathering of the till on wide, flat surfaces of country during interglacial periods, aided by the action of frost, wind, sun, and animals and the organic acids arising from the growth of vegetation. The iron, silica, colloidal clays, and simpler colloidal silicates have been carried downwards from the surface and the calcareous materials have been leached out, though to a shallower depth than that reached by the oxidation. In this way, the percentage of alumina in the surface layers has increased at the expense of the other constituents.

From the point of view of Pleistocene geology, the State of Iowa is probably the most important in North America. It lay within the influence of the Labrador and Keewatin ice-sheets, and, perhaps partly because of this position, served during the nineties of last century as the battle-ground where the idea of the multiplicity of the glacial period definitely obtained the victory in North America. The successive drifts, denoted the Nebraskan, Kansan, Illinoian, Iowan, and Wisconsin (separated by the interglacial horizons of the Aftonian, Yarmouth, Sangamon, and Peorian), are all to be found within its borders, while its records of the interglacial periods are probably fuller, better preserved, and have been studied in more detail than in any other part of America.

The mapping of the gumbotils by Dr. Kay and his colleagues during the last eighteen years has added greatly to our knowledge of the character and distribution of the different drifts and the interglacial layers. The Nebraskan drift, averaging 100 feet in thickness, is thought to have covered originally the entire State, not excluding its north-east corner, formerly contained within the 'Driftless Area', where isolated patches of an old drift have been observed on the remnants of the Pre-Pleistocene peneplains. The Kansan drift, about 40 feet thick, covered the whole State, except the so-called 'Driftless Area'. The Illinoian drift occurs in the south-east, the Iowan drift in the north-central third, and the north-west. The Wisconsin drift, characterised by its fresh and youthful features and immature drainage, is restricted to the north-west central part of the State. Plate II. of this Report gives a very welcome map of the areal distribution of the several drifts as determined by the old sections and by the new ones exposed in the making of more than 15,000 miles of graded roads.

The Aftonian and Yarmouth interglacial periods, according to the authors, are each to be measured by hundreds of thousands of years. The steep-walled and drift-buried valleys, which are distinctive features of the bedrock topography, are thought to have been cut, not in preglacial times as is generally held, but chiefly in Aftonian times. The depth of the Aftonian erosion is locally so great as 400 feet or more, though figures of 200 feet are more common.

The belief in such prolonged interglacial intervals seems to be counter to the trend of thought on the eastern side of the Atlantic, where the tendency is to curtail the length of the Glacial Period.

The average thickness of the Nebraskan gumbotil is 8 feet; of the Kansan, more than 11 feet; and of the Illinoian, 3 feet. The Iowan and Wisconsin tills have no gumbotils.

A description of the drifts and their gumbotils forms the bulk of the present book, while one chapter (iii.) is devoted to a complete and invaluable summary of the history of investigation and classification of the Pleistocene accumulations of the State. It contains a restatement of the case for the retention of the Iowan glaciation as a separate glaciation, a view which has been repeatedly questioned by Leverett, partly from field studies, partly from the difficulty of equating five glaciations in North America with four glaciations in Europe.

The report is well illustrated with maps and pictures. The usefulness of the photographs, some of which are by no means clear, would have been enhanced by the insertion of marginal names and lines opposite the different horizons they portray.

Our Bookshelf.

Death Customs: an Analytical Study of Burial Rites. By Dr. E. Bendann. (The History of Civilization Series.) Pp. xiii + 304. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1930.) 12*s*. 6*d*. net.

MISS BENDANN has brought together the evidence bearing upon the conception of death among the peoples of four areas—Australia, Melanesia, northern Siberia, and India. The object of her analysis is to demonstrate the varying effect of the character of the concept upon death and burial customs. For this purpose, under the headings 'similarities' and 'differences', various beliefs, rites, and customs, such as the origin of death, causes of death, disposal of the dead, dread of the spirit, mourning, taboo, the special function of women in mourning rites, and so forth, are examined in detail. She deals " rather cavalierly ", as Dr. Goldenweiser puts it in his preface, with Spencer, Tylor, Frazer, Rivers, and others; but whether her criticism is also judicious, it may be left to the reader to decide. Her own conclusion is that " we have no authority to speak of a uniform line of development which carries man from one stage to another ", while certain kinds of parallel sequence which make for an advance in cultural development are thought to be due " not so much to historical causes as to psychological ones ". Thus the author's final position represents a compromise between the evolutionary point of view and that of the historical school. The death complex is regarded as in part composed of certain inherent psychic features, and the only elements which are held to be exclusively characteristic of the death situation are mourning customs as such and the ideas in regard to the life after death.

The Rôle of Research in the Development of Forestry in North America. By I. W. Bailey and H. A. Spoehr. Pp. xiv + 118. (New York: The Macmillan Co., 1929.) 6*s*. net.

THE primary object of this book is, the authors state, to determine how and to what extent certain categories of the natural sciences may be of service to sylviculture during different stages of its development. In connexion with the sciences, the authors consider that there are two distinct methods of investigating complex biological phenomena—one the extensive observational method of the descriptive sciences, and the other the intensive analytical method of the basic experimental sciences.

The subject is dealt with under the heads: Agriculture as contrasted with sylviculture; research and its application in sylviculture as contrasted with agriculture and medicine; present status of forestry in the United States; existing agencies for descriptive and empirical investigation in forestry; can research in the basic experimental aspects of forestry be developed and handled adequately by existing agencies; and, finally, new agencies required for research, particularly in the fundamental physiological and ecological aspects of forestry. There is much in this little book which should appeal to a wider circle of foresters than those in North America for whom it is especially written; the authors may be congratulated on a most useful and interesting piece of work.

Essays and Addresses: Sociological, Biological and Psychological. By a Surgeon. Pp. xiii + 277. (London: H. K. Lewis and Co., Ltd., 1930.) 10*s*. 6*d*. net.

THIS book is a collection of lectures, addresses, and articles published during the last twenty years, recording thoughts and opinions on various social problems approached from the biological point of view. Although the individual chapter subjects vary considerably, three fundamental principles are apparent throughout the volume. They are the necessity for a fuller recognition of the influence of evolution in all human affairs, the importance of hereditary constitution, and the need for a closer application of biological principles in the attempt to solve social problems. The conclusions put forward are not concerned with theories and principles alone. In a discussion of some causes of racial decay, a practical method of national stocktaking is suggested, a means of ascertaining quality as well as quantity. As the considered opinions of one who combines a scientific training with a close study of racial welfare requirements, and who is held in the highest esteem in his own profession—the authorship is but thinly veiled—this book merits the attention of all whose duty it is to guide legislation as applied to the improvement of national health.

The Archæology of Roman Britain. By R. G. Collingwood. (Methuen's Handbooks of Archæology.) Pp. xvi + 293 + 8 plates. (London: Methuen and Co., Ltd., 1930.) 16*s*. net.

THIS is a book which was badly needed indeed. The literature of Roman Britain is highly specialised, difficult of access, and extremely technical. Mr. Collingwood has aimed at supplying the elementary but fundamental knowledge which is essential in entering upon the study of Romano-British culture. Still more will it help those who, not being specialists, wish to follow intelligently the reports of results which are being achieved season by season on a number of sites up and down the country. Each of the different classes of antiquities is here described in detail—roads, camps, forts, towns, villas, temples, native settlements, and so forth. Especially valuable are the chapters which deal with the pottery, both Samian and coarse ware. The chapter dealing with the latter is of interest not merely to the beginner but also to the expert, for in it Mr. Collingwood has made a first attempt to form a series of nearly a hundred dated types. The very full illustration from drawings by the author, both in this chapter and in that dealing with brooches, will be found invaluable. Mr. Collingwood has been at great pains to give every assistance to the student.

The Truth about Cancer. Published for the British Empire Cancer Campaign. Pp. xv + 124. (London: John Murray, 1930.) 2*s*. 6*d*. net.

THE various committees of the British Empire Cancer Campaign which have been concerned in the preparation of this small book for the general public have succeeded very well in a difficult task. The ' man in the street ' is perhaps not much concerned to understand the nature of malignant tumours, but he will certainly be less liable to die of cancer if he will absorb the broad facts about its causation and treatment which are set out so plainly here. More stress might have been laid on prevention, on the special efficacy of tar and soot in causation, on the lessons to be learned from the fact that industrial labourers have much more cancer than professional men. The account of the early symptoms is particularly well done, and should bring many people to their doctors at a time when a cure is reasonably within range.

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.*]

Fluorescence of Mercury Vapour under Atomic and Molecular Absorption.

IT is familiar that mercury vapour under pressures of a few centimetres of mercury gives a green fluorescence when excited by wave-lengths near the resonance line λ2537. Proceeding away from the resonance line, I have observed the fluorescence with wave-lengths so long as λ3450, though at this extremely low excitation dense vapour is needed. This note deals with excitation near the resonance line.

The fluorescence is much brighter near the entrance than elsewhere, due to rapid exhaustion of the most effective constituents of the exciting radiation. I have emphasised that there is a *discontinuity of intensity* as we proceed along the beam, and this is attributed to the existence of two kinds of absorption, atomic and molecular. Atomic absorption is dominant at first. The radiation capable of this kind of absorption is limited to about 0·05 A. on either side of the resonance line. I call the fluorescence from it the *core* effect, and the much weaker fluorescence, due to outlying radiation, the *wing* effect. The latter does not suffer rapid extinction as the beam traverses the vessel. Some continental physicists who have been interested in the question are unable to accept this point of view, and consider the apparent discontinuity an illusion, regarding the fluorescence-absorption as molecular in every case.

A full discussion will be published later. I write now to record that the reality of the distinction between the wing and the core effect is confirmed by observing what happens when a suitable addition of hydrogen gas is made to the mercury vapour. It is easy to adjust the hydrogen admixture so as to extinguish completely the core effect, leaving the wing effect almost unaltered. I have obtained the latter with hydrogen pressures so high as 10 cm.

RAYLEIGH.

Terling Place, Chelmsford,
Dec. 16.

Evidence for a Stellar Origin of the Cosmic Ultra-penetrating Radiation.

WHILE in former years all observers were agreed that the sun does not contribute any noticeable amount to the total intensity of the cosmic ultra-radiation, the increase in the sensitivity of the apparatus used within recent years, and the increase in the number of observations made at different stations and under different experimental conditions, makes it possible to investigate once more whether the influence of the sun is altogether negligible.

Very accurate and trustworthy registrations of the cosmic radiation have been carried out with Prof. G. Hoffmann's high-pressure ionisation chamber at Muottas Muraigl (2456 m. above sea-level) in the Engadine. These measurements show, beyond any doubt, that the average intensity of the radiation is somewhat greater in daytime than during the night. G. Hoffmann and F. Lindholm [1] give the average difference between day and night intensities as 0·12 mA., ~0·0125 ions per c.c. per sec. while the apparatus was unscreened from above, and 0·04 mA., ~0·0042 I with a lead-screening of 6 cm. and 9 cm. thickness. (The letter 'I' always denotes "ions per c.c. and sec.".) F. Lindholm,[2] with the same apparatus, found from longer series of observations (8 months) the values in the accompanying table (see Table 6 of his paper).

In Hoffmann and Lindholm's apparatus a compensation current of one milliampere corresponds to an ionisation of 0·104 I. Therefore the total intensity of the ultra-radiation with the apparatus unscreened from above was about 2·50 I at Muottas Muraigl.

The difference between day and night intensity can be taken, provisionally at least, as the actual intensity of the solar penetrating radiation. One can see at once that at Muottas Muraigl, 2456 m. above sea-level, about one-half of this solar radiation component is able to penetrate through 10 cm. of lead. This component is therefore far more penetrating than the gamma rays from radioactive substances. If we assume that all of the above-mentioned 0·011 I is of solar origin, we can compute the absorption coefficient in lead μ_{Pb} (it will suffice to take the case of perpendicular incidence) from the equation

$I = I_0 e^{-\mu_{Pb} d}$ taking $I_0 = 0{\cdot}011$, $I = 0{\cdot}0058$, and $d = 10$ cm.; thus we obtain $\mu_{Pb} = 0{\cdot}064$ cm.$^{-1}$ and the mass absorption coefficient $\left(\frac{\mu}{\rho}\right)_{Pb} = 5{\cdot}7 \times 10^{-3}$ cm.^{2}/gm.

This value is almost exactly equal to the mass absorption coefficient value of the total cosmic radiation at the same altitude ($(\mu/\rho)_{Pb} = 6{\cdot}3 \times 10^{-3}$ cm.^{2}/sec. as found by Büttner on the Eiger glacier 2·3 km. above sea-level).[3] If we assume that part of the (0·011 I) difference between day and night values with unscreened apparatus is due to an increase in the average content of radium emanation and its products in the air during daytime, then we should get an even more pronounced hardness of the solar penetrating rays, that is, a smaller value for their mass absorption coefficient. Therefore we are justified in concluding that *the sun emits penetrating rays of at least the same penetrating power as the well-known cosmic ultra-radiation. The total amount of the solar penetrating rays* (*at 2456 m. above sea-level*) *is about one-half per cent of the total intensity of the cosmic radiation, as it is seen from the accompanying table.* Of course, one might think it possible to explain the increase in the total radiation during daytime as due to an indirect influence of the sun (that is, an increase in the scattering of the ultra-rays by the heating of the atmosphere during the day). In this case, however, one would expect that this scattered radiation, represented by the difference between the day and night values, would be much softer than the general cosmic radiation; but this is in contradiction to the experimental results analysed above.

Recent observations of R. Steinmaurer [4] on the summit of the Sonnblick (3100 m. above sea-level) in the summer of 1929, made with three different instruments (two of the Kolhörster double loop-electrometer type and one of the Wulf–Kolhörster type), also show clearly that the total ultra-radiation in daytime is slightly higher than at night; the difference amounts to about 0·7 per cent (0·06 I, average difference for the three forms of apparatus mentioned above, the total intensity on the Sonnblick being about 8·7 I with the screening open on the top). The increase of radiation was also observed with apparatus screened with 7 cm. iron all around, but the number of these observations on the Sonnblick is not sufficient for quantitative calculations. It may be mentioned that even in the old observations on the summit of the Obir (2000 m. above sea-level), made by V. F. Hess and M. Kofler,[5] the solar influence is noticeable (the total intensity of the ultra-radiation plus earth-radiation during the day being 11·11, during the night 11·09 I, in the average for 13 months), although at that time the apparatus were not screened from the earth radiation. The difference of 0·02 *I* was—at that time—considered as practically amounting to zero.

Observations with apparatus of the Wulf- or Kolhörster type for shorter periods (like those of Kolhörster-v. Salis on the Jungfraujoch, on the Mönch, and of Büttner at other places in the Alps) naturally do not show the influence of the solar component of the ultra-rays, on account of the lesser degree of accuracy of the means; therefore Corlin,[6] using the observations on the Mönch and the Zugspitze, came to negative conclusions as to the solar influence. From the data given below it is quite safe to conclude, according to the most accurate and most numerous observations at present available, that *the sun contributes an amount of about 0·5 per cent to the total intensity of the cosmic ultra-radiation at 2·5 km. above sea-level. The penetrating power of the solar ultra-rays is at least as great as that of the total cosmic radiation.* There is no doubt that this solar component of the ultra-radiation is also present at lower levels; on account of its very small absolute intensity it will, of course, be far more difficult to prove its existence in these levels. An analysis of the very accurate registrations of the total radiation by Hoffmann and Steinke in Königsberg and in Halle in this direction might be successful.

Period.	Number of Days.	Armour open above.		
		Mean Values.		Difference (Day—Night).
		Day.	Night.	
1928 January–March . . .	(32)	24·46 mA.	24·34 mA.	0·12 mA. = 0·0125 *I*
1928 June, July, October . .	(39)	23·98 „	23·88 „	0·10 „ = 0·0104 *I*
1929 January–February . .	(11)	24·68 „	24·59 „	0·09 „ = 0·0094 *I*
		Weighted average difference.		0·011 *I*

Period.	Number of Days.	Armour closed (10 cm. lead screening all around).		
		Mean Values.		Difference (Day—Night).
		Day.	Night.	
1928 March	(2)	19·54 mA.	19·50 mA.	0·04 mA. = 0·0042 *I*
1928 July	(8)	19·21 „	19·17 „	0·04 „ = 0·0042 *I*
1929 February	(6)	19·46 „	19·38 „	0·08 „ = 0·0084 *I*
		Weighted average difference behind 10 cm. lead.		0·0058 *I* (ions/c.c./sec.)

If the sun, as the fixed star nearest to our planet, emits rays of about the same qualities as the total cosmic penetrating radiation, one cannot but assume that all fixed stars are sources of a radiation of similar qualities. The sun being a relatively old star of the yellow dwarf type may, of course, be expected to yield far less total quantity of the ultra-penetrating radiation than, for example, the younger giant stars. Naturally, the ultra-penetrating rays which we observe can only come from the outermost layers of the stars, since they are not able to penetrate material layers of more than a few hundred metres water equivalent.

It is not possible, at present, to say more about the nature of these stellar ultra-rays: whether they are electrons or protons accelerated in cosmic electric fields, or indeed photons (quanta) created by atomic mass shrinking or annihilation processes. This hypothesis of a partly stellar origin of the ultra-penetrating cosmic radiation does not necessarily exclude the possibility that another part of this radiation is created in interstellar space by the formation of certain elements out of hydrogen, according to Eddington's and Millikan's ideas, although the principle of minimum hypothesis would rather induce us to try whether the stellar origin hypothesis, based on the experimental evidence of the solar ultra-penetrating rays, would suffice to explain the observed facts.

The conclusions put forward in this note certainly support the original ideas of Prof. Nernst first mentioned in 1921.[7] A few years ago, when the first results of observations on the daily period according to sidereal time were published, he wished that it were possible to increase the sensitivity of our apparatus until we could detect the ultra-rays from a single stellar nebula or a single star. I think the results put forward here indicate that a modest beginning has been made in this direction. At least it has been possible now to detect the influence and the penetrating power of the ultra-rays from the sun. It may be added that the evidence here brought forward for a stellar origin of the cosmic ultra-rays is completely independent of the existence of a daily period according to sidereal time, a subject which is still under discussion.

Victor F. Hess.

Institute of Experimental Physics,
University of Graz, Austria,
Nov. 4.

[1] *Gerlands Beitr. z. Geophysik*, **20**, p. 52; 1928.
[2] *Gerlands Beitr. z. Geoph.*, **26**, 416-439; 1930.
[3] *Zeitschr. f. Geophys.*, **3**, 179; 1927.
[4] *Sitz. Ber. Akad. d. Wiss. Wien*, II. a. **139**, pp. 281-318; 1930.
[5] *Phys. Zeitschr.*, **18**, p. 585; 1917.
[6] *Zeitschr. f. Physik*, **50**, pp. 808-848; 1928.
[7] "Das Weltgebäude im Lichte der neueren Forschung", Verlag Springer, Berlin.

An X-Ray Study of Mannitol, Dulcitol, and Mannose.

A recent investigation, carried out at the Davy Faraday Laboratory of the Royal Institution, gave the following results for these three substances:

Mannitol. Space-group, Q_4; $a = 8{\cdot}65$ A., $b = 16{\cdot}90$ A., $c = 5{\cdot}56$ A.; density, 1·497 gm. per c.c.; number of molecules per cell, 4.

Dulcitol. Space-group, C_{2h}^5; $a = 8{\cdot}61$ A., $b = 11{\cdot}60$

A., $c = 9·05$ A.; $\beta = 113° 45'$; density, 1·466 gm. per c.c.; number of molecules per cell, 4.

Mannose. Space-group, Q_4; $a = 7·62$ A., $b = 18·18$ A., $c = 5·67$ A.; density, 1·501 gm. per c.c.; number of molecules per cell, 4.

A study of the X-ray data suggests that in all three cases the long dimension of the molecule corresponds to the a-axis; in the alcohols, the molecules appear to have the long-chain configuration; in the sugar, that of the manno-pyranose ring, with the longest dimension in the direction of the a-axis.

The reasons for assigning these structures to the various crystals will be discussed in a paper which will appear shortly. THORA C. MARWICK.

Textile Physics Laboratory,
The University, Leeds, Nov. 29.

Structure of the Crystal Lattice of Cellulose.

FROM an examination of the available data for cellulose and the sugars, we have formed the conclusion that the six-atom sugar ring is associated in the crystalline state with certain linear dimensions which are approximately constant, and that at least one of these dimensions usually corresponds to one of the axial lengths of the unit cell. The existing crystallographic data are as follows:

	a.	*b.*	*c.*	Density.
Native cellulose	8·3	10·3	7·9, $\beta = 84°$ [1]	1·52
Hydrate cellulose	8·14	10·3	9·14, $\beta = 62°$ [2]	1·56
Cellobiose	5·0	13·2	11·1, $\beta = 90°$ [3]	1·556
Sucrose	11·0	8·7	7·65, $\beta = 103\frac{1}{2}°$ [4]	1·588
Mannose	7·62	18·18	5·67 [4]	1·501
Glucose	10·40	14·89	4·99 [3]	1·544
Fructose	8·06	10·06	9·12 [3]	1·598
Sorbose	6·12	18·24	6·43*	1·654

* Calculated from the density, crystal class, and axial ratios.

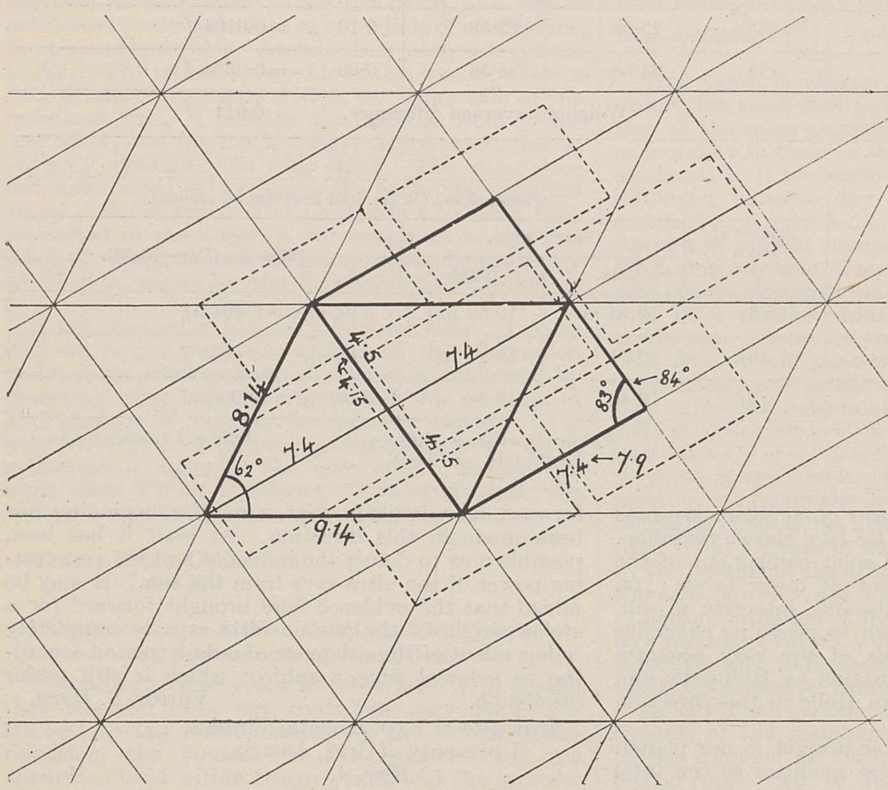

FIG. 1.

The most striking feature of the above list is the small variation in density shown by these saccharoses. This in itself strongly suggests an approximate close-packing of some molecular unit, but when we arrange the data as in the following table, it becomes still more apparent how the dimensions of this unit—undoubtedly the sugar ring with its side-chain—impress themselves on the dimensions of the various unit cells.

	Axial Dimension.	Cross-sectional Product.	
Native cellulose	10·3	8·3 × 7·9 sin 84 = *65·2*	*66·6*
Hydrate cellulose	10·3	9·14 × 8·14 sin 62 = *65·7*	
Cellobiose	11·1	5·0 × 13·2 = *66·0*	
Mannose	5·67	(½ ×)18·18 × 7·62 = *69·3*	
Sucrose	11·0	8·7 × 7·65 cos 13½ = *64·7*	
Sucrose	7·65	(½ ×)11·0 × 8·7 cos 13½ = *46·5*	*51·7*
Glucose	(2 ×)7·45	10·40 × 4·99 = *51·9*	
Mannose	7·62	5·67 × (½ ×)18·18 = *51·5*	
Mannose	(4 ×)4·55	5·67 × 7·62 = *43·2*	*41·0*
Fructose	(2 ×)4·56	(2 ×)5·03 × 8·06 = *40·6*	
Sorbose	(4 ×)4·56	6·12 × 6·43 = *39·3*	

Putting $xy = 66·6$, $yz = 51·7$, and $xz = 41·0$, in order to determine the mean values of x, y, and z respectively, gives $x = 7·27$, $y = 5·64$, and $z = 2 \times 4·58$. We suggest that the interpretation of these results is that on the average, the sugar ring takes about 4½ A. normal to the ring, about 5½ A. across the ring in the direction of the cellulose chains, and about 7½ A. across the ring in the direction of the side-chain, $-CH_2.OH$.

Applying now these values to the case of cellulose, we see that there is no *dimensional* reason why the plane of the hexagonal glucose residues should be taken parallel to the a-axis (8·3 A.), as has been proposed by Meyer and Mark.[1] In fact, the balance of evidence, particularly the evidence to be derived from the dimensions of cellobiose and the stable form of cellulose (hydrate cellulose, mercerised cellulose), indicates that the plane of the rings should lie more nearly parallel to the c-axis (7·9 A.).

The great advantage of this point of view lies in the way in which it links up the structures of native and mercerised cellulose, and in the simple picture which it offers of the mercerisation process. Fig. 1 shows diagrammatically how closely related are the two structures, and how small a change is required in order to pass from one to the other. The change in density is very small, and it may be recalled that for some time it was believed that both native and mercerised cellulose gave rise to one and the same X-ray photograph. All this is quite in keeping with what we know of the changes in other dimorphous crystals.

Against these arguments must be placed the evidence which has been adduced from intensity measurements. But both the theory and practice of intensity measurements on natural fibres are in a very immature state, and it is risky to argue that any proposed structure of cellulose accounts for the paucity of X-ray reflections, when a similar phenomenon is shown by other natural fibres, such as silk and hair, built up of totally different molecular units.

W. T. ASTBURY.
THORA C. MARWICK.

Textile Physics Laboratory,
The University, Leeds,
Nov. 29.

[1] Mark and Meyer, *Z. f. physikal. Chemie*, B, **2**, 115; 1929.
[2] Andress, *Z. f. physikal. Chemie*, **122**, 26; 1926. Burgeni and Kratky, *Z. f. physikal. Chemie*, B, **4**, 401; 1929.
[3] Hengstenberg and Mark, *Z. f. Krist.*, **72**, 301; 1929.
[4] Astbury (sucrose) and Marwick (mannose). Unpublished results obtained in the Davy Faraday Laboratory of the Royal Institution.

Ovoviviparity in Sea-Snakes.

IN a communication on this subject in NATURE of Oct. 11, 1930, p. 568, Dr. Smith discusses my note on *Laticauda colubrina*. I am quite aware that Dr. Smith's statement that all sea-snakes are viviparous was something more than a mere reiteration, but I consider that both he and previous authors have generalised from insufficient data.

When I wrote my previous note, I was fully alive to the fact that the deposition of eggs might conceivably be an abnormal occurrence, brought about by captivity. I have since had the opportunity of investigating the matter more fully, and had prepared an account (to appear in the *Bulletin of the Raffles Museum*, No. 5, which will be published shortly), before Dr. Smith's letter appeared.

Witnesses whom I have no reason to doubt have found the eggs and observed hatching. This takes place on islands near Singapore in June, July, and August.

Four females kept in captivity produced eggs, none of which contained an embryo, although some of the eggs were laid a considerable time after the snakes arrived.

In view of the evidence which I have collected, on one hand, and Dr. Smith's remarks on a specimen of this species, containing embryos, on the other, only one conclusion appears possible: the species must be capable of either type of reproduction. Either a local race inhabiting the islands near Singapore is oviparous, or the individual is influenced by the possibility or otherwise of access to dry land.* Such an explanation is by no means impossible; the Laticaudinæ are definitely in a transitional state between a terrestrial and an aquatic habitat; ovoviviparity is a form of oviparity, and far removed from true viviparity, a mere question of the point in development at which the egg, already a separate entity, is deposited. The form of the skull and of the ventral shields, the method of casting the skin, the presence of ticks, all point to a shore habitat in the locally obtained specimens of *Laticauda colubrina*. The flat tail and, possibly, the colour are the only adaptations to a marine life.

Dr. Smith mentions a specimen which deposited eggs at the Zoological Society's Gardens; I believe this to be a specimen recently obtained by me off Singapore, and dispatched to the Zoo. It appears to have borne out its local provenance by depositing eggs during August. The fact that the eggs were laid singly proves nothing; two of my specimens laid batches of six.

On the general question of reproduction in sea-snakes, then, it appears that we may say that the Hydrophiinæ, *in those species that have been observed*, bring forth their young alive, but there is no evidence to show whether they are truly viviparous or ovoviviparous; of the Laticaudinæ, examples of oviparity and ovoviviparity have been observed, and it is possible that these two degrees of the same condition may take place within the bounds of a single species.

NORMAN SMEDLEY.

Raffles Museum, Singapore, Nov. 8.

* Semper's discovery of a female guarding her young on land is strong evidence of oviparity; it is almost inconceivable that a snake which has developed ovoviviparity, a definite adaptation to an aquatic life, should take the trouble to come ashore to deposit its young.

Periodic Process in a Chemical Reaction.

THE accompanying photograph (Fig. 1) shows a rather remarkable case of a periodic process in a chemical reaction. The object shown is a potassium photoelectric cell made in this laboratory. The cell was made by the usual method in which, after careful baking-out of the glass, potassium is introduced by distillation from a reservoir sealed on to the vacuum system. The potassium was then formed into a uniform layer on the bulb and the window opened by gentle heating.

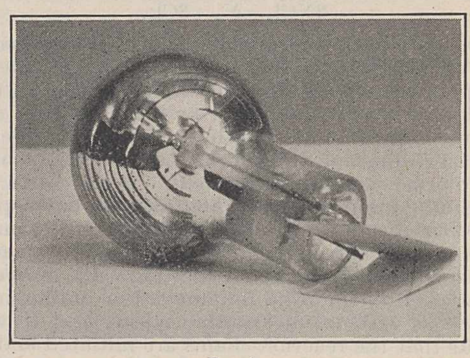

FIG. 1.

On sealing off the cell from the pumps a minute crack occurred behind the projecting tube which encloses the cathode lead. An exceptionally small leak was thereby caused and the potassium layer oxidised very slowly. Instead of oxidising uniformly, sharply marked rings were attacked first. Even when the potassium was completely oxidised the rings were still visible, as the oxide in them was white while the remainder was a very pale yellow, and finally the material in the rings turned to liquid potash solution while the remainder was still solid.

The rings are roughly circular with centres at the crack, and the approximate radii of successive rings measured along the surface of the bulb are as follows:

Curve No.	Radius.	Curve No.	Radius.
1	1·2 cm.	8	3·3 cm.
2	1·85	9	3·7
3	2·2	10	4·1
4	2·5	11	4·5
5	2·7	12	5·0
6	2·9	13	5·6
7	3·1	14	6·6
		15	7·7

The diameter of the glass bulb was 6·6 cm.

W. T. GIBSON.

Les Laboratoires Standard,
46 Avenue de Breteuil,
Paris (VIIe), Oct. 29.

The Photosensitised Decomposition of Nitrogen Trichloride and the Induction Period of the Hydrogen-Chlorine Reaction.

AN investigation was commenced by us about two years ago with the view of obtaining further evidence as to the mechanism of the induction period produced in the photochemical hydrogen–chlorine reaction by the addition of small measured quantities of ammonia and other substances.[1]

In preliminary experiments with ammonia it was observed that a small continuous increase of pressure of strictly zero molecular order occurred during the induction period. Ammonia reacts with excess of chlorine to produce nitrogen trichloride and ammonium chloride,[2] and the observed effect is explained as a photosensitised decomposition of the nitrogen chloride by the chlorine. A closely similar reaction, terminating suddenly with a semi-explosive pressure change, was observed in mixtures consisting of pure chlorine and small quantities of nitrogen trichloride only, the total pressure increases obtained corresponding to the net reaction

$$2NCl_3 = N_2 + 3Cl_2.$$

Quantum efficiency measurements with homogeneous light of wave-lengths 366 $\mu\mu$ and 436 $\mu\mu$ indicate that the photosensitised decomposition of the nitrogen trichloride in chlorine alone, proceeds by way of reaction chains of short length, the quantum efficiency falling to a limiting value in the neighbourhood of 2 as the chlorine pressure is increased. 'Inert' gases, such as helium, argon, nitrogen, and oxygen, have specific retarding effects when added to the mixture, and, as the pressures are increased, finally depress the quantum efficiency towards the above limiting value of about 2. Variation of the total illuminated or unilluminated surface is without measurable effect, and it would appear that the reaction chains are initiated and controlled in the gas phase.

A further study of the induction period has shown that hydrogen has a retarding influence on the decomposition of the nitrogen trichloride numerically equal to that of helium.

The inhibiting effect of nitrogen trichloride on the hydrogen–chlorine reaction may be explained in the light of modern views of the negative catalysis of chain reactions ; and one is led to the conclusion that small quantities of hydrogen chloride, comparable in amount with the nitrogen trichloride destroyed, should be formed during the induction period. This has been confirmed. Details of these investigations, together with a quantitative interpretation of results, will be published elsewhere at an early date.

J. G. A. GRIFFITHS.
R. G. W. NORRISH.
Dept. of Physical Chemistry,
Cambridge, Nov. 22.

[1] Chapman and McMahon: *J. Chem. Soc.*, **95**, 1717; 1909; **97**, 845; 1910. Norrish: *J. Chem. Soc.*, **127**, 2323; 1925.
[2] Cf. Noyes and Haw: *J. Amer. Chem. Soc.*, **42**, 2167; 1920.

The Band Spectrum of Silver Hydride.

ON account of difficulties in getting a convenient source of light, earlier investigations on the band spectrum of silver hydride[1] (AgH) were mainly limited to a small wave-length region at λ3180-λ3480. By means of a device, I have now been able to extend these investigations to a region including a very great number of bands.

The source of light is an electric arc operating in hydrogen at reduced pressure. The positive electrode is made of a silver-aluminium alloy. The aluminium (10 per cent) has a wonderful effect on the intensity of the silver hydride bands, and in addition the troubling N_2-spectrum disappears completely. The increase of the intensity is probably due to a decrease of temperature in the arc—the alloy chosen corresponding to the minimum points on the melting diagram of Ag-Al—an effect quite analogous to that of the high potential small current arc used previously.

In this way, the rotational structure of fourteen bands belonging to the $^1\Sigma \rightarrow {}^1\Sigma$ system in silver hydride have been analysed and arranged in a vibrational scheme. It appears from this scheme, that the vibrational levels of the lower electronic state can be expressed by the formula:

$$F''(v) = 1723{\cdot}5v'' - 33{\cdot}5v''^2 - 0{\cdot}0094v''^3.$$

The excited electronic state, however, exhibits certain irregularities of spacing in its rotational and vibrational levels, which may originate from a perturbing electronic level. An approximate calculation of the dissociation energy in both states gives us:

$$D' \sim 6300 \text{ cm.}^{-1}. \qquad D'' \sim 19000 \text{ cm.}^{-1}.$$

Combining these values with that of the electronic frequency of the system ($\nu_0 = 29{,}900$ cm.$^{-1}$) the energy difference between both products of dissociation will correspond to a term difference of about 19,000 cm.$^{-1}$, and supposing that the hydrogen atom is left unexcited, this difference should fit into the term scheme of the silver atom. It might be suggested that the normal level (^2S) and the still unknown $^2D'$ correspond to these products, but strong objections could be raised to this suggestion.

The investigation is now being pursued with high dispersion showing a beautiful isotope effect in the bands. This and the problems already mentioned will be discussed more fully in a future paper.

ERNST BENGTSSON.
Laboratory of Physics,
University of Stockholm,
Nov. 19.

[1] E. Bengtsson and E. Svensson: *C.R.*, **180**, 274; 1925. E. Hulthén and R. V. Zumstein: *Phys. Rev.*, **28**, 13; 1926.

Properties of Dielectrics in Electric Fields.

I AGREE with Mr. Addenbrooke, in his letter in NATURE of Nov. 22, as to the desirability of avoiding the illogical nomenclature involved in applying the term 'dielectric constant' to a quantity which is apt to vary greatly according to the prevailing conditions.

I should like to point out, however, that this matter has not been overlooked by physicists and electrical engineers.

We believe that V. Karapetoff[1] first urged the use of the term 'permittivity' as originally proposed by O. Heaviside[2] in place of specific inductive capacity. This term is now common amongst British and American electrical engineers, and is given as preferred to specific inductive capacity, dielectric constant, etc., in the "British Standard Glossary of Terms used in Electrical Engineering", published by the British Engineering Standards Association in 1926. Further, the term 'inductivity' has also been proposed.

It might be of interest to point out here that according to Faraday's conception, the specific inductive capacity of a substance is a mere number, being the ratio of two measurements, one of which is made with the substance and the other with air or the ether (vacuum) as dielectric medium. In arranging the system of units so that the specific inductive capacity of the ether is unity, the quantity still remains a numeric.

According to Heaviside, however, a medium must possess two physical properties if waves are to be propagated therein, and he therefore suggested it was desirable to postulate their real existence, and admit that they are measured by the 'permittivity' and 'permeability' of the substance in question, notwithstanding that the precise physical interpretation may remain unknown.

Something similar was done in regard to atomic weights, which were referred to the weight of the hydrogen atom taken as unity, before the real existence of atoms was established.

To this extent, therefore, it may be stated that the 'permittivity' and 'permeability' of a substance measure real physical properties, though, as in the case of the atomic theory with the discovery of atomic numbers, a more fundamental property may one day be found.

A. MORRIS THOMAS.

The British Electrical and Allied Industries
Research Association,
36 and 38 Kingsway, London, W.C.2,
Dec. 4.

[1] "The Electric Circuit"; 1912.
[2] "Electromagnetic Theory", vol. 1, p. 21; 1893.

Conjunctival Halos.

THE halos familiar to those who resort to swimming baths at night present a subject of some interest. They are referred to in a pamphlet published by the Ministry of Health on "The Purification of the Water of Swimming Baths" (1929), p. 18, as follows: "Owing to the difference in composition between tears and bath water, any prolonged swim causes a slight mechanical or osmotic conjunctivitis, as may readily be observed, after a long swim, by looking at a distant light by night, when the light will be seen surrounded by a halo, due to slight conjunctivitis."

There are, in fact, two spectrum-coloured halos, each with its outer edge red, thus indicating diffraction as their cause. The inner halo shows considerable dispersion. It is noteworthy that, unlike the effect seen through lycopodium-covered glass, the space immediately surrounding the source of light is dark.

The radii of the halos are easily measured by means of a 'Jacob's rod', and are found to be:

Radius of red outer edge of 2nd order halo $= 8° \; 25'$.
" " " 1st order halo $= 4° \; 49'$.

The second order spectrum is comparatively faint and therefore the first order value is the more trustworthy.

Inserting this in the equation $(a+b)\sin\theta = (2n+1)\frac{\lambda}{2}$, and taking the wave-length of the red light as $700\mu\mu$, we get 0·0125 mm. as the value of the 'grating interval' $(a+b)$. The second order spectrum gives the value 0·0120 mm.

It seems, therefore, that the surface of the cornea is covered with structural elements of this order of magnitude. Shelford Bidwell arrived at a similar conclusion from other evidence. The experiment described in his "Curiosities of Light and Sight" (1899), pp. 124-129, indicates the existence of elements $\frac{1}{2000}$ inch (0·0127 mm.) in length or breadth.

The refractive index of the cornea is 1·350 (Krause, in Helmholtz); and of water 1·333. This difference is evidently enough to bring the structure into sufficient relief to produce the diffraction.

Tyndall (*Phil. Mag.*, [4], vol. 11, p. 332; 1856) has described a similar effect in which the centre of the ring-system is bright.

SIDNEY MELMORE.

The Yorkshire Museum,
York.

An Ostrich Shamming 'Wounded'.

THE device of pretending to be wounded in order to lure marauders from the nest is one that has been recorded in the case of a considerable number of species of ground-nesting birds, mostly belonging to the more specialised families. So far as I can recollect, it has never been observed in the case of the ostrich.

Dr. T. A. Nash, a former pupil of mine now in the service of the Government of Tanganyika, writes to me as follows:—"On Oct. 24 last I noticed a male ostrich coming straight towards me, not farther off than 50 yards. The bird trailed its wings as if they were broken, and then seeing me, started off slowly at right angles to its original direction. One wing would flap spasmodically and then the ostrich would sit down, looking backwards to see how near I was. As I approached, the bird would stagger to its feet, lumber on a few yards, and then sink down. Once it appeared to be too weak to stand up and toppled over on to its side, where it lay panting. Feeling certain that the ostrich had been mauled by a lion, I called for my rifle in order to shoot it, when one of the boys called, 'The bird is well and only acting; it must have a nest near'. Leaving one boy to watch the bird, the rest of us retraced our steps, and we found the nest about 40 yards away from where I had first seen the bird.

"The 'nest' simply consisted of a clearing in the grass, with eight young birds sitting on the powdered black earth amidst broken egg-shells. Other young had scuttled off into the long grass. In addition, there was one egg in the nest. Without touching anything, we concealed ourselves at some distance off. Almost immediately we saw the male trotting back in perfect health, accompanied by the female. The female must have been at some distance off, feeding, the male being left to look after the nest—and very well he did it."

It is interesting to find such intelligent behaviour in so primitive a bird as the ostrich.

E. W. MACBRIDE.

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Letter from Charles Darwin to Lord Farrer.

I SEND herewith a copy of a letter to the late Lord Farrer from my father, Charles Darwin. So far as I can ascertain, it has never been published. It was evidently dictated, probably in the afternoon when tired by his morning's work. His remarks on observation and reasoning seem to me to be of especial interest. A letter on the same subject, definitely admitting his error, is given in "More Letters", vol. 2, p. 373.

"May 19, 1868.

"Many thanks for your notes. I do not doubt that you are right and I wrong. How I came to make such a blunder I do not know, for I examined the flowers repeatedly. I suppose I reasoned from the shape of the caudicle, and it is a fatal fault to reason whilst observing, though so necessary beforehand and so useful afterwards. I will try to find a specimen to convict myself. I wish you or someone could find out what insects visit the fly ophrys and for what purpose. I am delighted to hear that you are interested about the structure of orchids. I was formerly quite fascinated with these plants, especially with O. Pyramidalis and the common listeria."

LEONARD DARWIN.

Cripps's Corner, Forest Row,
Sussex, Dec. 4.

Stellar Structure and the Origin of Stellar Energy.*

By Prof. E. A. Milne, F.R.S.

PERHAPS the most striking general characteristic of the stars is that they can be divided into two groups of widely differing densities. In the first group, which comprises the majority of the known stars, the densities are of 'terrestrial' order of magnitude; that is to say, their mean densities are of the order of the known densities of gases, liquids, and solids. They range from one-millionth of that of water to ten or, in rare cases, perhaps fifty times that of water. In the second group the densities are of the order of 100,000 times that of water. Of the second group, the 'white dwarfs', only a few examples are known, but they are all near-by stars, and it is generally agreed that they must be of very frequent occurrence in Nature, though difficult of discovery owing to their faintness. Whether stars exist of intermediate density remains for future observation. The possibility of the existence of matter in this dense state offers no difficulty. As pointed out by Eddington, we simply have to suppose the atoms ionised down to free electrons and bare nuclei. At these high densities the matter will form a degenerate gas, as first pointed out by R. H. Fowler. But this leaves entirely unsolved the question of why, under stellar conditions, matter sometimes takes up the 'normal' density and sometimes the high density. Owing to the probable great frequency of occurrence of dense stars, it might reasonably be asked of any theory of stellar constitution that it should account for dense stars in an unforced way.

There are two main theories of stellar structure at the present moment. That of Sir James Jeans accounts for the existence of giants, dwarfs, and white dwarfs, but only at the cost of *ad hoc* hypotheses quite outside physics. It assumes stars to contain atoms of atomic weight higher than that observed on earth, and it assumes them to be relentlessly disappearing in the form of radiation; it appeals to discontinuous changes of state consequent on successive ionisations, for which there is little warrant. I think it is true to say that the majority of astronomers do not accept this theory.

The theory of Sir Arthur Eddington does not claim to account for the observed division of stars into dense stars and stars of ordinary density; nor does it establish the division of ordinary stars into giants and dwarfs. On the other hand, it claims to establish what is known as the mass-luminosity law from considerations of equilibrium only, that is, without introducing anything connected with the physics of the generation of energy. It claims to show that the observed fact that the brighter stars are the more massive can be deduced from the conditions expressing that the star is in a steady state, mechanically and thermally. It does this by making the hypothesis that the stars (giants and ordinary dwarfs) consist of perfect gas. Closer consideration of the actual formulæ used by the theory shows that it scarcely bears out the claims made for it by its originator. The 'formula for the luminosity' of a star makes the luminosity very nearly proportional to its effective temperature, and so the so-called proof of the mass-luminosity law involves a semi-empirical element, namely, an appeal to the observed effective temperatures of the stars, for the observed values of which the theory fails to account. Another difficulty encountered by the theory is that it makes the interiors of the more luminous (giant) stars cooler than those of the fainter stars, and it makes the interiors of both too cool for the temperature to have any appreciable influence on the rate of generation of energy, by stimulating, for example, the production of radioactive elements or the conversion of matter to radiation.

The claim to establish the mass-luminosity law from mere equilibrium considerations cannot, however, be sustained for a moment. We may regard a star in a steady state as a system provided with an internal heating apparatus (the source of energy). It adjusts itself—state of aggregation, density distribution, temperature distribution—until the surface emission equals the internal generation of energy L. But provided the luminosity L is not too large (in order that the mass shall not burst under radiation pressure), it is clear that a given mass M can adjust itself to suit any arbitrary value of L. If, starting with one steady state, we then alter L (upwards or downwards) by altering the rate of supply of energy, the star will simply heat up or cool down until the surface emission is equal to the new volume of L—precisely like an electric fire. L and M are thus independent variables so far as steady-state considerations are concerned. The fact that L and M show a degree of correlation in Nature must be connected with facts of an altogether different order, namely, with the physics of energy-generation. It is essential to recognise the difference between the formal independence of L and M as regards steady-state considerations and the observed correlation of L with M in Nature. The observed mass-luminosity law must depend on the circumstance that in some way the more massive star contrives to provide itself with a stronger set of sources. The claim to establish the mass-luminosity law from equilibrium considerations only appears to me a philosophical blunder. Further, it is unphilosophical to *assume* the interior of a gas to be a perfect gas; either knowledge of the interior is for ever unattainable or we should be able to infer it from the observable outer layers.

When we dispense with the perfect gas hypothesis and at the same time recognise the independence of L and M as regards steady-state considerations, it is found that a rational analysis of stellar structure automatically accounts for the existence of dense stars without special hypothesis. Further, it shows, as common sense would lead us to expect, that the more luminous stars must have

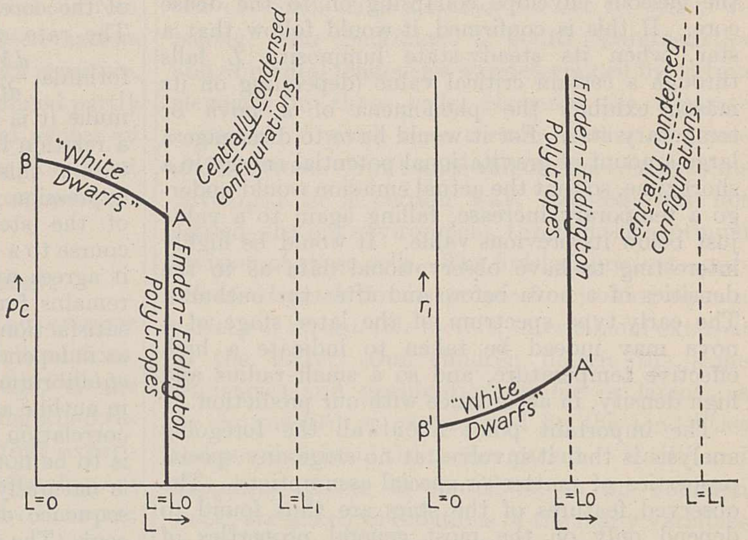
* Substance of lectures delivered at the Royal Institution on Dec. 2 and Dec. 9, 1930.

the hotter interiors. Here the temperatures are found to range up to 10^{10} degrees or higher, depending on luminosity—a temperature sufficient to stimulate the conversion of matter into radiation. In addition, it shows that the central regions of stars must be very dense, ranging up to 10^7 grams cm.$^{-3}$ or higher. Thus the difficulties met by earlier theories fall away as soon as the ground is cleared philosophically.

The foregoing ideas suggest the following as the fundamental problems of stellar structure: (1) What are the configurations of equilibrium of a prescribed mass M as its luminosity L ranges from 0 upwards, M remaining constant ? (2) What is the effective temperature T_e associated with a given pair (M, L) in a steady state ? (3) What is the value of L which will actually occur for the physical conditions disclosed by the answer to problem (1) ?

We observe that the outer parts of a star are gaseous. Consequently we can solve the problem of the state of any actual star by integrating the equations of equilibrium *from the boundary inwards*; we are entitled to assume the gas laws to go on holding until we find that the conditions are incompatible with them. We then change to a new equation of state, and carry on as before. We change our equation of state as often as may be necessary until we arrive at the centre.

The answer to the first of the problems formulated above has been worked out, for certain types of source-distribution and opacity, by the method of inward integration. The results are sufficiently alike to be taken as affording insight into the nature of stellar structure in general, and are as follows. For a given mass M, of prescribed opacity, there exist two critical luminosities L_1 and L_0 $(L_1 > L_0)$ such that for $L > L_1$ no configurations of equilibrium exist; for $L_1 > L > L_0$ the density and temperature increase very rapidly as the centre is approached $\left(T \propto r^{-1}\left(\log \frac{\text{const.}}{r}\right)^{-\frac{1}{2}}\right)$, so that in the centre there is a region of very high temperatures and densities where the gas laws are violated; for $L = L_0$ a diffuse perfect gas configuration is possible; for $L_0 > L > 0$ the only perfect gas configuration is a hollow shell provided with an internal, rigid supporting surface of spherical shape. Since in Nature no internal supporting surface is provided, to find the actual configuration when $L_0 > L > 0$ we construct the artificially supported hollow configuration and then remove the supporting surface. The mass must collapse, and collapse will proceed until a steady-state is attained in which, except for a gaseous outer fringe, the gas laws are violated. Such configurations may be termed 'collapsed'. Configurations for which $L_1 > L > L_0$ may be termed 'centrally-condensed'. The physical origin of the different types of configuration is simply the varying effect of light-pressure. For $L = L_0$ the light-pressure due to L is just sufficient to distend the star against its self-gravity and maintain it in the form of a perfect gas. For $L_1 > L > L_0$ light-pressure is so high that for equilibrium to be maintained gravity at any given distance from the centre must be assisted by concentrating as much matter as possible inside the sphere in question; when this process is carried out for all spheres, we get a central condensation. For $L_0 > L > 0$, light-pressure due to L is so low that the mass cannot support itself against its own weight in the form of perfect gas, and collapse sets in until the gas-laws are disobeyed. The diffuse configurations $L = L_0$ are unstable with respect to small changes of L.



FIGS. 1 and 2.—The linear series of steady-state configurations of a mass M, of prescribed opacity, as its luminosity L varies. (The 'white dwarfs' are the 'collapsed' configurations of the general theory. The 'Emden-Eddington polytropes' are the gaseous diffuse configurations of the general theory; they are unstable, in general, with regard to deviations of L on either side of the value L_0. The 'centrally-condensed' series has not been fully worked out—it awaits the construction of certain tables—but it may be provisionally identified with stars in the state of giants and ordinary dwarfs. The diagram is to be understood as classificatory, not evolutionary.) (ρ_c = central density, r_1 = external radius.)

For collapsed or centrally-condensed configurations the centre will be occupied by a gas in a degenerate state. When the mean densities or effective temperatures of collapsed configurations are calculated, using the Fermi-Dirac statistics for the degenerate gas, they are found to agree with the observed order of magnitude for white dwarfs. Thus, collapsed configurations may be identified with white dwarfs. A white dwarf is thus a dense star simply because its luminosity is too low, and its light-pressure accordingly too low, for it to support its own mass against its own gravity. From another point of view the calculation affords an observational verification of the numerical value of the 'degenerate gas constant' the coefficient K in the degenerate gas law $p = K\rho^{\frac{5}{3}}$, and so a check on the Fermi-Dirac statistics.

If collapsed configurations may be identified with white dwarfs, centrally-condensed configurations may be provisionally identified with ordinary giants and dwarfs, though the full determination of the properties of centrally-condensed configurations awaits the construction of certain tables. Centrally-condensed configurations appear to have the properties that as L decreases from L_1 to L_0 the effective temperature rises to a maximum and then decreases again. This would correspond to the observed division into giants and dwarfs. I give this deduction with some caution, as it is not yet demonstrated rigorously in the absence of the tables above mentioned.

A point not yet settled is the question of the continuity of the series of centrally-condensed configurations with the collapsed configurations (Figs. 1 and 2). There are indications that as L passes through L_0 from above to below, the external radius of the configuration may decrease discontinuously, the gaseous envelope collapsing on to the dense core. If this is confirmed, it would follow that a star, when its steady-state luminosity L falls through a certain critical value (depending on its mass), exhibits the phenomena of a nova or temporary star. For it would have to disengage a large amount of gravitational potential energy in a short time, so that the actual emission would undergo a temporary increase, falling again to a value just below its previous value. It would be highly interesting to have observational data as to the densities of a nova before and after the outburst. The early-type spectrum of the later stage of a nova may indeed be taken to indicate a high effective temperature, and so a small radius and high density, in accordance with our prediction.

The important point about all the foregoing analysis is that it involves at no stage any special properties of matter or special assumptions. The observed features of the stars are thus found to depend only on the most general properties of matter in association with light-pressure.

A question logically distinct from these is the origin of stellar energy. Here we require to know something of the physics of energy-generation. The following suggestions are frankly of a speculative character. Let us assume, in accordance with a hypothesis first made by Jeans (not his later hypothesis of super-radioactive atoms), that protons and electrons can unite to form radiation. Then thermodynamic considerations show that the process must be reversible—photons can generate matter. We know that matter at ordinary temperatures is stable. Hence we may postulate the existence of a critical temperature above which the process can go on in either direction. Suppose this critical temperature has been passed at 10^{11} degrees. Calculation then shows that at 10^{11} degrees almost the whole of the *mass* in an *enclosure* would be in the form of radiation; and further, that lowering of the temperature of the enclosure would result in more of the surviving matter present disappearing in the form of radiation. The process is in fact the thermodynamic opposite of evaporation: steam condenses to water with emission of energy, and the process is accordingly encouraged by cooling; matter 'evaporates' (to radiation) with emission of energy, and the process is encouraged by cooling. Now, the centre of a star is a sort of thermodynamic enclosure with a slight leak. It follows that if (as the steady-state theory indicates) the central region of a fairly luminous star is at a temperature of 10^{11} degrees and a high density, then this central region is effectively a reservoir of very dense radiant energy, with a mere sprinkling of ordinary matter present. Natural cooling of this reservoir provides the star's emission to space, and the reservoir is itself maintained by the conversion of matter into radiation inside it and on its confines.

Calculations based on this idea are consistent with the usually accepted evolutionary time scale, and predict a rate of 'generation' of energy ϵ per gram of the right order, namely, $\epsilon = -\frac{4c^2}{T}\frac{dT}{dt}$ throughout the mass of the core, where $-dT/dt$ is the rate of cooling. The rate of loss of mass is given by the usual formula $\frac{dM}{dt} = -\frac{L}{c^2}$. By combination of these formulæ it is found possible in principle to establish a relation linking M with T_c (the central temperature); this is the additional relation which, by expression of T_c in terms of L and M by means of the steady-state theory, must lead in due course to a mass-luminosity correlation. Whether it agrees with the observed mass luminosity law remains for future investigation, but it is a final satisfaction that, after first considering L and M as independent variables, we are able to use the equilibrium configurations thus disclosed to arrive in outline at a solution of the problem of the actual correlation of mass and luminosity in Nature. It is to be noted that the star's generation of energy is naturally non-explosive, for it is simply a consequence of the natural tendency of the star to cool. The star behaves, in fact, simply like a freely cooling body containing a central region of very high specific heat—namely, a pool of intense radiant energy, which is gradually drained away though partially reinforced by the conversion of matter. From this point of view, it is not that a star descends an evolutionary path because its rate of generation of energy slackens; it is rather that the act of evolving and the act of radiating energy are identical.

These suggestions as to the origin of stellar energy and the mode of stellar evolution are not to be pressed. They are to be sharply distinguished from the steady-state theory, which by the rational process of proceeding from the known stellar exterior step by step into the unknown interior indicates an inevitable series of configurations which correspond to the observed bifurcation of celestial objects into 'ordinary' stars and 'dense' stars.

NOTE.—The fundamental result of the rational method of analysis of stellar structure described in the foregoing article is the division of configurations into two types, the 'collapsed' and the 'centrally-condensed'. The existence of these two types can be demonstrated without complicated mathematics by the following argument. Let r_1

(*Continued on p.* 27.)

Supplement to NATURE

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Biology in Education and Human Life.*

By Prof. A. V. Hill, F.R.S.

DURING the last quarter of a century it has gradually been realised that biological science, no less than physical science, has an important rôle to play in the affairs of human life. Man is a creature partly of his inheritance (which we are just beginning to understand), partly of his environment and education (which have long been matters of study and discussion). His nature, as a sensitive, responsive, and creative being, is determined partly by the material—in a wide biological sense—of which he is constructed, partly by the treatment to which—in development and education—that material has been subjected.

Human Nature and Environment.

I would not deny—far from it—the extreme importance of the environment: of the traditions, of the stores of wealth and knowledge, of the accumulations of wisdom, wit, and loving-kindness which surround us. Do not imagine that experimental science leads necessarily to materialism in those who follow it. Like Martha, indeed, we are often cumbered about much serving in our laboratories: we have to be careful and troubled about many things—including the working of our apparatus: which leaves us often, alas, with too little time for reading or reflection. Those of you, however, who, like Mary, have chosen the good part, do not be too sure that we poor experimental scientists are entirely lacking in appreciation of the more spiritual affairs. It is only when provoked by theological dogma, or by prejudice blinding people's eyes to the most evident facts, that we lose our heads and tempers and become breakers of idols. Naturally, I think, we are sane and reasonable people, people who if treated with a little kindness and understanding may often be made quite decent members of society. Admitting, however, the value of the accumulated wealth and wisdom in our environment, of the culture stored by centuries of thought and labour, the hard facts of experience and experiment tell us certain things, which cannot be denied, as to the biological background of our human nature. These things, of which so many educated people are quite, or almost, unaware, are what I wish to discuss here.

Each of us arose from the union of two cells, one of which alone decided the sex to which we belong. Our inheritance of bodily characteristics and of mental tendencies was determined by certain elements in those cells, elements the separate existence of which is as certain as that of atoms and electrons. Our bodies and our nervous systems developed in a certain way, affected—but not settled—by our environment, through the continual division of those cells. The finished product—ourselves—depends for its proper functioning upon a variety of measurable factors, internal and external to the body. Our children inherit the same tendencies and possibilities, visible or latent, as we do, masked or exaggerated by the tendencies and possibilities of their other parents. Health and happiness, power to contribute to the common stock, are linked as functions of the many variables of inheritance and surroundings. The peculiarities of brain and nervous system, of internal secretions and digestion, are mingled with education and environment, with poetry and religion, in producing mind and character. Great, therefore, as are our birthrights of environment, vast as are the unconscious effects of tradition and upbringing, we delude ourselves if we do not recognise that the nature of man the individual, and of mankind the organised society, depends in large measure on biological factors.

The General Ignorance of Biology.

It is easy to be too ignorant of these elementary facts: it is possible for grown-up men and women, otherwise educated people, to be wholly unaware of all that pertains to the science of living things. Even among scientific men themselves, many are quite innocent of any acquaintance with that major half of natural knowledge which comes under the category of biology. What would they say of a biological colleague who knew nothing of elementary

* Being the Henry Sidgwick Memorial Lecture delivered at Newnham College, Cambridge, on Nov. 22.

algebra, who could not use simple physical apparatus, who had never learnt to employ a balance, who could not tell the difference between momentum and energy? So great indeed is their innocence that many of them suppose the problems of biology to be quite simple, only rather messy and inexact! How many historians, scholars, lawyers, even philosophers, have any biological knowledge? Yet what would they think of a biologist who was completely ignorant of history, literature, or philosophy, who could not read a single foreign language? It would seem, however, that to be unversed in matters so important as those with which biology deals, and withal of such supreme interest, is no less to be deplored than to be quite unlearned in humane letters.

It is possible in the University of Cambridge to obtain an honours degree in science by taking the Natural Sciences Tripos and studying only physics, chemistry, and mathematics. It would be equally possible to take three biological subjects, but these would necessitate at least a certain knowledge of chemistry and physics. No man or woman, I feel, should be able to go out from this place with the hall-mark of a scientist who has not taken, here or at school, some course in general biology. Many unfortunates, gifted with no power of solving equations or of conjuring with triangles, struggle for years in attempting to pass the mathematical examination for matriculation in various universities: and yet there is no requirement at all of knowledge far more fundamental to human life than mathematics. Latin our children must take in the "Little-Go". Latin is essential to the proper understanding of literature: biology only to the proper understanding of man! Mathematics and Latin are an excellent discipline for the mind: granted for those who have that kind of mind. But would you teach them these to the exclusion of all more natural knowledge? Would our colleagues in those subjects, often knowing nothing of biology, dare to assert that there is no mental discipline to be found in the study of life phenomena? Few discoveries are of such general significance, such universal application, not many facts have had such an effect on human thought in all its aspects, as that of evolution. Are the implications of evolution of less significance than those of the binomial theorem or of Latin grammar?

Economics deals with human life, with man in his social aspects; it cannot fail to be concerned with problems of population, food supply and transport, public health, heredity, eugenics, psychology, and medicine: all matters of great significance involving, if they are to be properly understood, the biological factor. How many economists have any acquaintance with biology? Admitting the value and importance of history as a factor in political economy, admitting the mental discipline of the classics and (for the sake of argument) the greater grace and dignity of the writings of those who have been brought up on Greek and Latin; admitting that mathematics enables the student to think in terms of flux and change, and is bound to aid in a study involving probability and the laws of large numbers of differing individuals: admitting all these things, is there no place for biology in a scheme of teaching and research in economics? I do not imply that economists should be experimental biologists. We teach physics and chemistry to our medical students, not because we expect most of them to use these sciences in their practice —they certainly will not—but as a necessary discipline and preparation for their minds. To exclude physics and chemistry from medicine would seem just as reasonable as to omit biology from political economy.

Biology in Relation to other Science.

One difficulty in the teaching of biological science arises from the fact that this requires a knowledge of other things: of chemistry and physics, of a certain minimum of mathematics. It is possible for a mathematician, a physicist, or a chemist to be unaware of most that lies outside his proper study. Such narrowness is rarely found in a biologist: his work requires at least a nodding acquaintance with the other sciences. Except to the pure naturalist, and often indeed to him, the phenomena of life are bound to raise questions of chemistry and physics, or of meteorology and geography, at every turn. The coefficient of thermal expansion of water, for example, and its variation with temperature, determine the relative richness of cold and tropical regions in living fauna. Currents and climate, temperature and radiation, the constitution of the land, the composition of the air, these determine the incidence and possibilities of life. The concentrations of phosphate and nitrate in sea water are limiting factors in the amount of its living material; solar radiation acting on the plankton determines the great growth of spring and early summer. The presence of carbon dioxide in the air, of iodine, calcium, and oxygen in the streams: such factors, and an infinite variety of others, provide a necessary basis for any discussion of the natural habits and development of animals and plants.

Often enough the physical and chemical questions provided by life are very complex and difficult, requiring special training and experience for their solution. Herein, indeed, lies the difficulty, not only in teaching biology, but also in tempting the ablest minds to take it up as a profession.

This difficulty can be solved only by a compromise. In its elementary stages the study of biology provides little of the discipline which we associate with mathematics, or with Latin and Greek. There is no *pons asinorum*; there are no things peculiarly difficult to understand; there are no problems to solve, no examples to set, no proses to translate, no poems to juggle into hexameters. The mind, like the body, can only be trained to its best performance by setting it to do what is hard, in facing and overcoming difficulties, in making efforts not merely of repetition but also of achievement. Elementary biology provides little of the mental gymnastics which we associate with these older studies. Moreover, in all but its simpler stages, biology requires a knowledge of other sciences: without these, large fields of it are meaningless. The tendency, therefore, and in principle a good one, is to teach those other sciences first. Unless, however, we are prepared to tolerate a degree of specialisation in our schools which is undesirable both for education and for science itself, there is little time or opportunity left for still another scientific subject. Biology in consequence is left to take a second place—or no place at all—at school. The best minds of the coming generation are steeped in mathematics and physical science—if in any science—and it is difficult later to draw them off into biology.

Recruits to Biology.

In the past the recruits to physiology and other biological subjects came largely from those who had studied classics and mathematics in their earlier days and then decided to devote themselves to natural science. The Science Tripos at Cambridge—as it was—had a great advantage in this respect, by leading many of the ablest students to study one at least of the biological subjects. The possibility of taking mathematics, as well as physics and chemistry, has largely closed that channel. I am sufficient of a reactionary to feel some of the advantages of the older traditional type of education. The practical difficulty has arisen owing to the much more widespread teaching of science at school. In previous days we came to a university with our minds open, and if we decided to study science we chose our subjects without prejudice. By the time, nowadays, that a student has spent at school some years already at one subject, he is unlikely to be so reckless as to burn his boats and transfer his allegiance elsewhere. Moreover, there is such a demand by their teachers for men and women of the highest ability, that every possible inducement is offered them, if they be able enough, to remain where they are.

I know that my mathematical and physical friends would be deeply grieved — and quite rightly, from their own point of view—were we biologists able to tap the source of their ablest students. Our problems, however, are at least as important, at least as interesting, and far more difficult than theirs, and I have no doubt at all that many of the ablest workers in our universities who now devote themselves to mathematics, physics, and chemistry would have made, had they been caught early, equally distinguished biologists. I am sure, indeed, that many of our classical or legal friends, had they been given the chance, would have done at least the same: they are not so incompetent either! As a practical step, biology must demand that, with all its intellectual interest and its importance in human affairs, it should be brought sufficiently to the attention of boys and girls to enable them to decide with their eyes open whether that, or something else, is what they wish to study. The quality of our recruits would rise, could time be found in the last few years of school to introduce, in a general way, the ideas and possibilities of biological science. Those should be regarded as lacking education who are altogether ignorant of the nature of living things.

Biology an Essential Factor in Education.

The discipline of the mind, important as it is, is not the only object in education, any more than is the production of athletic champions the chief purpose of physical training. Many of the subjects taught at school—history, geography, modern languages, poetry, divinity, music—are to be regarded rather from the point of view of their cultural value than as simple mental gymnastics. Experience has shown that biology also can be included in this larger category, even for children of a relatively tender age. An admirable pamphlet, "Biology in the Elementary Schools and its Contribution to Sex Education", published by the American Social Hygiene Association, describes a series of experiments in the teaching of biology, even to quite young children, by a group of sympathetic and intelligent people. "To children in general, regardless of their upbringing, the world of living nature is vastly interesting." "Children have shown in the course of their studies in biology ample evidence of their ability to classify facts, recognise relations between ideas, make generalisations, formulate results." "They have found new problems in old haunts, have examined them resourcefully, critically, objectively." It is true that such teaching requires more skill and understanding, more forethought and preparation, than much of the established routine of the schools. Biology poorly taught is as bad as history poorly taught. To introduce biology wholesale, and without the provision of intelligent and sympathetic teachers, might be dangerous and would certainly lower its value as an ingredient in a humane and liberal education. Let us retain without question the subjects which discipline the mind by their formal precision, their logical difficulties: but among those which are taught in order to breed a wider understanding of the world, I would urge that, in the ideal school, biology in its general aspects should have an assured and honourable place. That place, however, must be acquired gradually.

In a variety of ways such a minimum of biological knowledge as I would have every child possess can minister to his or her needs and thoughts and difficulties. The problems of sex are much simpler if seen from the natural and objective point of view. Reproduction is an honest and straightforward matter from the biological aspect. Inborn differences in mental and physical qualities, and the manner of their origin, are essential factors in the structure of society: our views of human relationships are bound to be affected by the existence of such differences—and to breed rational views on human relationships is one chief purpose of education. The basis of the family or the tribe, the relative effects of inheritance and environment, the aristocratic or the democratic principles in government, all these are matters which lively young minds will ponder and debate, and which ultimately depend upon the intrinsic properties of man, the biological unit. Problems of mental and bodily health, of nutrition, of physical training, of disease, belonging naturally in one sense to medicine, are most readily approached by children, as by adults, through the channel of biology.

It is possible, of course, to trade on ignorance, for selfish and even for unselfish ends. Those who believe in war may object to enlightened education on matters pertaining to reproduction as likely to diminish the supply of 'cannon fodder'. Those who desire to maintain the rights of inherited power, or rank, or wealth, may prefer to uphold the biological fallacy underlying an aristocratic constitution of society. Those who look to socialism as a cure for human ills may try to disguise the fact that all individuals are not, and cannot conceivably be made, alike in quality or character. To all, however, who desire to know and to spread the truth in such matters, trusting in the good sense of mankind, there can be no question that if the claims of biology are verified, it is right to demand for it a proper place in education.

Inheritance and Eugenics.

Can the claims of biology be verified? I will give a few examples. Let us take first the subject of inheritance, and assume (for the sake of argument and simplicity) the gene theory of its mechanism. In recent years, owing to careful experimental studies, the manner in which natural characteristics are inherited or handed on has become apparent, if not in detail, at least in general outline. There are many common fallacies about inheritance, derived from imperfect experimental knowledge or by false deduction from experience. Much of so-called eugenics is based upon such fallacies. It is often imagined, for example, that by preventing the breeding of feeble-minded individuals the race might in a few generations be completely relieved of the burden of feeble-mindedness. Assuming (to quote Jennings) that the feeble-minded make up about one-third of one per cent of the population, it is possible to compute that about ten per cent of the population bear *one* of the defective genes, a pair of which lead to the defect in question. In a population of 50 millions there is a group of 45 millions having none of the defective genes at all; another group of 5 millions, quite normal-minded but with one defective gene, people whom we may describe as carriers of feeble-mindedness, the defect being latent but ready to appear in the offspring if combined with a similar one from the other parent; and a minor group of 160,000 actual feeble-minded, carrying two defective genes. If both the second and the third groups together could be prevented from breeding, feeble-mindedness could be eliminated in a single generation. This, however, in our present state of knowledge, is quite an impossible achievement; there is no way of recognising a defective recessive gene except in its occasional effect on the offspring. If we could prevent—and to this there are merely the usual sentimental objections—

the breeding only of the third group, the actual feeble-minded, we should get rid at once of about 11 per cent of these defective people in the next generation.

The procedure, however, of eliminating this 11 per cent would have affected very little the reservoir of carriers, the five million just mentioned. Repeated in the next generation it would have comparatively little additional effect, and would need to be continued indefinitely to maintain even the ground gained. I am not saying that this should not be done—it *should* be done, but we must not expect too much from it. It has been computed that if a character governed by these rules affected one per thousand of the population, and if we attempted to eliminate it by preventing the propagation of those who possess its two defective genes, it would require 68 generations (or 2000-3000 years) to reduce its incidence to 1 in 10,000. Two morals may be drawn: (1) that eugenic hindrance to breeding, with the knowledge we now possess, might produce a definite but not a startling effect in bettering the race ; and (2) that research in such matters should be pressed on, for if we could find the means of recognising latent defective genes in those who carry them, we should have forged a tool which, in a single generation if men would submit to its use, would relieve mankind for ever, or at least until they arose spontaneously again, of some of the scourges of the race.

Mankind, in all probability, has many millions of years yet to run before forces quite outside our control finally render the earth unfit for habitation. Anything which we can do, by rearing a fitter race of men, to make the future happier and richer would seem to be well done. Some qualities are obviously more desirable than others. There exist human beings who are vigorous, wise, virtuous : others that are not ; the differences depend in part upon inheritance. Could we eliminate the tendencies not only to undesirable mental qualities but also to harmful physical ones—susceptibility to disease such as cancer and tuberculosis, deformities, various forms of weakness and unfitness—how happy and how beautiful a race might yet reign upon the earth. Look, as Jennings says in his book, " The Biological Basis of Human Nature ", on what has been done for the breeds of cattle and poultry and for cultivated plants. Shall we use, it is often asked, our knowledge of genetics for the improvement of domestic animals and fruits, and neglect the infinitely more important improvement of the human stock ? This is the question which eugenists ask. The answer—to some a very unexpected one—can readily be given, loosely quoting Jennings's words :

" There is no obstacle in the known principles of genetic science to the attainment of such a result, provided we can decide on the qualities we wish to preserve or promote in our human stock, and provided that the necessary methods are applied with the necessary thoroughness for the necessary length of time. The difficulties are not in the theory but in the practice. A practical breeder must be placed in complete control with instructions to fear not God neither regard man in the execution of his project. He will mate a few individuals possessing characteristics as near the desired ones as he can find, and he will stop the propagation of the rest. Then he will proceed to bring to light the defective genes by reversing the rule of family eugenics, that is the canons against inbreeding. The selected progeny of his first cross will be inbred, as cattle are inbred. This will bring together, on the one hand, defective genes, on the other, desirable genes ; the results will appear in the personal characteristics of the individuals produced. A great stock of defective and deformed individuals will appear along with a number that are not defective or are less defective. Those showing undesirable traits will again be eliminated ; the rest again inbred. By a continuation of this process, with at times judicious crossing of superior individuals followed by further inbreeding and elimination, the defective and undesirable genes will gradually be uncovered and removed from the race. In this way after many generations a race will have been produced all of whose individuals show the combination of characteristics sought ; a combination of the highest characteristics found in man (so far as none of these are incompatible with the others). The obstacles to the production of this result lie not in the theory of the matter but in its practice. Obviously, however, the practical obstacles are insuperable."

Mankind would not submit to the tyranny required. This type of eugenics, based upon the analogy of the domestic animals, does not lie within the bounds of practicality.

Applications of Biology.

The first and perhaps the most dramatic applications of modern biology have been in the prevention of disease. Pasteur followed up his demonstration that spontaneous generation does not occur, with the discovery that infectious diseases, such as typhoid, diphtheria, and pneumonia, are caused by living organisms. Most of these are bacteria ; many of the rest, like those of measles, are too small to be seen. Others are of an animal nature, like the active causes of malaria and sleeping sickness. Together with such discoveries arose the science of parasitology. The life histories of various parasites were unravelled, with the result that it has been possible in many cases to stamp out the corresponding disease or affection. Frequently there is an association between some parasite or animal and the microscopic agent of some disease. Anti-typhoid inoculation, the control of diphtheria, the elimination of malaria over wide areas of the earth —these have been some practical consequences of such work. No longer do we think of disease as due to evil spirits, or as magic sent by God for our punishment. In such matters biology has certainly produced a very evident effect.

In the economic fields of agriculture, forestry, and cattle-raising the study of parasites and of the organisms of disease has proved no less important. Throughout the British Dominions to-day there is urgent need for zoologists and botanists, young men of enterprise and scientific training, to aid in solving important practical problems. The demand is far greater than the supply. At the present time, at Plymouth, a certain degree of success seems already within range in predicting the quality and the approximate locality of herring fisheries from year to year. Water supply and sanitation require biological knowledge, bacteriological technique. The transport of living fruit from the ends of the earth is a joint problem of biology and engineering. The freezing of meat, the drying of milk, the preservation of eggs, the canning of fish, the safeguarding of vitamins in food, the standardising of drugs, all such matters implicitly assume a certain biological knowledge. These are not unimportant things in human life. Constructing Latin verse or studying Greek philosophy may be better gymnastics for the mind, but even Cabinet ministers and leader-writers might find a little biology useful for an understanding of the world.

It is not necessary to insist upon the close relation between physiology and medicine, the oldest almost of all sciences and arts. No man has served medicine better than William Harvey, who by the vivisection, as he says, "of toads, serpents, house-snails, shrimps, crevisses, and all manner of little fishes", together with a host of other animals, discovered the circulation of the blood—the greatest single discovery in the whole of medicine. From his day downwards along the years the services of physiology to medicine, and to the alleviation of human disability and suffering, have accumulated. Not many of us are doctors, but most of us from time to time are patients. To understand even a little of what medicine means, of the general principles upon which it is based; to regard ourselves objectively, when we are sick, as an experiment; to think of public health, of medicine, and of surgery in concrete terms instead of as a form of magic: surely if an elementary knowledge of biology can secure these things—and I think it can—it deserves a better place in our curricula. Perhaps the most important service of biology is to give men a reasonable attitude towards life.

Psychology.

These are practical affairs. In universities, however, and in schools, we study things not merely because they are practical but chiefly because they are interesting: things that are interesting will be practical enough in good time. In most branches of learning, we have to weigh the value of human evidence. Evidence, as we know, is coloured by emotions and desires: few, however, realise how often or how much. Why is it that one person, or one group, inevitably draws one type of conclusion from the evidence, another draws a different? In our conscious minds we are honest, or we try to be honest, enough: why, however, do we reach different conclusions from the same apparent facts? In historical matters we must often ask whether it is not more probable that human senses were deceived, that human judgments were at fault, than that such and such a thing ever happened at all. In records of miraculous cures and of wonders of all kinds, in the tales of witnesses of accidents in ordinary life, we know how our opinion of the value of evidence must always be tinged with a certain scepticism. The senses of man may be deceived, his sensations may be misunderstood or misinterpreted, his judgment—especially after the event—may be distorted by what he wishes, or thinks he ought, to believe.

These are matters of human psychology and behaviour: and psychology is based upon the physiology of the senses and the brain. Those who have no idea of the mechanism of sensation, who believe in the absolute existence of all they see or hear or feel, who do not realise that these are simply judgments, summaries, pictures in the nervous system, of millions of nerve messages received from their peripheral sensory organs, are all too ready to be led astray into false judgments of fact. Thus arise beliefs in the existence of things that do not exist at all, outside our own sensations. Common superstitions, magic, spirit photographs, premonitions, all the incredible things we read even to this day in the daily Press about omens or curses or bad luck—these would vanish into thin air were the evidence to be examined objectively in the light of what is known of the fallibility of human senses and judgment. I have often thought that a university should have a professor of conjuring to demonstrate how easily we can be deceived: and a reader in mental disorder to convince us how much our judgments, even of matters of fact, may be affected by our expectations, our state of health, our emotions, our desires.

Psychology, to the degree that it has an objective basis, is founded upon observation and experiment on animals and men. 'Behaviourism' may not be so important as some of its advocates claim: conditioned reflexes may not be the origin of all our actions, as certain enthusiasts maintain: psycho-analysis may invent, as well as discover, the hidden causes of our mental states. Other sciences also have made grave mistakes in their youth: Which among them shall first cast a stone at psychology? How often has physics discovered a complete formula for the universe? How often has the mystery of life been solved? Based, however, on the physiology of sensation, on the objective study of reflex and cerebral activity, on observation of the behaviour and development of animals and men, on the analysis of instinctive actions and intelligent reactions: based on these there can be no doubt of the importance, or of the future growth, of psychology. Psychology is a biological science—biological in its widest sense—and it has great gifts to bring to the other branches of human knowledge in allowing us to appreciate and understand men's motives, men's instincts, men's behaviour as individuals or in larger groups, and the various disturbances which affect their minds and conduct.

We can take a more charitable view of apparently perverse behaviour if we realise that abnormal mental states are relatively common, and that desires and emotions, feelings and memories, underlie all human conduct. We shall be more likely to be reasonable ourselves if we recognise the imperfections of our cerebral machinery, if we appreciate our own motives, if we understand—which is not at all easy—the origins of our actions. The most humane approach to the study of human conduct, I would urge, is one which takes due account of the biological factors in humanity.

Progress by Experiment.

Biology in the present stage of its development is inevitably concerned with practical experiment: it has not yet attained the precision of knowledge at which theoretical treatment of its problems is often of significance. Physics, on the other hand, in its philosophical implications, is stretching out far into the unknown: its mathematical aspects are occupying the attention of some of the greatest intellects of the age. It is possible for a man to make the most important contribution to physical science, although himself quite unskilled and unversed in experiment or observation. This is not yet possible in biology, nor will it be for many years to come. Biological material is so much more complex, so much more difficult to fit to a decisive experiment, the number of its variables is so much greater. We have to deal with an almost infinite variety of mechanisms, confined in a single living cell which may lie almost on the limits of visibility.

Reflect, for example, on what our inheritance means. We are in the first place human beings, not onions or elephants: then perhaps we are white human beings, with red hair, blue eyes, and freckles: we have physical, mental, emotional, and moral characters of all kinds: we hand these on in turn to our children and our children's children through unlimited generations. We do so merely by the influence of a single living cell. The male cell, with all its infinite variety of mechanisms and possibilities, weighs something of the order of a one-hundred millionth of a milligram. Picture the whole paternal inheritance of all the people in the United States of America derived from a single milligram of material: the inborn characteristics of the entire human race present on the earth to-day drawn from chromosomes weighing less than a single drop of water. The astronomers arouse our imagination and envy by their tales of the almost infinitely great: think of all future human history, in its endless variety, depending on material weighing less than a pin; *then* we can realise that the problems of biology are not altogether easy.

Vitalism and Mechanism.

Much labour and much skill have been devoted for many years to the study of such highly differentiated tissues as muscles and nerves. We do not pretend to explain the growth, the apparently purposeful development of these in the body. Our highest aim for the moment is to understand their working. Success, though meagre, has been sufficient to give us confidence that there is nothing to stop us on the road of our desire. To the degree that physics and chemistry are reasonable and intelligible, so also the phenomena of life are reasonable and intelligible. It is quite sure that no sentinel stands across the path to forbid our further advance. We hear much discussion of the relative philosophical merits of mechanism and vitalism: both contain elements of truth, but the whole truth is neither in the one nor in the other.

There is no more reason for expecting to explain life in terms of physics than physics in terms of life. The powers of the human intellect alone are the limit to our understanding of either. When a physical event occurs in a living cell or creature it has a physical cause, which, assuming we are skilled and clever enough, we can discover. If, however, as Jeans says, all physics is ultimately mathematics, and the order behind the universe is mathematical, then, mathematics being a function of one corner of the human mind, physics is ultimately physiology! Philosophically we can have it which way we like: practically, in biology, we must make good and significant experiments and observations.

Competition and Co-operation.

If we survey the totality of living things, we see two main forces at work: that of competition or the survival of the fittest; that, on the other hand, of co-operation in the service of the community. The higher animals are communities of cells—and the cells must work together or the community will perish. Man is a gregarious creature; he lived at first as a member of a family, then as a member of a tribe, more recently as a member of a nation. Some day, it is certain, he will live as a member of mankind. The evolution of mankind as a living organism has been extraordinarily rapid in recent years; that of man the individual is bound to be, at the present stage and hereafter, very slow. Already we see, in such organisations as the League of Nations, the idea at work of mankind as a single organism, trusting not chiefly to the survival of the fittest, but to the principle of co-operation. The conception of mankind as a living biological unit is one of great significance for the future of the race. By eugenics, so far as it is practicable—and with further knowledge it may become not only practicable but easy—we shall ensure that survival of the fittest shall continue to keep the race from degeneration, without the bloodshed and cruelty of its natural incidence. By co-operation we shall make certain that the malignant growths of national hatreds do not wreck an otherwise healthy organism.

The Claims of Biology.

I make strong claims for biology—but do not think I am advertising my own wares. Indeed, if I can analyse my motives properly, I am protesting against my own ignorance of, my own lack of education in, the most interesting things in the world. Had I spent a little less time at Latin and Greek, had the theory of equations and the convergence of infinite series loomed a little less large on my horizon, I might have had time, if someone would have taught me, to learn about living things at an age when they could be remembered. Knowing just enough, however, to realise the wonder, the beauty, the complexity of life in its scientific sense, and the degree to which workers with every variety of mind can contribute to the living organism of biological knowledge, I have set out to urge that the claims of biology must be treated very seriously.

There are not many departments of knowledge in which its contribution can be neglected; there are not many aspects of life which can remain indifferent to its teaching. Nearly half a century ago died Francis Maitland Balfour, brother of Mrs. Sidgwick, a man whose early promise—could it have been fulfilled—would have placed him among the greatest of Cambridge biologists. Another brother, Arthur James Balfour, died recently: all his life a friend, and far more than a friend, of science, even in his last years he rendered, by his counsel, very important service to medical research and to applied psychology. Henry Sidgwick himself, were he alive to-day, would have been one of the first to see the significance of biology, in its wider aspects, in matters of human conduct. The days fortunately are gone when children had to be informed that babies are sent down ready-made from heaven. The stage has been passed where full-grown men and women can be told that the ideas of absolute good or evil are derived from the same mysterious source. Henry Sidgwick's ethics was in keeping with the point of view of to-day, that the idea of good is intimately associated with the highest welfare of the race; with the notion that the health, the happiness, the wisdom, the beauty of mankind as a sentient living organism must be the final arbiter in deciding what is good and right.

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be the radius of a configuration, arbitrarily assigned beforehand. Let us endeavour to construct a gaseous configuration with this radius. If such a configuration be capable of being constructed, let us in imagination take a journey inwards to the centre, starting from the boundary. Let M be the total mass, $M(r)$ the 'surviving' mass left inside the sphere of radius r when we have reached the distance r from the centre. Then $M - M(r)$ is the mass already traversed. Consider now the influence of light-pressure. If L is large, light-pressure will be large and will balance an appreciable fraction of gravity, and accordingly the density-gradient will be small. But if L is small, light-pressure will be small, and the density-gradient will be large. Thus, when L is large, we shall have traversed a smaller mass $M - M(r)$ in the shell between r_1 and r than when L is small. Consequently, when L is large, $M(r)$ will be larger than when L is small. In other words, as we journey inwards, when L is small we 'consume our mass' faster than when L is large. If L is sufficiently small, we may have consumed our whole mass M before we arrive at the centre; in that case the only configuration of radius r_1 and mass M is a hollow shell internally supported by a rigid spherical surface. If L is sufficiently large, we shall, however, tend to have an appreciable mass $M(r)$ surviving unconsumed however near we approach the centre, and this surviving mass $M(r)$ can only be packed inside r at the cost of high density with violation of the gas laws. Thus these configurations for large L must be centrally condensed. For small L, on the other hand, no configurations of radius r_1 and mass M, unsupported, can exist, and the actual configurations must be 'collapsed' ones. 'Collapsed' configurations prove to be much more nearly homogeneous than 'centrally-condensed' ones.

Scientific Centenaries in 1931.

WITH the forthcoming celebrations in London in September, first of the centenary of the discovery by Faraday of electromagnetic induction and then of the centenary of the British Association, the year 1931 promises to be one of outstanding interest to men of science, especially as these events will be preceded by the Second International Congress of the History of Science and Technology, also to be held in London. At Cambridge, too, a committee of distinguished men has been appointed in connexion with the centenary celebrations of the birth of Maxwell (1831–1879). Among other famous physicists who were born the same year as Maxwell were P. G. Tait (1831–1901); D. E. Hughes (1831–1900); Sir Francis Bolton (1831–1887), a founder of the Institution of Electrical Engineers; S. H. Burbury (1831–1911); and Johannes Bosscha (1831–1911), once the acknowledged leader of Dutch physicists; while a hundred years ago died J. T. Seebeck (1770–1831), the discoverer of thermo-electricity, and Henry Foster (1796–1831), the Copley Medallist of the Royal Society in 1827. Two hundred years ago, on Oct. 10, 1731, Cavendish was born at Nice.

Among the anniversaries of 1931 of great interest to mathematicians is that of the tercentenary of the death of Henry Briggs (1561–1631), the first Gresham professor of geometry, and from 1620 Savilian professor at Oxford, an appointment in which he succeeded Savile himself. The first improver of logarithms after Napier, Briggs wrote two great works, his "Arithmetica Logarithmica" and "Trigonometria Britannica". At his death Briggs was buried beside Savile in the chapel of Merton College. Another well-known name is that of Brook Taylor (1685–1731), "one of the most able British mathematicians after Newton", and secretary to the Royal Society. Baron Maseres (1731–1824), the mathematician and judge, was born the year Taylor died. Maseres, Taylor, Briggs, Burbury, Cavendish, and Tait, like Maxwell, were all graduates of Cambridge; while last century, few Cambridge mathematicians had a higher reputation than E. J. Routh (1831–1907), who shared the Smith prize with Maxwell. The year 1831 also saw the death of the remarkable French woman mathematician, Sophie Germain (1776–1831).

Of the names of astronomers recalled by the passing of a century, mention may be made of Jean Louis Pons (1761–1831), the discoverer of 37 comets; of the Rev. F. Fallows (1789–1831), the first Royal Astronomer at the Cape of Good Hope, where he died; of Edward Stone (1831–1897), who was the predecessor of Gill at the Cape; and Bredichin (1831–1904), the successor of Otto Struve at Pulkova Observatory. A very notable achievement in astronomy is recalled by the tercentenary of the observation by the philosopher Gassendi, on Nov. 7, 1631, of the transit of Mercury across the sun's disc. The occurrence had been predicted by Kepler, but Gassendi alone among his contemporaries appears to have made adequate arrangements for observing the transit, and happily his foresight and ingenuity were amply rewarded by his success.

Other distinguished men of science born a hundred years ago include the American agricultural chemist, Samuel William Johnson, whose two books, "How Crops Grow", 1868, and "How Crops Feed", 1870, were translated into French, German, Russian, Italian, and Japanese; the German chemist, Hans Heinrich Landolt (1831–1910), who was spoken of in the *Journal of the Chemical Society* as "the patriarch of physical chemistry"; and the British chemists, Matthiessen (1831–1870), Northcote (1831–1869), Bloxam (1831–1887), and Atkinson (1831–1900), all of whom enriched chemical literature. The year 1831 also saw the birth of the great Austrian geologist, Eduard Suess (1831–1914), Copley Medallist of the Royal Society in 1903, whose name is now to be seen on a tablet affixed to 4 Duncan Terrace, Islington, where he was born; of Carl Albert Oppel (1831–1865), the eminent German palæontologist; of Othniel Charles Marsh (1831–1899), long in charge of the division of vertebrate palæontology in the United States Geological Survey, and the discoverer in 1871 of the first pterodactyl remains; and of Eugène Renevier (1831–1906), the distinguished Swiss geologist. Swiss science is also represented by François Huber (1750–1831), the naturalist, who, though smitten with blindness, wrote a notable work on the habits of bees; British surgery is represented by John Abernethy (1764–1831), of St. Bartholomew's Hospital, one of the foremost medical teachers of his time; the birth of British industrial chemistry by Archibald Cochrane, ninth Earl of Dundonald (1749–1831), who wrote an account of coal tar and established works for the manufacture of soda from common salt, but reduced himself to penury. The bicentenary of the birth of Erasmus Darwin (1731 - 1802) will not only recall an interesting figure of the eighteenth century, but also will serve to remind us that on Dec. 27, 1831, his famous grandson, Charles Darwin, left England in H.M.S. *Beagle.*

In the realm of engineering and invention many interesting centenaries will fall due. Sir Hugh Myddleton, who gave London its first waterworks, died in 1631; Patrick Miller, who, with the aid of Symington, experimented with steam-boats in 1788, was born in 1731; while 1831 saw the deaths of Symington himself; of Blenkinsop, a pioneer of the locomotive; of Sir Samuel Bentham, and of Henry Maudslay, probably the finest mechanician of his day. The same year saw the birth of Sir Andrew Noble, the great artillerist; of Ludwig Nobel, 'the Baku oil king'; of Pullman, maker of the first sleeping-car; and of James Starley, who "by his improvements rendered bicycles and tricycles machines capable of general use", and by his energy raised Coventry to the position of a centre of industry.

Obituary.

Dr. Ellwood Hendrick.

A *FRIEND* cannot be defined. He is never made: he comes, when and how who shall say? Only where the wind listeth. He cannot be a woman: subtle, homosexual harmonies tie the relationship. He is the greatest and rarest of discoveries: the inestimable loss. The intensity of friendship may vary greatly: waiting as it does upon opportunity for its upgrowth, ripening with time, its character is of instant determination: at least, you know at once who are the people you will like.

Ellwood Hendrick, almost by his name, made instant appeal to me ten years or so ago when we met at one of our summer chemical gatherings. To write the common, catalogued, laudatory notice of such a man is impossible, the more as he has no base professional claim. When with him I had the feeling that "Rip van Winkle" was at hand, having Jefferson's inspired presentation of the delinquent in mind—a vision unfortunately impossible to the modern generation. Hendrick was a bit of a Rip and both in build and manner of Dutch complexion, with sufficient *Diable au corps*, I believe of Irish origin, to make him artist and humorist as well—no mere testubical chemist. Giving avuncular advice on the study of chemistry, he could slyly write—

You'd better join the Church before
  This course is well begun,
Because you'll need to exercise
  The art of faith, my son.

I used to think theology
  Was rather rough on doubt
But chemistry with ions beats
  Theology all out.

Long an admirer of Lafcadio Hearn—the strangest of hybrids, Greek-Irish by descent—in reading his "Life and Letters", by Elizabeth Bisland (1906), I had wondered what manner of man the Ellwood Hendrick could be to whom Hearn had addressed such wonderful outpourings, even calling him 'Dear, Devilishly Delightful, Old Fellow' (in 1891). Hearn wrote his friend's epitaph in using these words. This is what I at once found him to be. We exchanged letters freely and it took me but a short time to fathom the secret of Hearn's love of the man. The full story of this friendship was given by Hendrick, in an essay he contributed to the *Bulletin of the New York Public Library* last year; he had presented the precious originals of the Bisland letters to the Library in 1919.

Hendrick tells how he first met Lafcadio Hearn, in 1888, in New York, at a select gathering of literary people, including Elizabeth Bisland—the most beautiful woman he ever saw. Hearn was then on his return from two years in the French West Indies; this was a year before he went to Japan. Quickly seeing how utterly miserable Hearn was in the presence of strangers, owing to his intense shyness, accentuated by his partial blindness, Hendrick soon took him away—as an old Heidelberg Corps student should, naturally to 'a none too respectable beer cellar', the only possible place of resort in the circumstances. The beer fulfilled its divine appointed purpose. They talked of many things. In the end Hendrick resolved that here was his opportunity:

". . . that if this man would only let me, I would cultivate his friendship and be with him as much as I might, for it seemed as though, through him, a light was dawning on my horizon.

"Perhaps I had better explain a little about myself. I had studied chemistry abroad and had planned to organise a great synthetic organic chemical industry in the United States. It had started and proceeded for three years until we finally produced excellent materials. But our sales organisation was defective, tariff changes and a bad year ensued; there arose disagreement among the proprietors, the bonds foreclosed and that was an end to it all for me. I was young and foolish and resolved to have nothing more to do with chemistry which had been, I felt, a false mistress to me. The dreams of my boyhood and young manhood were shattered, I believed my future to have been destroyed, that nothing but common-place things would be available to me and that the whole business of living was hardly worth while. It was easy enough to make a living by sticking to my job but even if it did lead to a better post and more pay it lacked the distinction on which I had set my heart—and been disappointed. In short, my ambition was hardly to be recognised.

"I did not tell these things to Lafcadio as I have told them here but he sensed the situation. And just as I resolved that night to cling to this man in the hope of enlightment, I believe he resolved to fan the almost extinct spark of ambition in his new companion, who was ten years his junior, until it might burn again and warm his disappointed soul."

Ellwood Hendrick was born at Albany, N.Y., on Dec. 19, 1861; he died in his New York home on Oct. 29, 1930. Educated for the most part abroad, at twenty he became manager of the Albany Aniline Dye Works—it is not surprising that he was unsuccessful. He then spent over thirty years in insurance work. He returned to chemical work, in 1917, with the Arthur D. Little Co., Cambridge, Mass. In 1924, he was appointed curator of the Chandler Museum in Columbia University. Of late, he exercised a great influence upon the social development of Columbia students, seeking to make them men of the world. All sorts of willing helpers came to his aid—distinguished actresses and others. He had a very pretty pen, as all know who have his delightful volume of "Percolator Papers" (Harper Bros., 1919), a model in its way—named after the organ of the New York Chemists' Club. He could write on subjects so far apart as Saul of Tarsus and C_2H_5OH—even ascribe to the latter the greater influence for good in the world.

Hendrick was a perfect letter writer. Early in March of last year, he wrote me a rapturous account of "Green Pastures", the work of his friend Marc Connelly. "I'm so full of it, I want to write about it to some sympathetic soul." To him it was a wonderful picture of the way in which the 'darkies' took the Bible and adjusted it to their own minds. (This may not be without repercussion upon ourselves, if we consider what is the effect upon students of textbook tarradiddles and modern pseudo-scientific mysticism.) "It is all real from a simple and childish point of view that everybody had once. I urge you to see it. It is free from all the offensiveness of apologetics." His charm, in fact, lay in his being himself a primitive. In "Green Pastures", Hendrick was in the element native to his spirit. HENRY E. ARMSTRONG.

WE regret to announce the following deaths:

Mr. T. F. Bourdillon, formerly conservator of forests, Travancore, on Dec. 19, aged eighty-one years.

Dr. Geo. F. Freeman, director of the Federal Experiment Station at Mayaguez, Porto Rico, since April last, an authority on cotton breeding, on Sept. 18, aged fifty-three years.

The Right Hon. Lord Melchett, P.C., F.R.S., chairman of Imperial Chemical Industries, Ltd., on Dec. 27, aged sixty-two years.

Prof. John Munro, emeritus professor of mechanical engineering at the University of Bristol, on Dec. 19, aged eighty-one years.

Prof. Pierre Termier, Inspector-General of Mines and Director of the Service de la Carte Géologique, who was elected in 1909 a member of the Section of Mineralogy of the Paris Academy of Sciences, aged seventy-one years.

News and Views.

WE have on more than one occasion had suggested to us that articles on investigations being carried on at various research centres would be of interest to scientific workers elsewhere. The selection of such centres is, however, a little difficult, and the result might be regarded as invidious, unless it referred to the activities of a particular investigator and the group of workers around him. After all, scientific research is peculiarly individual whether carried out alone or with the help of others. It seemed to us, therefore, that an approach to investigators themselves, inviting them to state the main subjects to which they are now devoting attention or problems which they would like to see solved, might lead to some interesting and suggestive notes. Inquiries, with this intention, have been sent to a number of people engaged in research, and in another column we associate replies received with the birthdays of those who have sent them. It is proposed throughout the year to publish similar notes under the title of "Birthdays and Research Centres", and we believe that the information thus brought together will prove of wide interest.

IN the issue of NATURE for Dec. 27, under "News and Views", reference is made to "the birthday anniversaries of three veteran workers in science and educational progress". In the case of Dr. William Garnett, who celebrated his eightieth birthday on Dec. 30, mention should be made of his work in Newcastle and the counties of Northumberland and Durham during the ten years he resided in Newcastle-upon-Tyne. When in 1884 he was appointed principal and professor of mathematics in the Durham College of Science in Newcastle, he found the College still in occupation of temporary premises ill adapted for its work. Circumstances combined to crown Dr. Garnett's insistent advocacy for the erection of special buildings; a site was acquired, and building operations begun with the north-east wing, which was opened in 1888, to be followed six years later by the completion of the south-east and south-west wings. In 1894 Dr. Garnett resigned the principalship to take up the organisation of technical education for the London County Council. Since that time the work in Newcastle has progressed; not only is the main building completed, but also many others have been erected on the site, in connexion with what is now known as Armstrong College. Further, it was mainly on Dr. Garnett's initiative that the University of Durham sought and obtained a supplementary charter, which provided for the admission of women to degrees in all Faculties save that of theology; a restriction removed later when the University was reconstituted. Finally, Dr. Garnett took an active and prominent part in promoting and organising schemes for technical education, not alone in Newcastle, but also in the counties of Northumberland and Durham.

JAN. 5 is the bicentenary of the death of Étienne François Geoffroy, the French chemist and physician, who was a fellow of the Royal Society and a member of the Paris Academy of Sciences. Born in Paris, Feb. 13, 1672, the son of a well-to-do pharmacist, Geoffroy studied at Paris and Montpellier, visited various parts of France, and came to England as physician to the French Ambassador. In 1707 he was made professor of chemistry at the Jardin des Plantes and later on became Dean of the Faculty of Medicine at the Collège de France. He did much by his personal influence to mitigate the severity of the strife then raging between Parisian physicians and surgeons, and he was the author of a "Traité de la matière médicale" which was published after his death. "Geoffroy", says Senier, "was the first to construct Tables of Affinity, in which the substances are arranged in columns, each having successively less attraction for the one mentioned first. This was undoubtedly a very great advance, and led directly to the important work of Bergmann." Geoffroy's younger brother, Claude Joseph (1685–1752), also a member of the Paris Academy of Sciences, wrote some sixty memoirs on natural history and chemistry; while his son, Étienne Louis (1725–1810), a correspondent of the Institut, was the author of the "Histoire des insectes des environs de Paris" and other works.

EARLY last year we directed attention to the pamphlets issued by the Safety in Mines Research Board headed "What Every Mining Man should Know". The third of these pamphlets has just been issued and has for its title "How Some Firedamp Explosions are Prevented". The pamphlet explains in simple language the various methods used to safeguard against gas explosions (to use the phrase of the pamphlet itself). It would perhaps have been wiser to have spoken everywhere not of a safeguard against gas explosions but of minimising the danger of gas explosions, because it cannot be too often repeated that no invention yet produced is an absolute safeguard against explosions, but that the various modern methods described in this pamphlet do make explosions of firedamp far less likely to occur. It is needless to say that the pamphlet is well and clearly written, but it may be doubted whether it will really accomplish its desired end. First of all, as has already been pointed out, it is doubtful whether any large number of coal miners will even take the trouble to read these pamphlets. In the second place, it will be seen from the Annual Report of H.M. Chief Inspector of Mines for 1929 that in that year there were 68 explosions of firedamp causing accidents, of which no less than 50 were caused by the use of naked lights. It is obvious that until the prohibition of naked lights in collieries is carried much further than it is at present, explosions of firedamp are bound to occur. Nevertheless, it is obvious that the more widely information such as that contained in the present pamphlet is disseminated among coal miners, the greater is the probability that the men themselves will learn to take efficient precautions against such occurrences.

THE Report of the Science Museum for 1929, recently published by the Board of Education, contains statistics of the number of visitors, particulars of the progress of the various departments, lists of acquisitions and their donors, and the report to the Board of the Advisory Council, of which Sir Hugh Bell has for many years been the chairman. That the popularity of the Museum has increased during the last few years, and especially since the opening of the new galleries in Exhibition Road, is well known. The efforts made to meet the public taste have indeed been so successful that at times the galleries have been inconveniently crowded. Attendance charts included in the Report show, as might be expected, three peaks coinciding with the school holidays at Christmas, Easter, and August, when the Museum is thronged with boys and girls. The working models, a feature the Museum owes to the late Mr. Isaac Last, have always proved attractive, and though it may be doubted that the working of, say, the Rateau steam turbine, is understood by many who turn it round, there are simpler exhibits which the young can understand. With reference to this, the Report says: "A most interesting and instructive series of working models, within the range of their intelligence, could be designed and exhibited in a special gallery or galleries, which would serve as an introduction to the exhibits in the main galleries". There is no room at present for such a collection, but a commencement has been made with the construction of the models required.

THE question of further accommodation at the Science Museum is referred to several times in the Report, which states that it is not possible to exhibit certain objects or develop some of the collections, owing to the want of space. About seventeen years ago, the late Sir Francis Ogilvie read a paper on the Science Museum to the Royal Society of Arts, and this, when published, contained a plan of the new buildings as suggested by the Departmental Committee on the Science Museum and the Geological Museum. The plan showed a range of buildings extending from Exhibition Road to Queen's Gate. Had the War not intervened, no doubt the whole of this scheme might by now have been well advanced. But so far only one of the three sections has been erected. When the great advances made during the last quarter of a century in physical science, engineering, and technology are taken into consideration, we are not surprised that the growth of the collections has outstript the growth of the Museum buildings. The new Geological Museum is now being constructed, and it is to be hoped means will be found for carrying on with the second section of the Science Museum. In its scope, the Science Museum reflects very fully the great industries on which the material progress of Great Britain depends, and at the same time recalls the work of the great pioneers who made us, at one time, the engineers and manufacturers for the whole world. It is of the greatest value for technical men, teachers, and students to be able to study both past and present practice, as they can do at the Science Museum; while the importance of the Museum as an educational institution is proved by the use made of it by the schools of London and elsewhere.

Hitherto European broadcasting has been very successful in avoiding interference between the waves from transmitting stations, but recently there has been serious interference between London Regional, Mühlacker, Graz, and what is apparently a harmonic from the Warsaw station. This is due partly to the small space in the broadcasting spectrum allotted to each of the transmitting stations and to the very high powers now being radiated into space by some of them, but it is mainly due to the fact that the European broadcasting conferences have not the power to control and dictate to the transmitting stations. Some of the countries, also, do not respond to their recommendations. Luckily, happy relations hold between the broadcasting authorities, and so a remedy for the Mühlacker interference—which has sometimes taken away nearly all the pleasure of listening to the London Regional transmission in the south of England—will be devised. The power at present emitted from Mühlacker is 70 kilowatts, and as it is proposed to double it in the future, the necessity of preventing interference is urgent. Judging from the number of very high power transmitting stations at present being erected in Europe, it would be well for the broadcasting authorities to look ahead and take steps to avoid interference. In this respect Europe is not so happily situated as the United States, where there is a central authority appointed by the Government which can dictate to and control the various transmitting stations. In the States, also, there is no risk, as in Europe, of disagreement between two nations on political issues.

The section for scientific and optical instruments and photographic apparatus at the British Industries Fair, Olympia, London, Feb. 16-27, will occupy some 6000 square feet on the ground floor of the Grand Hall. A joint exhibit has again been organised by the British Optical Instrument Manufacturers' Association. There will be instruments for all branches of research and industry and for educational purposes, including a particularly fine exhibit of visual aids to teaching. It is, perhaps, not generally known that British manufacturers of optical glass supply lenses to America for cinema cameras and projectors, and that one firm is actually exporting the bulk of its spectacle lenses to the United States. Every kind of modern optical instrument is obtainable from British manufacturers, and there are some British instruments not made elsewhere which are used all over the world, including Germany. There will be a novel display of marine and aerial lighting equipment, including a flashing buoy-light and aerodrome floodlights and models of lighthouses and airway beacons. The section for chemicals at the Fair will occupy some 11,000 square feet on the ground floor of the Grand Hall. Invitations to the Fair may be obtained by scientific workers, teachers, and others on application to the Department of Overseas Trade, London, which entitle the holder to travel to and from the Fair by rail at the rate for a single journey plus a third.

A demonstration of the work being carried out in radiology by the Radiological Branch of the Research Department, Woolwich, was given on Dec. 18 and 19. The items were demonstrated by members of the staff, and a general summary was delivered afterwards by the director, Mr. V. E. Pullin. Among the items demonstrated were the following:—Exhibits illustrating the technique in the preparation of radiographs of metallic objects; the designs and construction of experimental X-ray transformers, together with their accessory apparatus; an experimental X-ray equipment designed to work at 250,000 volts, with either valve or mechanical rectification, and with or without smoothing condensers; oscillograph studies of the current and voltage wave forms in an X-ray circuit; the construction of experimental X-ray tubes up to 300,000 volts; apparatus for the radiographic examination of gun tubes and similar heavy forgings: demonstrations of X-ray crystal analysis of steel by means of line spectra, where precision measurements to an accuracy of one in a thousand were shown; also X-ray analysis of explosives and propellants, together with new designs of X-ray spectrum apparatus. A large number of guests, both from the Services and outside academic and industrial organisations, were present.

In a communication elsewhere in this issue, Dr. V. F. Hess again raises the question of whether part of the cosmic radiation may come from the sun. There can be no question that any solar component is very small, and that the accuracy of most of the older measurements would not have sufficed to show its presence. Dr. Hess considers, however, that this is established by recent work of Hoffmann and Lindholm with a large high-pressure apparatus, which has been used at a height of 2456 metres at Muottas Muraigl, in the Engadine. These observers found consistently that the ionisation due to the penetrating rays was about one-half per cent greater by day than by night, and, moreover, that the absorption coefficient of the difference in ionisation was about the same as that of the whole of the cosmic radiation. Dr. Hess takes the view that it is legitimate to suppose that the difference represents the contribution of the sun, and that the absorption measurements show that this is at least as hard as the main radiation. Corlin's conclusion—based on a statistical analysis—that the sun is not a radiator, is referred to lack of precision in the data employed by him. If Dr. Hess's views prove to be correct, and the sun, and so presumably all stars, are to be regarded as sources of the rays, it will become desirable to reconsider critically the alternative view that they arise in interstellar space.

Considerable interest and no little controversy was aroused in America in 1927 by the announcement that Mr. Harold Cook had discovered metates for grinding corn and an arrowhead in association with fossilised mammalian bones of Pleistocene age in the Holloman gravel pit at Frederick, Oklahoma. In view of the verdict passed on similar discoveries which have served as a basis for a claim for a high antiquity for man on the American continent, it is not surprising that the announcement was received with considerable reserve, and the conclusion that the Oklahoma gravels afforded evidence of the contemporaneity of man and a Pleistocene fauna in America was questioned by more than one anthropologist of standing. The accuracy of the interpretation of the geological evidence by Mr. Harold Cook and others is now disputed by Dr. O. F. Evans, of the University of Oklahoma, in a communication to the *Journal of the Washington Academy of Sciences*, vol. 20, No. 19. Dr. Evans, in the light of his wide experience of the geology of the region, maintains that the gravels of the Holloman pit are a redeposit made after a period of post-Pleistocene uplift, having been eroded by a stream in the bed of which the pit was situated. This stream was diverted shortly after the redeposit was made. The artefacts which were found in association with the fossilised bones had been lying on the surface of the gravels when the latter were eroded, and were redeposited with them. Dr. Evans's citation of similar deposits in the adjacent area supports his view, to which the relatively recent character of the artefacts—in any case, an element of doubt—gives further cogency. Once more ' indisputable ' evidence for Pleistocene man in America has failed to carry conviction.

The sixteenth meeting of the International Geological Congress will be held in the United States in 1932, with headquarters at Washington. A series of excursions, to occupy about ten days late in May, is being arranged to precede the general sessions : these will be partly in the north-east, to suit the convenience of those arriving at New York ; partly in the southern States, starting from Washington ; and in addition there will be a transcontinental trip for those landing at San Francisco. The Organisation Committee is planning the preparation and publication of a monograph on the petroleum resources of the world, and papers on this subject will be conspicuous in the programme of the general sessions. The latter are provisionally fixed for the early part of June. Other topics proposed for special consideration include estimates of geological time ; problems of batholiths and metalliferous deposits ; sedimentation ; geomorphology of arid regions ; and fossil man. Suggestions for other topics are invited, and should be sent to the General Secretary. After the general sessions, two alternative transcontinental excursions are proposed, each occupying 32 or 33 days ; and two shorter excursions, one to the iron and copper districts of the Lake Superior region (13 days) and the other to Oklahoma and Texas (10 days). If desirable, the latter may be transferred to the group of excursions preceding the general sessions, in order that petroleum geologists may not be excluded from one of the transcontinental trips. Excursions to Alaska and the Hawaiian Islands are also under consideration, and will be arranged if a sufficient number of visitors express the intention of taking part. All inquiries should be addressed to the General Secretary of the Organising Committee, Sixteenth International Geological Congress, Washington, D.C.

The first annual report of the Executive Council of the Imperial Agricultural Bureaux has been published. Eight bureaux dealing respectively with soil science, animal nutrition, animal health, animal genetics, animal parasitology, plant genetics (crops and herbage plants being considered separately), and fruit production were set up in 1929 under the directorship of the heads of the research institutes in Great Britain at which they are located. The chief officer, however, in almost every case has had training or experience in some part of the Empire overseas. The main function of the bureaux is to act as clearing-houses of information in that branch of agricultural science with which they are concerned, and to promote direct contact with research workers overseas. Arrangements have been made for the collection of research information from all parts of the world and for summaries to be disseminated to all workers in the Empire. Although the first year was necessarily devoted largely to organisation, several of the bureaux have already been able to make a start in the distribution of the information they have collected. Research work is not undertaken by the bureaux, but they are able to put workers in different countries encountering similar difficulties into touch with each other, and thus aid co-operation. As regards finance, all the Empire countries represented on the Executive Council contribute a share to a common fund. A sum of £20,000 was originally suggested as the total yearly contribution, and estimates for next year amount to £19,300. Each bureau is being encouraged to develop along its own lines, but although there may be diversity of detail they all have a common object—service to the workers on agricultural science in the Empire. The success of the bureaux, however, depends on the measure of support given by the research workers and the use they make of them.

An Association of International Patentees, Incorporated, with headquarters in New York and corresponding-secretaries in various parts of the world, has recently been formed. Its objects are to care for the interests of patentees and their congeners, to promote improvements in patent law, to help patentees to find financial support, to organise exhibitions and conferences, and to supply information. The movement is at present mainly centred in the United States, though it aspires to become international. Its vice-presidents include eleven ministers of various nations accredited to the United States, Dr. Hugo Eckener, Prof. Einstein, and two distinguished representatives of Canada and British Honduras. The advisory board is drawn from England and the United States, the committee on scientific and educational research from Canada and the United States, and the advisory committee on patents from foreign diplomatic representatives accredited to the United States. National councils are in process of formation in other parts of the world. The success of such a body in exerting international influence and in attaining its objects—particularly the notoriously difficult one of finding financial support for struggling inventors—must depend mainly on the personality and enthusiasm shown by its more active promoters, and the probable extent of its success can scarcely be predicted at this early stage.

PLANS for a new building at the Massachusetts Institute of Technology contain unusual provisions for fundamental research and advanced instruction in physics and chemistry. Funds for starting the building, which will join two wings of the present buildings on the east side of the main buildings, are available from the gift of £500,000 by Mr. George Eastman in 1916. The new four-story structure will include a well-equipped shop for the construction and maintenance of instruments, a lecture room, and a joint library and reading room for the use of the staff and students in physics and chemistry. The research rooms have been designed to permit of great flexibility. The construction specifications call for a structure of unusual rigidity with foundations of heavy reinforced concrete to aid in eliminating vibration. An additional separate spectroscopic laboratory will be housed in a building which will occupy a site in the quadrangle formed by the new physics building. The two floors of this laboratory will be supported on a foundation entirely separate from that of the outer walls and the roof of the building. This foundation is to be more than three feet thick, and composed of alternate layers of sand, felt, transite board, ground cork, and reinforced concrete. These elaborate precautions are expected to eliminate shocks and vibration from industrial processes in the neighbourhood and the movement of traffic on adjacent highways. Provision will also be made for maintaining extreme constancy of temperature in this laboratory. The equipment will include apparatus which has been collected at Leland-Stanford University by Prof. G. R. Harrison, who this year joined the staff of the Massachusetts Institute as Director of the Research Laboratory of Experimental Physics. Plans for a cryogenic laboratory for fundamental studies in the science of low temperatures are also under consideration. The main physics building is being designed by Messrs. Carlson, of the architectural firm of Coolidge and Carlson, and the spectroscopic laboratory by the engineering firm of Charles T. Main, Inc.

ACCORDING to an article in *Paper Making and Paper Selling*, which has been reprinted by the New Northfleet Paper Mills, the process of making vegetable parchment by immersing suitable paper in sulphuric acid was discovered by W. E. Gaine in England in 1853. After later investigations by the German chemist, A. W. Hofmann, and the development of machinery, enabling the production of parchment to be carried out as a continuous process, by a Bohemian paper-maker, Robert Fritsch, the manufacture of parchment developed almost exclusively on the Continent, and within a few months of the outbreak of War the parchment required for the packing of foodstuffs for the British Army and Navy was practically unobtainable. Since the War, under the initiative of Mr. William Harrison (chairman of the Inveresk Paper Company), the British Vegetable Parchment Mills, at Northfleet, Kent, have been established, and this account of their activity, issued by the mills, is printed on imitation Japanese vellum made by the mills and accompanied by a range of samples of British parchment which seems to show that the technique of the production of this valuable product upon a commercial scale is now fully mastered.

THE October issue of *Isis*, the International Review devoted to the History of Science, contains an article by the editor, Dr. G. Sarton, on the discovery of the dispersion of light and the nature of colour. The first three pages are devoted to an account of pre-Newtonian work, including Markus Marci's decomposition of white light by a prism and his proof that the rays so obtained did not change their colour, and Grimaldi's suggestion that the colours were due to different undulations. The next thirteen pages are occupied by a facsimile reproduction of Newton's "New Theory about Light and Colours", which was published in the *Philosophical Transactions* of the Royal Society for Feb. 19, 1672. Last year the September issue contained Dr. Sarton's article on the discovery of the law of conservation of energy, with facsimile reproductions of Mayer's "Bemerkungen über die Kräfte, etc.", in the *Annalen der Chemie und Pharmacie* for 1842, Joule's "Calorific Effects of Magneto-Electricity and the Mechanical Value of Heat" in the Report of the British Association for 1843, and a page of Carnot's manuscript written between 1824 and 1832. The comments on the controversy as to the relative values of the contributions of Mayer and Joule sum up the position judicially.

SOME months ago the Royal Horticultural Society asked for information about portraits of certain eminent horticulturists and botanists to complete a supplementary volume to *Curtis's Botanical Magazine*, which will contain the photographic reproductions of the portraits and biographical notices of those to whom the volumes were dedicated (one hundred in all). All but one of these portraits have now been traced. The portrait required is that of the Rev. John Clowes (1777–1846). He was born at Broughton Hall, near Manchester, was a member of Trinity College, Cambridge, and a fellow of the Collegiate Church, Manchester (now the Cathedral). He gave up the benefice on succeeding to the family estates in 1833. In his time he was a prominent orchid amateur, and his fine collection of orchids was left by will to the Royal Botanic Gardens, Kew. He should not be confused with the famous Swedenborgian of the same name, whose portrait now hangs in Chetham's Hospital, Manchester, and who died in 1831.

NAUKA POLSKA (Science and Letters in Poland), published by the Institute for the Promotion of Science and Letters in Poland (J. Mianowski Funds, Warsaw, Staszic Palace, 1930), is a periodic publication, the first volume of which appeared in 1918. It is devoted to general information about the progress of science and the arts in Poland and abroad, although the Polish side is naturally the dominating feature. Unfortunately, the whole of it is published in Polish without even short summaries in any other European language, thereby decreasing its value as a means towards international co-operation. Of the two volumes published last year, Vol. 12 contains a complete list of all archives, museums, libraries, and scientific institutions and societies in Poland, with a concise account of each; Vol. 13 contains some articles of general interest and special articles on the organisation of learning in several European countries. There are also included news of scientific activities both in Poland and abroad, reviews of new books, and bibliographies of sociology and the history of science (1928–30).

DR. R. S. TAYLOR, Principal Medical Officer, Somaliland, reports the occurrence of no fewer than eighteen earthquake shocks which were experienced at Zeila (11° 20′ N., 43° 30′ E.) between Oct. 24 and Oct. 28. One shock occurred on Oct. 24, two on Oct. 25, twelve on Oct. 27, and three on Oct. 28. No details of times or intensities are given, but the shocks were probably slight and local only; nevertheless, the report is of interest, because Somaliland is not an 'earthquake country', and earthquakes are very rarely experienced there.

THE following have been elected officers for the year 1931 of the Canadian Phytopathological Society: *President*—W. P. Fraser, University of Saskatchewan, Saskatoon, Sask.; *Vice-President*—D. L. Bailey, University of Toronto, Toronto, Ont.; *Secretary-Treasurer*—T. G. Major, Tobacco Division, Central Experimental Farm, Ottawa, Ont.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A physics master at Cowley School, St. Helens—The Secretary for Education, Education Office, St. Helens (Jan. 13). A research assistant in the physical chemistry department of the University of Leeds—The Registrar, The University, Leeds (Jan. 14). An assistant lecturer and demonstrator in chemistry in the University College of South Wales and Monmouthshire—The Registrar, University College, Cardiff (Jan. 14). A sewage works chemist in the surveyor's department of the Urban District of Dagenham—The Clerk of the Council, Council Offices, Valence House, Chadwell Heath, Essex (Jan. 17).

Our Astronomical Column.

Astronomy in Virgil.—Mr. S. B. Gaythorpe appropriately celebrates the Virgil bi-millenary by a paper in the November issue of the *Journal* of the British Astronomical Association on the astronomical allusions in his poems. He notes that Anchises places astronomy high among the arts that make a nation glorious: "With the rod they will trace the paths of heaven and tell the rising of the stars" ("Aen." VI.). There is a well-known problem as to who was intended by Virgil for the unnamed companion of Conon "Who marked out with his rod the whole heavens for man" ("Ecl." III.). Many astronomers' names have been suggested, but Mr. Gaythorpe suggests that the allusion is simply to the unknown man who first divided the heavens into constellations.

Most authorities have assumed that Virgil was quoting from some work that was ancient even in his days when he spoke (in "Georgic" I.) of the Bull opening the year with his golden horns. Mr. Gaythorpe notes that there is a sense in which it was true in his own times. In mid-April Aldebaran could have been seen to set heliacally, with the horns of the Bull plainly visible in the twilight, and Sirius (also mentioned in the poem) farther to the left. It is clear that Virgil recognised the practical use of such observations for regulating the times of sowing and other agricultural operations. Mrs. Evershed, in a companion paper, notes that Dante, in the "Inferno" and "Purgatorio", makes Virgil give accurate information on many points of astronomy. Virgil seems, however, to have made an error about the southern hemisphere, thinking that its inhabitants reversed not only summer and winter but also night and day; "When dayspring comes to us, there Hesperus kindles his lamp" ("Georg." I.). In the corresponding passage in Dante, the travellers have emerged at the antipodes of Italy, so the reversal of night and day comes in correctly there.

Spectrum of β Lyræ.—A detailed analysis of the spectrum of this extraordinary star was undertaken at intervals by the late Mr. F. E. Baxandall during the last ten years of his life, and the results of his study are now given in the *Annals of the Solar Physics Observatory of Cambridge* (edited by Prof. F. J. M. Stratton). Two series of spectrograms taken at Cambridge, together with an earlier series kindly lent by the Allegheny Observatory, form the basis of this investigation, which adds many details to our knowledge of this stellar system, without, however, deciding conclusively its physical nature. The absorption spectrum is apparently of dual origin—an oscillating *B*8–type spectrum, and one of type *B*5, which, though not stationary as previously thought, shows only slight radial velocity variations. There is also a suggestion of a third source of absorption lines which may be of the nature of a Trojan planet. Contrary to earlier hypotheses, the *B*5 star is apparently smaller and more massive than the *B*8 star, but is surrounded by an extensive gaseous envelope which is responsible for the bright lines. Several outstanding anomalies still remain unexplained, but the memoir is a valuable contribution to the subject, and forms a fitting memorial to the labours of its originator.

Two more Trojan Planets.—The Trojan group of minor planets is growing rapidly. Odysseus was discovered some months ago, and two more Trojans are announced in *U.A.I. Circ.* No. 307. These were discovered at Königstuhl on Oct. 17, and designated *UA* and *UB* 1930. Using arcs of six weeks, Drs. Kahrstedt and Stracke have deduced orbits that indicate periods so close to that of Jupiter as to justify the designation of Trojans. The period found for *UA* is about a year longer than that of Jupiter, but it cannot yet be considered as accurately known. There are now five Trojans (including Odysseus) the longitude of which exceeds that of Jupiter by about 60°, and four (including *UA* and *UB*) on the other side of Jupiter. The eccentricity of *UA* is given as 0·29, so that it is nearly twice as far from the sun at aphelion as at perihelion. The magnitudes of both planets are about 14½. The interesting planet 944 Hidalgo, which travels out almost to Saturn's orbit, is now returning sunward, and an ephemeris is given for next July in "Kleine Planeten"; but as the magnitude is only 18½, it will probably not be detected until the following year. Its orbit is quite cometary, but its aspect has always been stellar.

Research Items.

Healing in Ontong Java.—Measures taken for healing the sick in Ontong Java (Lord Howe's Island) in the Western Pacific are described by Mr. H. Ian Hogbin in *Oceania*, vol. 1, No. 2. Disease, in common with the weather, success in fishing, sorcery, and a hundred other things which affect the daily life of the people, are caused by *Kipua*. Every individual soon after birth receives a *kipua* (spirit), a double or airy body invisible to ordinary eyes. Although a *kipua* is not closely attached to its owner, it is not free until he dies. It then becomes free, and only then can it interfere in the ways mentioned, in the lives of other people. Illness being caused by the *kipua* can only be treated by ceremonies addressed to the *kipua*. An exception is made in the case of boils, contusions, ringworm, malaria, sprains, and swelling of the limbs, which are treated by natural means. The more serious diseases are classified ; two classes, convulsions and paralysis, are regarded as incurable ; but each of the remaining classes has its own specialist. The remedies are the property of certain joint families and are transmitted from headman to headman. An essential factor in the healing is a *pule* (cowrie) shell to which unbroken white coconut leaf, pandanus leaf, and a piece of the healer's hair are tied. The first essential is to find out which of the *kipua*, usually the spirits of the man's own ancestors, wish him to live and which wish him to die. Two methods are simple and may be carried out by anyone. The question being put to the *kipua*, the answer is given by knots made in strips of coconut leaf or by small pebbles. The more elaborate method requires the service of the specialist, a medium. When the sick man and his relatives have repaired to the house of the medium, the latter is possessed by each of the *kipua* invoked in turn, who states through him its wish. When the name of the *kipua* responsible has been ascertained, a ceremony follows, in the course of which the *kipua* is besought by prayer to give good things instead of evil.

Spread in British Isles of Black-necked Grebe.—The disappearance of the black-necked grebe (*Podiceps nigricollis*) as a British breeding bird was connected with the drainage of the fen area, but its recent re-establishment and spread shows an adaptability which makes it surprising that it should ever have become extinct. In 1904 it was first discovered to be breeding in Wales, in 1915 in a western lough in Ireland, in 1918 at Tring Reservoirs, and a few months ago C. G. Connell recorded the nesting of at least two pairs in a loch in the Forth area of Scotland (*Scottish Naturalist*, p. 105, 1930). Now C. V. Stoney and G. R. Humphreys have found in western Ireland a colony which they estimate to consist of about two hundred and fifty pairs, and that in a lough not more than two or three miles long and half a mile wide (*British Birds*, vol. 24, p. 170). It has been assumed, in regard to the spread of the black-necked grebe, that the colonists in the British Isles were immigrants from the Continent, where the species breeds in countries no farther away than Denmark, Germany, and Livonia. But the presence of the large Irish colony makes it possible that the new breeding places may have been peopled from the west rather than from the east.

Intestinal Protozoa of Wild Monkeys.—Robert Hegner and H. J. Chu (*Amer. Jour. Hyg.*, vol. 12, pp. 62-108, July 1930) report on an examination of forty-four wild Philippine monkeys, *Macacus philippinensis*, twenty-eight males and sixteen females, to determine whether they are parasitised with intestinal protozoa, and to compare these with species that occur in man. Cysts of *Entamœba histolytica* were not abundant and were mostly uninucleate, *E. coli* was found in twenty-two of the monkeys, and *E. gingivalis* in thirty-seven. *Endolimax nana* was present in twenty-two monkeys and *Dientamœba* in two (this is the first record from the monkey). Three species of *Trichomonas* were recorded. *Giardia lamblia* is a fairly common inhabitant of the duodenum and *Chilomastix mesnili* was present in fifteen monkeys. *Balantidium coli* was obtained from eight of the monkeys and showed great variation in size, probably due to racial rather than to specific differences. The authors consider that the evidence afforded by this investigation is " insufficient to separate as distinct species the eleven types of protozoa described from wild Philippine monkeys and the corresponding eleven types that live in man ".

Observations on Living Tissues.—Prof. Eliot R. Clark and his colleagues in the Department of Anatomy of the University of Pennsylvania have recently developed a method of studying the living tissues of the rabbit's ear (*Daily Science News Bulletin*, Science Service, Washington, D.C.). A double-walled chamber or window, one wall being of celluloid or glass and the other a very thin sheet of mica, is so arranged on the ear of a rabbit that a thin layer of tissue is enclosed between the two walls of the chamber and can be examined microscopically. As the chamber can remain in place for months, the same area of tissue can be repeatedly observed and the details of the blood circulation studied; and in specially thin tissue, which can be examined with an immersion lens, the growth of cells and of capillaries can be followed day after day. The method will be of value also for the study of transplantations and of the reactions of tissues to different conditions.

Fungi in Butter.—Grimes, Kennelly, and Cummins have carried out an examinaton of butter samples taken with all suitable antiseptic precautions from the interior of a 56 lb. sample which had been kept at low temperature for two weeks, since it was packed at an Irish creamery. The cream is pasteurised, and none of these moulds was found to survive the temperature of pasteurisation. It is concluded that they have probably entered the butter either from the churn or the air (many creameries are near the road-side, which increases the risk of contamination from this source). A list of twenty-nine moulds found in the butter is given in the *Scientific Proceedings* of the Royal Dublin Society, vol. 19 (N.S.), October 1930, and the authors note that many of them appear to deviate a little from the standard type of their species, which they think may be due to a process of development of insular strains, peculiar to Ireland.

Climatic Changes during the Pleistocene.—Dr. G. C. Simpson deals very fully with this still tantalising subject in the *Proc. Roy. Soc. Edinburgh*, **50**, pt. 3, No. 21, pp. 262-296 ; 1930. It is assumed that the glaciation of northern Europe during the Pleistocene was due to a shift of the pole associated with appreciable variations of solar radiation. The shift of the pole brought Europe into sufficiently high latitudes to permit the formation of an ice-sheet, but the variations of climate, such as are shown by the interglacial epochs, were due to the oscillations of solar energy. With two complete cycles of solar radiation it becomes possible to account for four advances of the ice. The Günz-Mindel and the Riss-Würm interglacial epochs occurred at the maxima of solar radiation and were therefore warm; they were periods of increased precipitation in all parts of the world, corresponding to the two pluvial epochs which are known to have occurred during the Pleistocene. The Mindel-Riss interglacial epoch is correlated with a minimum of solar radiation and it is therefore regarded as having been relatively cold and characterised by low precipitation. The sequence of vegetation types accompanying the climatic changes from maximum to minimum are: park-land, forest, tundra, grass with sparse trees, and steppe. The deductions are supported by the geological and archæological evidence available, and in particular it is possible to arrange the sequences of human culture, of the geological strata of East Anglia, and of the history of the ice age in the Alps into the inferred scheme of climatic changes.

Steam Tables.—The August issue of the *Journal of Research* of the Bureau of Standards, Washington, contains an account of the determination of the thermal properties of saturated water and steam from 0° C. to 270° C. by Messrs. N. S. Osborne, H. F. Stimson, and E. F. Fiock, and a critical review of the measurements of these properties now available by Mr. E. F. Fiock. The determinations were made by electrically heating in a closed vessel a sample of the fluid at one saturation state until it attained a second saturation state, and measuring the electrical energy necessary. The results are expressed in tables of heat content of liquid, latent heat, heat content of vapour, in international joules per gram; of entropy of liquid and entropy of vapour in international joules per gram per degree Centigrade, for each 10° C. from 0° C. to 270° C. The results of the critical review of existing data are embodied in charts of the same quantities, and they show that from 0° C. to 100 ° C. the published steam tables agree with each other within the limits of tolerance of the International Skeleton Steam Tables of 1929, but that at higher temperatures several of the tables give figures which lie well outside these limits.

Thunderstorms and Penetrating Radiation.—The idea has been entertained that part of the penetrating radiation (or ' cosmic rays ') might be due to the action of the large fields known to exist in thunderstorms. Prof. Millikan was, however, unable to obtain any evidence for this, and a new investigation by a different method, described by B. F. J. Schonland in the December number of the *Proceedings of the Royal Society*, confirms Prof. Millikan's result. On the contrary, it has been shown by Dr. Schonland that a *reduction* in the intensity of the radiation takes place when there is an active thunder-cloud overhead, the effect being greatest for those clouds for which there was evidence that the upper positive charge was in excess. The quantity of water in the clouds is quite inadequate to account for the screening, which must be attributed to their electrical fields. From Dr. Schonland's discussion of his results, it appears that the upper limit to the energy of most of the quanta or corpuscles which make up the penetrating radiation must be less than 5×10^9 electron-volts, a number which is reasonably consistent with the penetrating power of the rays. Dr. Schonland's results do not show definitely the nature of the primary radiation, but indicate that it consists either of ultra-gamma quanta or of positively charged particles.

Energy Losses of Electrons in Carbon Monoxide.—Study of the energy losses of electrons in a gas, although yielding far less precise information than can be obtained spectroscopically, affords a valuable check on data obtained by the latter method, particularly in the matter of the probability of certain types of transitions. An investigation of the motion of electrons in carbon monoxide, described by Dr. E. Rudberg in the December number of the *Proceedings of the Royal Society*, shows that the important characteristic losses in this case correspond to 8·19, 11·17, 13·14, and 16·72 volts. The first two of these can be identified fairly closely with transitions of the molecule from the fundamental state, which is simple ($^1\Sigma$), to other singlet states, indicating that such rearrangements of the molecule, under this particular stimulus at least, are more probable than transitions from the fundamental singlet state to the other well-known triplet states. The transitions are not, however, those which correspond to the minimum vibrational energy of the higher state, but to rather higher vibrational energy, in general accord with the principle that the change in the separation of the nuclei of the diatomic molecule is small in such cases. The other two losses of energy probably correspond to transitions to a higher (G) state, of which little is known, and to a state of the ionised molecule, respectively. Dr. Rudberg also gives data for the characteristic losses in carbon dioxide, but in this no correlation with spectroscopic data is possible, as the spectrum of this gas is as yet almost unknown.

Proteolytic Enzymes of *Carica Papaya*.—Nag and Banerjee (*Trans. Bose Research Institute*, Nos. 18 and 20, 1930–31) find that two proteolytic enzymes can be separated from unripe papaw fruit by shaking the expressed juice with kaolin and centrifuging. The liquid then contains an ' ereptase ' which digests Witte peptone but not fibrin, while from the kaolin sludge can be extracted with salt a ' peptase ' acting on fibrin but not on peptone. On the basis of these findings, the authors criticise the view of Grassheim that papain is a single tryptic ferment and agree with Vines that two enzymes are present.

Configuration of the Benzilmonoximes.—Experiments on the solubilities of the α- and β-monoximes of benzil in benzene are recorded in the October number of the *Journal of the Chemical Society* by T. W. J. Taylor and M. S. Marks, and the results are said to support the configurations for these compounds given by Meisenheimer. The argument is based on the assumption that the α-oxime in physical properties should be a hydroxylic substance, whilst in the β-oxime the typical hydroxylic physical properties should disappear, together with the assumption that the solubility of a hydroxylic substance is less than the ' natural ' value calculated from the melting-point and latent heat of fusion. The Beckmann transformation, in this case at least, thus involves the groups in the *anti*-position to one another.

Intensive Drying.—Some experiments on the vapour pressures of intensively dried benzene, described in the November number of the *Journal of the American Chemical Society* by E. J. Green, show that benzene which has been dried with phosphorus pentoxide in a fused glass apparatus for three years does not exhibit any change in vapour pressure with respect to the normal liquid in the same apparatus. Experiments are described which support the theory that the vapour pressure differences from the normal state may be explained by assuming the presence of minute traces of water vapour in the normal liquid rather than any catalytic effect due to the removal of water from the dried liquid. Calculations from solubility data show that only 0·000229 gm. of water is required to produce a partial pressure of 7 mm. of water in 1 gm. of benzene at 20°, whilst Raoult's law would require 405 times more water.

Geo-electrical Prospecting by A.C. Bridge Methods.*

By A. B. BROUGHTON EDGE.

ELECTRICAL methods of exploring for mineral or for investigating geological structures are numerous, but with few exceptions they fall into two groups, according to the manner in which the ground and the concealed conductive bodies lying within it are excited, and how the resulting electrical field is investigated.

(i.) *Surface Potential Methods.*—In these, direct or alternating current is passed conductively through the ground between earthed electrodes spaced up to a mile or more apart. The prospecting operations consist in determining the resulting distribution of potential in the ground and in interpreting the geological significance of any anomalies that are recorded.

(ii.) *Electromagnetic Methods.*—In these, the ground is excited inductively by means of loops of insulated wire suitably disposed on the ground surface and carrying alternating current, usually at a frequency between 200 and 60,000 cycles per second. The survey is then carried out with portable search coils, by means of which investigations are made of any anomalies that appear in the magnetic field.

The object of the present article is to describe two methods of using a form of A.C. bridge (ratiometer) for electrical prospecting purposes, one of which comes under the first and the other under the second of the two groups that have been defined above. The general principle, which is that of the ordinary A.C. bridge, was first applied by the author in 1925 to surface potential surveys carried out in Rhodesia. The method was afterwards used in Australia by the Imperial Geophysical Experimental Survey, and from it the A.C. potential ratio method and instruments in the forms described below were developed.

FOR DETERMINING SURFACE POTENTIALS.

In order to explain the advantages of the A.C. potential ratio method it is necessary to refer to the well-known equipotential line system which, hitherto, has been the only generally known means of investigating A.C. surface potentials. Although the tracing of equipotential lines over the surface has the advantage of simplicity, it also has a serious defect, since it takes no account of the complex phase conditions that arise when alternating current is applied to ground of variable conductivity. In such circumstances the resultant field has an *elliptically polarised* structure, in which true equipotential points can only have an instantaneous existence. Although the conception of equipotential lines in such an alternating field is theoretically unsound, the out-of-phase effects met with in practice are not so great as a rule as to preclude the mapping of lines from which a general idea of the conductivity conditions can be obtained. It often happens, however, that a survey of this kind becomes a very slow and inexact performance, and sometimes, when in the neighbourhood of important conductive bodies, the phase conditions are such that the method breaks down completely.

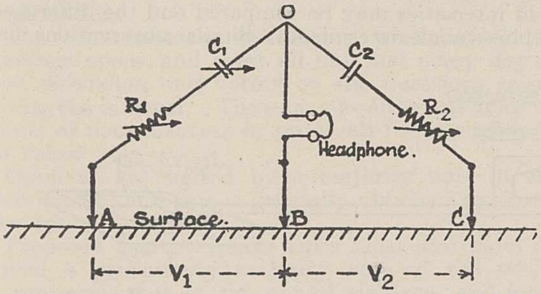

FIG. 1.—Principle of A.C. potential ratio method.

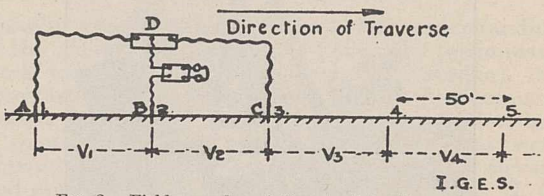

FIG. 2.—Field procedure A.C. potential ratio method.

The fact that this system becomes increasingly inaccurate as a buried conductor is approached is a sufficient indication that an additional surface potential method is required, by which the phase anomalies, which themselves are of diagnostic value, may be properly determined. The A.C. potential ratio method described below is intended to fulfil this purpose.

The principle of the method is shown in Fig. 1, in which A, B, and C are contacts made with the ground and AO and CO are ratio arms in each of which a condenser and a resistance are connected. Alternating current, usually at about 500 cycles per second, is passed through the ground between distant earthed electrodes. The purpose of the device is to compare the potential drops V_1 and V_2 between the equidistant pairs of contacts AB and BC, and to determine the difference in phase angle between them. To accomplish this, the capacity and resistance in each arm are adjusted until an exact balance is indicated by silence in the headphones. The potential drops V_1 and V_2 will then be directly proportional to the total impedances † in the arms AO and OC respectively, or in terms of the resistances R_1 and R_2, and the capacitative reactances X_1 and X_2, which are read directly from the instrument.

$$V_2 = \frac{R_2 \sin \tan^{-1}(R_1/X_1)}{R_1 \sin \tan^{-1}(R_2/X_2)} \cdot V_1$$

and $$\theta_2 - \theta_1 = \tan^{-1} R_2/X_2 - \tan^{-1} R_1/X_1,$$

where $\theta_2 - \theta_1$ is the difference in phase angle between V_2 and V_1; being of positive value when V_2 is leading V_1.

In Fig. 1 the capacity and resistance in each arm are connected in series, but other combinations may be used. As a result of a recent suggestion by D. C. Gall, an instrument is now being made in which a variable resistance alone is included in one arm of the bridge, the other arm containing a fixed resistance and variable condenser connected in parallel. By this arrangement a larger phase angle range is available and the advantage of direct reading is obtained. In the previous designs a somewhat tedious series of computations is necessary in order to obtain the potential ratios and differences in phase angle.

As a rule, the field observations are made along

* Detailed descriptions of these methods and the apparatus employed will be included in the forthcoming publication of the Imperial Geophysical Experimental Survey, entitled "Principles and Practice of Geophysical Prospecting". This preliminary account is published with the approval of the Geophysical Executive Committee.

† These should be of the order of 100,000 ohms. Otherwise the accuracy of the determination may be seriously affected by the unknown contact resistances at A and C which enter into the measurement.

straight lines, in the manner shown in Fig. 2; the station interval depending upon the nature of the problem under investigation but usually being about 50 feet.

The apparatus consists of three steel rods A, B, and

FIG. 3.—Ratiometer in use with amplifier on the operator's back.

C, driven into the ground and connected to the ratiometer D, which is carried by the operator together with the headphones and amplifier as shown in Fig. 3. Observations are made along the length of the traverse, the operator and his assistants moving forwards one station at a time, so that ratios are obtained for every successive pair of stations. In the case shown in Fig. 2, V_1 would be taken as an arbitrary unit and V_2, V_3, . . ., etc., would then be referred to it by successive multiplication of the individual ratios $V_2/V_1, V_3/V_2$, . . ., etc.* A potential anomaly curve may then be constructed by plotting these multiplied ratios above the mid-points of the station intervals to which they refer. The differences in phase angle are summed consecutively, positive or negative as the case may be, and are plotted in a similar manner as a phase variation curve.

It will have been observed that in order to obtain a balance with the bridge it is essential that the earth at contact B should be intermediate in potential with respect to the contacts at A and C. It may happen, therefore, that even on a straight-line traverse, points will be met with beyond which it is impossible to proceed in the ordinary way. This difficulty may be overcome by side-stepping and including one or more stations off the line of the traverse, but with a bridge of a somewhat different design, now under construction, these deviations should no longer be necessary.

In many cases it is sufficient to carry out a series of selected straight-line traverses over the ground to be examined and to prepare potential and phase variation curves in the manner indicated above. If a more systematic survey is required, observations must be made along a network of lines so that potential and phase values may be assigned to each station within the area. These values are determined by vectorial addition and, after adjustment of closing errors, equipotential and iso-phase lines may be interpolated.

Field experience in Australia has shown that variations in ground conductivity are recorded very faithfully by this method. In favourable circumstances the potential curves exhibit a well-defined peak over each wall of a buried conductor, and with further research it is thought that the corresponding phase anomalies will be found to have a still greater diagnostic value. In some districts in which marked variations occur in the surface conductivity, the method may be at a disadvantage unless the features to be investigated are of an outstanding character. It is of particular service, however, as an auxiliary to the equipotential line method which, although of admitted value for reconnaissance purposes, is too crude for detailed investigations.

FOR COMPARISON OF ELECTROMAGNETIC FIELDS.

This application of the ratio arm bridge relates to the simultaneous comparison of magnetic fields at different points in the neighbourhood of conductive bodies, and the case of the vertical components at two points A and B is illustrated in Fig. 4. The two identical coils C_1 and C_2, each having an area of several square feet, are supported in a horizontal position immediately above the points A and B and are connected together so that the e.m.f.'s induced in them will *assist one another*. The ratiometer is then inserted into the circuit in the manner shown and is operated in precisely the same way as in the surface potential application of the instrument. By this means the field intensities may be compared and the differences in phase angle determined. Similar observations may be made for other positions of the coils and, in fact, the apparatus may be used in various ways for investigating the character of the ellipse at any point, provided that the differences in phase angle do not lie outside the range of the bridge. It has been pointed out by D. C. Gall that in such cases a mutual inductance bridge would be more satisfactory and such an instrument is now under construction.

As a rule, the field procedure and plotting of intensity and phase variation curves will be carried out

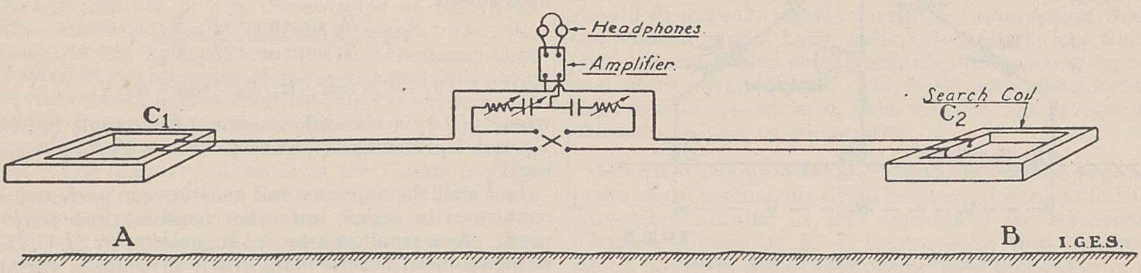

FIG. 4.—Comparison of magnetic fields with the ratiometer.

* This multiplication is of complex numbers, that is, V_2/V_1 and V_3/V_2 are multiplied to obtain the magnitude of the product, and their phase angles are added to obtain the phase of the product.

in the manner already described for the surface potential method, but lines of equal magnetic intensity and iso-phase lines may also be drawn.

The method described above resembles the two-coil balancing system due to Sundberg and Lundberg, in which two similar coils are joined *in opposition,* with an amplifier and telephone included in the circuit. In this case the relative strengths of the vertical fields are given by the secant of the angle through which one of the coils must be tilted out of the horizontal in order to produce a minimum of sound in the telephone. It has been pointed out by Eve and Keys,* that this procedure is not always satisfactory owing to phase difference in the currents induced in the two coils, and the fact that the tilting of one of the coils will usually introduce a horizontal component into the determination. These writers actually suggest a capacitance bridge in this connexion, but fear that such an instrument would prove too cumbersome for use under ordinary field conditions.

* "Applied Geophysics", p. 122 (University Press, Cambridge, 1929).

Nomenclature at the Eleventh International Zoological Congress.

THE account of the International Congress of Zoologists at Padua, published in NATURE for Sept. 27, 1930 (pages 489-490), contained only the briefest reference to the discussions and conclusions on nomenclature. The following account, which is strictly unofficial, may be of interest.

The International Commission on Zoological Nomenclature consists of eighteen members, distributed so far as is practically convenient throughout the world. Most of its work is conducted by correspondence, the intermediary being the secretary. The present secretary is in Washington and is permitted by the U.S. Government to avail himself of official facilities.

The commissioners meet in person at the International Congresses of Zoologists, which hitherto have been triennial, except for an interval from 1913 (Monaco) to 1927 (Budapest), but which by a resolution at Padua are henceforward to be quinquennial. Hitherto each commissioner has been appointed for the triennial period ; whether this will now be changed for a quinquennial period remains to be seen.

Certain changes in the mode of appointment were accepted by the Padua Congress. To replace the retiring commissioners, who are eligible for reappointment, the Commission, after considering the balance of subjects and of geographical regions, submits names to the Section of Nomenclature. The Section can propose other names. The nominees of both Commission and Section are referred to the Permanent Committee of the Congress, which makes the selection and reports it to the plenum of the Congress for confirmation.

The commissioners assemble a week before the Congress opens, and work all day and every day at final discussion and voting on the questions raised during the interval. These may be either opinions on points of nomenclature or proposals for alteration of the rules.

Opinions are settled by a majority vote of the Commission, and this is generally obtained by correspondence.

Proposed changes in the rules must also have received a preliminary majority vote of the whole Commission, that is, ten out of eighteen, and must then receive the unanimous vote of those present at the Congress, nine being a quorum. It follows that, on one hand, eight commissioners may have opposed a proposal in writing, but that nine present in person may carry it ; and on the other hand, that seventeen may have been in favour, but that one if present may block it. These are extreme suppositions, but in actual practice the situation is no better, because of the difficulty of bringing all the members together, or even of obtaining a quorum of the actual commissioners. To overcome this difficulty it has been the custom to appoint substitutes (alternates) for the absent commissioners from among zoologists attending the Congress. Thus many of those who actually vote may have an imperfect understanding of the questions at issue. At Padua the preliminary work was done by the chairman (K. Jordan), the secretary (C. W. Stiles), and three other commissioners ; two more commissioners arrived later, but a quorum was not formed until alternates were appointed. Of these there were no less than eleven, and among them Lt.-Col. J. Stephenson, Mr. G. C. Robson, and Mr. H. W. Parker acted for commissioners in various parts of the British Empire.

On this occasion a further difficulty was due to the fact that before the meeting none of the proposals for change in the rules had received enough votes either to kill it or to bring it up for discussion. Until the Congress assembled it was impossible to get the necessary votes, and then, even if they were obtained, it was too late for adequate and properly informed discussion.

This state of affairs is manifestly undesirable, and for many years considerable dissatisfaction with these arrangements has been expressed, notably with the demand for a unanimous vote by those present. There were two alternative amendments to this bylaw before the Commission, but unfortunately neither received enough preliminary votes to enable it to be discussed.

The same was the fate of other important proposals. Among them were alternative motions which would have had the effect of raising type-designation by elimination from the status of a recommendation to the status of a rule. This is a difficult question, and it is a pity that it could not be thrashed out.

A proposal to revert to the XII. Edition of Linnæus' "Systema Naturæ" as the starting-point of zoological nomenclature was definitely rejected, and the date of the X. Edition was fixed precisely as Jan. 1, 1758, in Article 26 of the rules.

The definition of publication for purposes of systematic zoology was discussed at length, and the conclusions will eventually be submitted in the form of an opinion.

The report of the British National Committee on Entomological Nomenclature was presented by Dr. K. Jordan, and its proposed emendations to the rules were considered. A few, of merely editorial nature, were provisionally adopted and others deferred for further consideration.

Proposals that superfamily names based on generic names should all end in *-oidea*, that new ordinal names should end in *ida*, and subordinal names in *ina* were discussed and held for further consideration.

Proposals to apply the law of priority to family and subfamily names, under certain conditions necessitated by other provisions of the Code, were also inevitably held over. The general opinion of the Commission seemed to be against further legislation for groups higher than genera.

As regards homonyms, it was agreed that, *ceteris* *paribus*, the name of a genus should take precedence over that of a subgenus ; the name of a species over that of a subspecies.

Article 19 of the rules says that " the original orthography of a name is to be preserved unless an error of transcription, a *lapsus calami*, or a typographical error is evident ". It was agreed that the word " transcription " included, or rather was intended to mean, " transliteration ". This article has sometimes important results in connexion with homonyms. Concerning such trivialities as whether one should write *brownii* or *browni*, the Commission showed a wise impatience. It also agreed that when a name, or part of a name in combination, had been spelled in diverse ways by different authors or even by the same author, it was not incumbent on a subsequent author, when making casual references, to follow this diversity of spelling. It was enough that he should do so in professed synonymic lists.

During the interval between the tenth and eleventh Congresses the Commission had formulated twenty-six opinions (Nos. 98-123), and these were adopted by the Congress. These opinions have been or are being published by the Smithsonian Institution.

The Commission would welcome the co-operation of special committees for groups of animals. Such co-operation already exists for entomology and proves of great advantage.

The Commission believes that much confusion would be avoided if students of zoology had the opportunity—if not the obligation—to attend lectures on the rules of nomenclature.

I have kept to the last the most controversial of the subjects that came up at Padua. This is the interpretation of Article 25b of the Code. It is there laid down that "The valid name of a genus or species can be only that name under which it was first designated on the condition . . . (b). That the author has applied the principles of binary nomenclature ". Article 26 says : " The tenth Edition of Linné's 'Systema Naturæ', 1758, is the work which inaugurated the consistent general application of the binary nomenclature in zoology ".

The question in dispute is the meaning of the phrase "binary nomenclature ". One interpretation is that it means that form of zoological nomenclature which most zoologists associate with Linnæus and notably with the tenth edition of his " Systema ", namely, one name for the genus, with which is associated another, so-called trivial name, to make up the *nomen specificum*. The addition of a third name to distinguish a subspecies, or even of a fourth for a variety, does not affect the principle that the species is designated by a double or binary name. The essence of the Linnean reform, as first fully expressed in the Tenth Edition, is the introduction of a *nomen triviale* in place of the former *differentia* ; the *nomen triviale* being a pure name, not necessarily with any meaning, whereas the *differentia* was a descriptive diagnostic phrase, however short it might be.

The other interpretation of " binary nomenclature " reduces it to mean no more than ' binary classification' ; in other words, the recognition of the two concepts *genus* and *species*, and their nomenclature, according to the old logical method, *per genus et differentiam*.

The introduction of this latter method into systematic biology is ascribed to the botanist Tournefort (1719). The method was at first followed by Linnæus as by many others, but he perceived its nomenclatural cumbrousness (as indeed had Tournefort himself) and got over the difficulty by using the *nomen triviale* in place of the *differentia*. This he essayed before 1758, but it was in that year, in the Tenth Edition, that he first applied it consistently to the whole animal kingdom.

Taking the rules as they stand, any unsophisticated zoologist would, I think, adopt the former interpretation. In the successive reports of the Congress and successive editions of the rules I have been unable to find anything that suggests the contrary, with the exception of four opinions (20, 24, 35, 89). These draw a distinction between the terms ' binary ' and ' binominal ' (undoubtedly they do not mean the same thing) and proceed to imply that ' binary ' indicates nomenclature *à la Tournefort*, while only ' binominal ' indicates nomenclature *à la Linné*.

The history of this interpretation of the phrase 'binary nomenclature' has been given by Dr. L. Stejneger in a most careful paper (*Smithson Miscell. Coll.*, vol. 77, No. 1, August 1924), which leaves no doubt that the revisers of the Code in 1901 really did give the phrase what one may call the Tournefort sense, and that their reason for that interpretation was the desire to include the generic names of Brisson, L. T. Gronovius, Scopoli, and other writers after 1758 who did not follow the nomenclatural system of Linnæus, and to include them without making exceptions to the rules.

That this was their intention was, as Dr. Stejneger himself admits, far from obvious, and it certainly has never been clear to a large number of zoologists. However that may be, there has been an increasing movement to give the phrase the same meaning as the tautological expression " binominal nomenclature ". A proposal to that effect was before the Commission at Padua, but failed to receive enough preliminary votes to bring it up for discussion. In the Section of Nomenclature, Dr. Walther Horn then proposed the following motion : " The Congress shall decide that only those publications shall be held to apply the principles of binary nomenclature in which the use of a single word for a generic name and a single word for a species name is consistently carried out ". This was passed by a large majority in the Section, and when it came before the plenary session of the Congress, instead of being referred, as one expected, to the Commission, it was put to the meeting without discussion, and again carried by a large majority.

It happens, most unfortunately, that those who support what I have called the Tournefort interpretation are for the most part citizens of the United States and include the distinguished and enthusiastic secretary of the Commission, whereas most of those who support the Linnean interpretation come from the rest of the world and in great part from Europe. I do not, however, see any reason why this divergence of opinion cannot be accommodated. The resolution does not, in my opinion, involve any alteration of the rules ; it is a question of interpretation. It does involve a redrafting of certain opinions, but it need not involve any change in their effect or in the acceptance of Brisson and the rest.

It should be remembered that in 1901 it was not possible to suspend the rules to meet hard cases. That practical reform was first achieved at Monaco in 1913. Therefore in 1901 the upholders of Brisson, Scopoli, and Co. were obliged either to alter the rules or to interpret them so as to admit those authors. They inadvisedly adopted the latter course and failed to make it clear.

Their interpretation has been used, as stated above, to admit the uninominal generic names of certain writers after 1758 who did not follow the Linnean method. But those writers did occasionally chance to use a specific *differentia* of a single word, and, on this interpretation, there seems nothing to prevent the admission of those appellations. That, however, does not seem desired by anyone.

Now we can suspend the rules, and we have already found it necessary to do so in order to eliminate certain authors who, under the Tournefort interpretation, were admissible (opinion 89).

My proposal therefore is that we should, as the Congress has resolved, adopt the Linnean interpretation, which I personally believe to be the natural meaning of the words; that we should formulate a new opinion admitting the generic names of Brisson and the rest by *ad hoc* suspension of Article 25b; and that we should redraft those opinions that are affected (20 and 24). As for opinion 89, I succeeded at the time in getting it so drafted that its effect would not be altered by the change of interpretation now passed by the Congress.

If these proposals are approved by the International Commission, I do not see why we should not continue to work with that harmony and good feeling which have hitherto prevailed at our meetings.

F. A. Bather.

University and Educational Intelligence.

Cambridge.—Prof. Owen Thomas Jones, Woodwardian professor of geology, has been elected to a professorial fellowship at Clare College.

At Trinity College, A. S. Besicovitch, University lecturer in mathematics, and L. Wittgenstein have been elected to fellowships.

The Appointments Committee of the Faculty of Geography has reappointed Miss M. S. Willis, of Newnham College, to be University demonstrator in the Faculty.

The Council of the Senate recommends the acceptance of the offer of the Council of the Royal Society to provide within three years a sum of £15,000 towards the building and equipment of a Laboratory for special physical investigations in the University of Cambridge, to be used in the first instance for magnetic and cryogenic research.

London.—The title of emeritus professor has been conferred on Dr. Alice Werner, formerly University professor of Swahili and the Bantu languages at the School of Oriental Studies.

On the recommendation of the Board of Management of the London School of Hygiene and Tropical Medicine, Sir George Newman has been appointed Heath Clark Lecturer for the year 1931.

Oxford.—Prof. A. Einstein will deliver the Rhodes Memorial Lecture for the year 1930–31; he will be in residence in Oxford during the next summer term.

St. Andrews.—On the recommendation of the Senatus Academicus, the Court on Dec. 19 unanimously agreed to appoint Dr. David Lennox to be reader in forensic medicine, and Dr. W. L. Burgess to be reader in public health, in recognition of their long and distinguished service to the University as lecturers in these subjects.

Mr. George H. S. Milln was appointed lecturer in radiology and electrical therapeutics in the University, and Dr. David Jack to be a lecturer in natural philosophy in the United College, St. Andrews.

The Senatus Academicus has appointed Dr. R. R. Marett, Rector of Exeter College, Oxford, as Gifford Lecturer for 1931–32.

It was reported that the last Examination for the diploma and title of L.L.A. will be held in May next. The only candidates to be received are those who have already obtained part of the qualification and desire to complete it.

Birthdays and Research Centres.

Jan. 1, 1869.—Prof. A. A. T. Brachet, For.Mem.R.S., Rector of the University of Brussels and director of the Laboratory of Embryology of the Faculty of Medicine in the University.

Le laboratoire d'Embryologie de la Faculté de médecine de Bruxelles suit principalement deux lignes de recherches : D'une part, l'analyse des localisations germinales et du déterminisme de la morphogénèse chez les Vertébrés, spécialement les Amphibiens; d'autre part, l'étude de la physiologie de la mise en marche du développement et des cinèses de segmentation.

Jan. 7, 1885.—Prof. A. J. Allmand, F.R.S., professor of chemistry, King's College, London.

The chemical laboratory at King's College is a comparatively small one, and the conditions, therefore, unfavourable for directed team-work research towards pre-specified major objectives. But I believe firmly that almost any subject, if worked on pertinaciously and with reasonable skill, conscientiously (that is, with self-criticism), and with the desire for early publication strictly suppressed, may yield at any time results of real interest, even of importance. On this account, I would hesitate to say which I consider the chief investigation now in progress in this laboratory.

My students are working (1) at photochemistry, particularly at present on the effect of wave-length on the union of hydrogen and chlorine, as also on other reactions; (2) on the problem of the complete evaluation of the partial molal free energies in systems of the type lead chloride–alkali metal chloride–water; (3) on the sorption of vapours and gases by charcoal and other solid sorbents.

These investigations have all been in progress for years and have all proved sufficiently fruitful to satisfy us.

Jan. 8, 1856.—Prof. H. Lecomte, professor of botany in the Paris Museum of Natural History.

Since his appointment to the professorship of botany in the Paris Museum, Prof. Lecomte has directed the work of the staff definitely to the study of Colonial floras, which were known before only in a fragmentary way. The "Flore Générale de l'Indo-Chine" was the first undertaken (1906); forty-four parts, out of about fifty it will comprise, have been already completed, with the devoted assistance of the scientific staff, of many Parisian botanists frequenting the Laboratory, and of professors from Paris and provincial universities. Besides, a great quantity of working material has been assembled and is ready to study for the preparation of floras of other French colonies: Guiana, Antilles, tropical Africa, Madagascar, New Caledonia. For some years past, and to complete this work, Prof. Lecomte has undertaken the anatomical study of tropical woods, of great interest from the point of view of the affinities it reveals, and also for the applications it enables one to foresee. Two important books have been published on woods of Indo-China and Madagascar.

Jan. 8, 1868.—Sir Frank W. Dyson, K.B.E., F.R.S., Astronomer-Royal.

A problem to which attention might usefully be given is the determination of the radial velocities of distant stars, such as those of early B type and those with the *c* characteristic in the southern half of the Galaxy. Dr. Oort has shown that the rotation of the system of stars round a point in galactic longitude l_0 would give rise to a term $Ar \sin 2(l-l_0)$ in their radial velocities where r denotes the distance and A is a constant. Prof. Plaskett from observations of 250 stars finds $A=17$ km. per sec. for a distance of 1000 parsecs and $l_0=325°$, but he could only observe four stars between the longitudes 193° and 343°, and until this lacuna has been filled up by observations in the southern hemisphere, this important result must be regarded as insufficiently verified.

Societies and Academies.

London.

Optical Society, Dec. 11.—**T. H. Court and Moritz von Rohr**: New knowledge on old telescopes. The paper is mainly historical.—**Mrs. E. Clifford**: On interpolating refractive indices. Some useful formulæ are obtained.—**H. Buckley**: On the determination of the transmission factors of coloured step lenses. In the 1928 report of the International Commission on Illuminations Committee on Coloured Glass for Signal Purposes, an outline of a method of measuring the transmission factors of coloured lenses used in railway signals is given. The deduction from the assumptions made in this report is incorrect.

Cambridge.

Philosophical Society, Dec. 8.—**C. G. Darwin**: The diamagnetism of the free electron. Landau's work on the diamagnetism of free electrons is illustrated by representing the boundary wall by a special law of force, for which the wave equation admits of exact solution.—**P. A. M. Dirac**: Note on the interpretation of the density matrix in the many electron problem. The probability of two or more electrons being simultaneously in specified places is evaluated in terms of the density matrix. It is found to be just the determinant of those matrix elements that lie in the rows and columns referring to the specified places.—**L. H. Gray**: The photoelectric absorption of gamma rays. Direct experimental evidence shows conclusively that the λ^3 law characteristic of the photoelectric absorption of X-rays is not valid for γ-rays. Not only is the absorption of hard γ-radiation very much greater than would be anticipated, but also the variation of the absorption coefficient with atomic number as well as with wavelength appears to be anomalous in the neighbourhood of 5 X.U. and suggests the existence of a new absorbing mechanism. An empirical photoelectric law is suggested.—**L. G. Vedy**: On the rotation of dielectrics in electrostatic fields and related phenomena. The rotation of a dielectric covered body, suspended between the poles of a Wimshurst machine, is due to the accumulation of charge on the surface of the body, under the action of the brush discharge, and to the subsequent electrostatic repulsion of the locally charged surface. The effect of the rate of decay of the surface charge on the rate of rotation is investigated theoretically.

Paris.

Academy of Sciences, Nov. 24.—**P. Viala and P. Marsais**: The Mycoliths of the vine in Palestine. The name Mycolith is given by the authors to masses produced by an agglomeration of very fine sand cemented together by the mycelium of a new species of Ascomycete, *Lithomyces nidulans*. These formations are called the vine fungus by cultivators in Palestine and the vine is ultimately destroyed by them.—**Serge Bernstein**: A method of summation of trigonometrical series.—Edmond Sergent was elected *Correspondant* for the Section of Rural Economy in succession to the late M. Trabut.—**J. Herbrand**: Determination of the ramification groups of a body starting from those of a super-body.—**Paul Lévy**: The law of large numbers.—**Gr. C. Moisil**: The equation $\Delta u=0$.—**Gaston Julia**: The convergence of series of rational repeated fractions.—**Jacques Chokhate**: An extended class of continued algebraical fractions and the corresponding Tchebycheff polynomials.—**N. Achieser**: The asymptotic value of the best approximation of some values by polynomials.—**Mandelbrojt**: Some theorems generalising the Riemann relation between $\zeta(s)$ and $\zeta(1-s)$.—**G. Fayet**: The favourable oppositions of the planet Eros. There will be a very favourable position in February 1931, and a fairly good one in November 1937.—**N. Stokyo**: The determination of the orbits of distant stars.—**Edgar Pierre Tawil**: A method of observation of non-stationary sound waves.—**V. Posejpal**: The direct determination of the volume of the electron.—**Mlle. Jacqueline Zadoc-Kahn**: The thermal variation of the magnetic double refraction of para-azoxyanisol above the temperature of the disappearance of the mesomorphic state. Experiments carried out with the large Bellevue magnet, with special precautions to secure uniformity of temperature. The relation found between the double refraction and the temperature is shown on a curve. The theory suggested by Cotton and developed by Kast, representing mesomorphic liquids as constituted by associations of molecules, is consistent with the curve shown.—**S. Rosenblum**: A new magnetic spectrograph with α-rays. The first experiments with the apparatus described showed photographically the fine structure in the case of thorium for the two lines α and α^1, the velocities of which differ by only 3/1000. The intensity of the field was relatively small, about 16,000 gauss.—**C. Raveau**: The utilisation of streams at the mouth. Correction.—**F. Pingault**: The conditions of formation and decomposition of cementite. At temperatures below 1000° C. pure cementite appears to be very stable, but at temperatures approaching fusion the cementite decomposes very rapidly, giving graphite.—**Augustin Boutaric and Maurice Doladilhe**: The modifications produced in the absorption spectrum curve of a solution of a colouring matter by the introduction of a colloid into the solution. A simple method is developed for determining whether a colouring matter is colloidal or not. Two hydrosols are taken the granules of which are of contrary sign, such as arsenic sulphide and ferric hydroxide, and some drops of the colour solution are introduced. If no diminution of colour is produced—and for this a simple colorimeter is usually sufficient—the colouring matter is molecular. If the colour is colloidal a clear diminution of opacity can be seen, often without the use of an instrument, after introducing the colloid; the granules possess the opposite sign to that of the colouring matter.—**Raymond Delaby and Raymond Charonnat**: The pyrolysis of vegetable oils with high acetyl index. From the analysis of the products of the dry distillation of grape pip oil it is concluded that the latter does not contain ricinoleic acid.—**Joseph Robin**: The 1·3 migration of amino groups. The mechanism. Application to other analogous reactions.—**Octave Mengel**: The lower limit of the Quaternary in the eastern Pyrenees.—**Maurice Blumenthal**: The relations of the subbetic and penibetic zones at the level of Archidona-Alfarnate (Malaga and Grenada).—**J. Thoulet**: Liquid submarine volcanic columns.—**Adrien Davy de Virville**: The zone distribution of *Rivularis bullata*.—**C. N. Dawydoff**: The Semper larvæ of Indo-Chinese waters.—**R. Fosse, A. Brunel, P. de Graeve, P. E. Thomas, and J. Sarazin**: The destruction in the seed of *Soja hispida* of one of its ferments without suppressing the activity of two others. A method of suppressing uricase in soja bean without destroying the activity of allantoinase or urease.—**E. Brumpt**: Intense parasitic relapses due to splenectomy, in the course of latent infections of

Egyptianella in the fowl.—**S. Jellinek**: The biological effects of short wave oscillating fields on living beings. The effects of d'Arsonvalisation have been attributed to the thermal effects of the high frequency, but the author does not agree with this and gives experimental evidence in support of his views.

COPENHAGEN.

Royal Danish Academy of Science and Letters, Oct. 17.—**Niels Bohr**: The use of the concepts of space and time in atomic theory. The recent development of atomic theory has disclosed a principal limitation of our ideas of motion. In this connexion a closer analysis of the foundation of space-time measurements of atomic particles is attempted.

GENEVA.

Society of Physics and Natural History, Nov. 6.—**R. Wavre**: Equilibrium figures and the planet Jupiter. The author applies his method of research for equilibrium figures to the case of Jupiter. He shows that on account of the great flattening of this planet it is necessary to take into account terms of order of the sixth power of the angular velocity, to agree with the data of Sampson relating to the planet and its satellites. His study also tends to show that Jupiter and Saturn, although more 'condensed' than the earth, are less so than is believed, and that from this point of view the comparison with the earth can be sustained. It is not necessary to assume the existence of a very dense nucleus, surrounded by a homogeneous fluid.—**P. Rossier** and **G. Tierey**: The statistical distribution of the stars as a function of spectral type. The authors give the results of a discussion based on two hundred negatives obtained, in 1928 and 1929, with the Schaer-Boulenger prism-objective of the Geneva Observatory. The normal exposure chosen was 20 minutes made on 'Cappelliblu' plates. The control stars are all of the *A*0 type.—**S. Ansbacher**: A case of poisoning by potassium chlorate. The author describes a case of poisoning by potassium chlorate in which the amount of this salt in the urine reached 2·6 per cent.

SYDNEY.

Linnean Society of New South Wales, Oct. 29.—**R. H. Anderson**: Notes on the Australian species of the genus *Atriplex*. Four species are described as new, and several new forms and varieties of established species are also defined.—**H. Claire Weekes**: On placentation in reptiles (2). Allantoplacentation is described in various lizards. A series showing increasing specialisation can be made out.—**T. Thomson Flynn**: The uterine cycle of pregnancy and pseudo-pregnancy as it is in the diprotodont marsupial *Bettongia cuniculus*. *Bettongia* is polyœstrous, breeding over the greater part of the year. Ovulation is spontaneous and unilateral. Pregnancy is alternate on each side, the contralateral uterus entering into a state of pseudo-pregnancy. The lactatory period of one pregnancy overlaps the gestatory period of the next succeeding one. The pregnant and pseudo-pregnant uteri until mid-pregnancy undergo identical changes.—**W. F. Blakely** and **Rev. E. N. McKie**: Additions to the flora of New England. This paper deals with six new species and two new varieties of plants from the New England Tableland, as follows: one species of *Grevillea*, one species and one variety of *Aotus*, one variety of *Brachyloma*, and three species of *Eucalyptus*.—**W. F. Blakely**: A new species of *Eucalyptus* from New England. A species of *Eucalyptus*, nearest to *E. conglomerata*, is described from Moredun Creek and other localities.

Official Publications Received.

BRITISH.

Memoirs of the Geological Survey of India. Palæontologia Indica, New Series. Vol. 15: The Fossil Fauna of the Samana Range and some neighbouring Areas. Part 1: An Introductory Note. By Lieut.-Col. L. M. Davies. Pp. v+15+4 plates. 1.4 rupees; 2*s*. Part 2: The Albian Echinoidea. By Dr. Ethel D. Currie. Pp. v+17-23+plate 4a. 12 annas; 1*s*. 3*d*. Part 3: The Brachiopoda. By Helen Marguerite Muir-Wood. Pp. v+25-37+plates 5-6. 1.4 rupees; 2*s*. Part 4: Lower Albian Gastropoda and Lamellibranchia. By L. R. Cox. Pp. v+39-49+plate 7. 14 annas; 1*s*. 6*d*. Part 5: The Lower Cretaceous Ammonoidea, with Notes on Albian Cephalopoda from Hazara. By Dr. L. F. Spath. Pp. v+51-66+plates 8-9. 1.6 rupees; 2*s*. 3*d*. Part 6: The Palaeocene Foraminifera. By Lieut.-Col. L. M. Davies. Pp. v+67-79+plate 10. 14 annas; 1*s*. 6*d*. Part 7: The Lower Eocene Corals. By Dr. J. W. Gregory. Pp. v+81-128+plates 11-16. 3.14 rupees; 6*s*. 6*d*. Part 8: The Mollusca of the Hangu Shales. By L. R. Cox. Pp. v+129-222+plates 17-22. 4.14 rupees; 8*s*. (Calcutta: Government of India Central Publication Branch.)

Department of Agriculture, Jamaica. Entomological Bulletin No. 5: Insect Pests of Sweet Potato and of Cassawa in Jamaica. By W. H. Edwards. Pp. ii+12+1 plate. (Kingston, B.W.I.: Government Printing Office.)

FOREIGN.

Spisy vydávané Přírodovědeckou Fakultou Masarykovy University (Publications de la Faculté des Sciences de l'Université Masaryk). Čis. 123: Příspěvek ke studiu tvorby solí glykokolu (Contribution à l'étude de la Faculté de la glykokolle de former des sels). Napsali J. V. Dubský a A. Rabas. Pp. 18. Čis. 124: Contribution to the Study of Blood Groups in Czechoslovakia. By Prof. V. Suk. Pp. 15. Čis. 125: Faultless Teeth and Blood Groups (with Remarks on Decay and Care of Teeth in Whites). By Prof. V. Suk. Pp. 11. Čis. 126: K problému buzení netlumených elektromagnetických vln (Sur le problème de l'excitation des ondes électromagnétiques non amorties). Napsal J. Sahánek. Pp. 24. Čis. 127: Odraz světla na kovech (Réflexion metallique). Napsal Josef Zahradníček. Pp. 16. (Brno: A. Píša.)

Spisy Lekarske Fakulty Masarykovy University (Publications de la Faculté de Médecine), Brno. Svazek (Tome) 8, Spis (Fascicule) 70-85. Pp. 276. (Brno: A. Píša.) 40 Kč.

CATALOGUES, ETC.

The Nickel Bulletin. Vol. 3, No. 12, December. Pp. 377-408. (London: The Mond Nickel Co., Ltd.)

Diary for 1931. (Bonnybridge: John G. Stein and Co., Ltd.)

Diary of Societies.

FRIDAY, JANUARY 2.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—S. J. Davies: An Experimental Investigation into Induction Conditions, Distribution, and Turbulence in Petrol Engines.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—W. A. Benton: Weighing Machinery.

SATURDAY, JANUARY 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. M. Tyndall: The Electric Spark (3): Air as a Conductor of Electricity (Juvenile Lectures).

MONDAY, JANUARY 5.

ROYAL GEOGRAPHICAL SOCIETY, at 3.30.—Dr. T. F. Chipp: What we get from the Tropics (Christmas Lecture for Young People).

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Lieut.-Col. A. G. Shortt: The Fifteenth Year of Tiberius.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Section) (at University, Liverpool), at 7.—D. B. Hoseason: The Cooling of Electrical Machines.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—T. A. D. Braddell: Criticism of Work submitted for Prizes and Studentships.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Prof. R. Robinson: The Synthesis of Certain Anthocyanins.

TUESDAY, JANUARY 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. M. Tyndall: The Electric Spark (4): The Mechanism of a Spark and other Forms of Discharge (Juvenile Lectures).

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.

INSTITUTE OF METALS (Birmingham Section) (at Chamber of Commerce, Birmingham), at 7.—R. A. Hacking: Blast Furnace Reactions.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Meeting), at 7.—Projection of Films:—O. Blakeston: Light Rhythms.—S. G. French: The Man who was Late.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—F. G. Woollard: Automobile Plant Depreciation and Replacement Problems.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases Section), at 8.—Col. S. L. Brug: Filariasis in the Dutch East Indies.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—J. W. Layard: Malekula.

WEDNESDAY, JANUARY 7.

ROYAL SOCIETY OF ARTS, at 3.—H. Barnard: Ancient and Modern Pottery (Dr. Mann Juvenile Lectures) (1).

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—F. M. Colebrook and R. M. Wilmotte: A New Method of Measurement of Resistance and Reactance at Radio Frequencies.—E. B. Moullin: A Variable Capacity Cylindrical Condenser for Precision Measurements.
INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at 20 Hart Street, W.C.1), at 7.—C. G. H. Hallett: Notes on the Theory of Radiant Heating.
ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—Modern Metal Cleaning.
ROYAL SOCIETY OF MEDICINE (Surgery Section), at 8.30.—Pathological Evening.

THURSDAY, JANUARY 8.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Northern Irish District) (at Town Hall, Bangor), at 3.—G. H. Fleming: Urban Works.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. M. Tyndall: The Electric Spark (5): Some Properties of Sparks and Arcs (Juvenile Lectures).
LINNEAN SOCIETY OF LONDON, at 5.—Prof. E. J. Salisbury: A Study of *Ranunculus parviflorus* L. with Special Reference to its Morphology and Ecology.—H. W. Pugsley and A. J. Wilmott: New British Plants.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—C. E. R. Bruce: The Distribution of Energy liberated in an Oil Circuit Breaker; with a Contribution to the Study of the Arc Temperature.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—A. Gouge: Some Aspects of the Design and Construction of Sea-going Aircraft.
INSTITUTION OF ELECTRICAL ENGINEERS (at Loughborough College), at 6.45.—E. G. Clark and G. Fowler: The Consumer's Point of View.
INSTITUTION OF AUTOMOBILE ENGINEERS (Bristol Centre) (at Merchant Venturers' Technical College, Bristol), at 7.—E. V. Pannell: Light Alloy Piston Development.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group—Informal Meeting), at 7.—Discussion on Faults and Failures in Colour Photography.
SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (at University, Bristol), at 7.30.—E. A. Ashcroft: Electrolysis of Fused Zinc Chloride.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Tees-side Branch Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—J. R. Cone: Ironwork Practice.
INSTITUTE OF METALS (London Section) (at 83 Pall Mall), at 7.30.—R. Genders: Extrusion.
OIL AND COLOUR CHEMISTS' ASSOCIATION (at 30 Russell Square), at 7.30.—Dr. T. H. Durrans: Solvents.
INSTITUTION OF WELDING ENGINEERS (at Institution of Mechanical Engineers), at 7.45.—H. D. Lloyd and J. S. G. Primrose: The Use of Pure Iron Electrodes for Welding Cast Iron.

FRIDAY, JANUARY 9.

ROYAL GEOGRAPHICAL SOCIETY, at 3.30.—Dr. C. M. Yonge: Life on the Great Barrier Reef (Christmas Lecture for Young People).
ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.
ROYAL ASTRONOMICAL SOCIETY, at 5.
MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.
INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—A. Dean and M. M. Macmaster: Mercury-Arc Rectifiers.
OIL AND COLOUR CHEMISTS' ASSOCIATION (jointly with Society of Chemical Industry, Literary and Philosophical Society, and Society of Dyers and Colourists) (in Psychology Department, University, Manchester), at 7.—W. O. D. Pierce: Human Factors in Colour Judgment.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. Doonan: Monel Metal: Some Notes on its Production and Industrial Application.
GEOLOGISTS' ASSOCIATION (in Botany Theatre, University College), at 7.30.—Special General Meeting.

SATURDAY, JANUARY 10.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. M. Tyndall: The Electric Spark (6): Large Sparks (Juvenile Lectures).

PUBLIC LECTURES.

TUESDAY, JANUARY 6.

UNIVERSITY OF LEEDS, at 6.—Prof. W. Garstang: Life in the Sea.

WEDNESDAY, JANUARY 7.

MUSEUM AND ART GALLERY, BELFAST, at 8.—F. Rutter: Modern British Art.

CONFERENCES.

DECEMBER 31 TO JANUARY 5.

GEOGRAPHICAL ASSOCIATION.

Friday, Jan. 2 (at London School of Economics).

At 10 A.M.—Major R. W. G. Hingston: In the Tree-Roof of the Guiana Forest (Lecture).

At 11.30 A.M.—Miss R. M. Fleming: Regions of Russia (Lecture).

At 2.30.—Meeting for Teachers in Secondary Schools for Discussion on a paper by B. C. Wallis on School Geography from the Point of View of an Examiner.

Meeting for Teachers in Primary Schools:—Geography and the Extension of the School Age. Discussion to be opened by E. J. Orford.

Saturday, Jan. 3 (at London School of Economics).

At 10.15 A.M.—Dr. P. W. Bryan: The Distribution of Houses in England and Wales as a Population Index (Lecture).

DECEMBER 31 TO JANUARY 7.

CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at University College).

DALTON ASSOCIATION.

Friday, Jan. 2, at 11.—G. W. Spriggs: Individual Work in Mathematics (Lecture).

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION.

At 2.—Dr. A. G. Maitland-Jones and others: Discussion on Hours of Sleep and the School Child in Day and Public Schools.

CHILD-STUDY SOCIETY.

At 5.30.—Prof. J. E. Marcault: What is Religious in the Child? (Lecture).

MODERN LANGUAGE ASSOCIATION.

Monday, Jan. 5, at 11 A.M.—Prof. E. W. Scripture and Prof. P. Menzrath: Discussion on Experimental Phonetics.

NATIONAL COLLEGE OF TEACHERS OF THE DEAF.

At 11 A.M.—Dr. J. Drever: The Educational Handicap of the Deaf from a Psychologist's Point of View (Lecture).

JOINT CONFERENCE.

At 5.—J. Fairgrieve, Lt.-Gen. Sir William Furse, Miss B. Hosgood, C. B. Thurston: The Teaching of Geography. Chairman: Sir Richard Gregory.

CENTRAL COUNCIL FOR SCHOOL BROADCASTING.

Tuesday, Jan. 6, at 11 A.M.—Prof. Winifred Cullis and others: The Teaching of Biology by Wireless (Lecture-Demonstration).

BRITISH SOCIAL HYGIENE COUNCIL.

At 5.—Dr. H. Crichton Miller: Marriage, Freedom, and Education (Lecture).

JANUARY 5 AND 6.

MATHEMATICAL ASSOCIATION (at London Day Training College).

Monday, Jan. 5, at 3.30.—Sir Arthur S. Eddington: The End of the World (from the standpoint of Mathematical Physics) (Presidential Address).

At 5.—Prof. A. R. Forsyth: Dimensions in Geometry.

Tuesday, Jan. 6, at 10 A.M.—A. Robson and others: Discussion on The Report on the Teaching of Mechanics in Schools.

At 11.30 A.M.—W. Hope Jones, Dr. F. J. W. Whipple, P. M. Marples, and others: Discussion on Gambling.

At 2.30.—Prof. J. E. A. Steggall: Faith and Reason in beginning the Calculus and Elsewhere.

At 3.45.—Prof. E. H. Neville: Limits in Geometry.

JANUARY 6 TO 9.

SCIENCE MASTERS' ASSOCIATION (at University, Birmingham).

Tuesday, Jan. 6, at 8.30 P.M.—Sir Charles Grant Robertson: Presidential Address.

Wednesday, Jan. 7, at 10.15 A.M.—J. Young: The Lunar Landscape (Lecture).

At 11.30 A.M.—Prof. W. N. Haworth: An Insight into Complex Molecular Structures (Lecture).

At 6.—Prof. Nash: The Work of the Physicist and Chemist in the Petroleum Industry (Lecture).

At 8.15.—The Lord Bishop of Birmingham: A Finite Universe? (Lecture).

Thursday, Jan. 8, 10 to 11.15 A.M.—F. Fairbrother and others: Discussion on General Science.

At 12.—Prof. K. N. Moss: Scholarships offered in Coal Mining and Metal Mining.

6 to 7.15.—Prof. F. W. Burstall: The Science Education of the Boy up to Eighteen Years of Age (Lecture).

At 8.30.—Meeting of S.M.A. with Representatives of the Commission on Educational and Cultural Films.

Friday, Jan. 9, at 10 A.M.—Prof. H. Munro Fox: Zoological Experiments for School Work.

EXHIBITION.

JANUARY 6 TO 8.

PHYSICAL AND OPTICAL SOCIETIES' EXHIBITION OF ELECTRICAL, OPTICAL, AND OTHER PHYSICAL APPARATUS (at Imperial College of Science and Technology), at 3 to 6, and 7 to 10.

Wednesday, Jan. 7, at 8 P.M.—E. Lancaster-Jones: Searching for Minerals with Scientific Instruments (Lecture).

Thursday, Jan. 8, at 8 P.M.—Sir Gilbert Walker: Physics of Sport (Lecture).

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