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The Universities and Colonial Scientific Services.[1]

THE unfortunate shortage of trained men at the end of the war, at a time when many of the Colonies were especially anxious for expert help in reorganisation and further development, led to various suggestions for the increase in the supply. Lord Milner, as Colonial Secretary, accordingly appointed a Committee in 1920 to investigate how the universities could best help in training men for the scientific services abroad and in securing the research necessary for the protection of the inhabitants of the Colonies against disease and for the development of their veterinary, agricultural, and mineral resources. The Committee consisted of Lord Chalmers as chairman, Sir Henry Birchenough, Sir John Rose Bradford, Sir Walter M. Fletcher, Prof. E. B. Poulton, Sir David Prain, Sir H. J. Read, Sir Stewart Stockman, and Sir Aubrey Strahan. The Committee has now issued its Report. It concludes that the universities can help mainly in two ways—in the fuller training of students and in the building up of a corps of advanced workers who would be available for the solution of especially complex problems.

The Committee's conclusion that the universities must impart to the students who desire to enter the Colonial services more than "book knowledge" will be universally approved, but the suggestion that some universities still give scientific courses without laboratory and practical instruction will be read with surprise. The Committee further insists that the men required must have "a training in the methods of research, and this involves post-graduate study." It concludes, therefore, that the universities can assist most usefully and directly by encouraging post-graduate study, and for this purpose urges that an increase of research fellowships and studentships would be of primary importance.

The Report implies that appointments in the scientific departments of the Colonies should be restricted to men who have been through post-graduate courses, but this limitation would be attended by serious drawbacks, especially in tropical colonies. The men would begin their service later and would retire when older or with a smaller pension, and the men who have taken the extra years of post-graduate work would be lower in seniority than those who had joined the service at the end of the ordinary university course. The better-trained men would thereby be debarred, as a rule, from securing the head appointments, with probably much consequent jealousy and friction. The attempt to correct this evil by dividing the staff of a small department into two grades and restricting the upper grade to men who have had post-graduate training would lead to even greater difficulties.

The Committee's conclusion implies that the courses for university degrees do not include training in the methods of research, although that training is the essential of university education. Research training should be improved, not by lengthening the time at the university, but by earlier specialisation in the case of students requiring a professional scientific qualification. The universities provide for two sets of students, whose requirements are different. They have to teach the pedagogic methods and general principles, by knowledge of which teachers may widen the mental outlook of their pupils and inculcate habits of scientific thought. They must also teach students who intend to adopt science as a profession, other than in secondary education and medicine, how to use the methods by which the various sciences have achieved their present position and may be further advanced. Now that a four years' course for the honours B.Sc. is becoming the rule, the university science courses should provide training in the methods of research for at least two of the four years for students who require it; and men so trained should be able to give useful service in the ordinary research work required in most colonial departments. The desired increase in the output of men trained for research would be even better secured by encouraging the universities to provide further teaching in research methods in the course for the B.Sc. without adopting the principle that such training "involves post-graduate study."

The second problem which the Report considers is the provision of experts to solve the specially intricate problems that would be met with from time to time. The university staffs might be expected to help in such

[1] Report of a Committee on Research in the Colonies. (Cmd. 1472.) 12 pp. 8vo. (His Majesty's Stationery Office, 1921.) 2*d*.

work, men being seconded for service as required. The Committee, however, expects such problems to be so numerous that the universities could give adequate help only if their scientific staffs were greatly enlarged. To secure this increase the Report adopts Lord Milner's suggestion that research departments should be established at those universities to which the subject would appeal by local interests or environment. Lord Milner has promised that if the universities would endeavour to collect funds from local industries for such departments, the Colonial Office would support the appeals by testifying that the establishment of new chairs and the enlargement of the professorial staffs in the departments of science throughout the universities would be a great and permanent service to the Empire.

Sir Walter Fletcher, in a reservation appended to the Report, regrets that its proposals regarding appeals for such endowments are so indefinite. He remarks that it leaves untouched the practical questions as to "Who will make the appeal? What appeal? By what mechanism or in what modes? And on what occasions?" He says that no steady cultivation of university resources for the ends proposed can be effected without a general scientific staff, and recommends a special advisory committee in each of the departments of science concerned. Sir Herbert Read replies to this criticism, in a covering letter annexed to the Report, that the Colonial Office has already the help of adequate advisory committees, and that in some subjects there are, indeed, too many. Thus, dealing with tropical medicine there are the Tropical Diseases Bureau, the Tropical Diseases Research Fund Committee, the Advising Medical and Sanitary Committee for Tropical Africa, and the Schools of Tropical Medicine in London and Liverpool. Sir Herbert Read remarks that in this case the machinery should be simplified and not enlarged; but, despite this experience, the establishment of scattered research institutes is the system which the Committee recommends. Laboratories for special researches attached to university departments are subject to the risk of lack of continuity between the work of one professor and that of his successor. This drawback may be reduced by the establishment and endowment of research chairs to superintend such laboratories; but, even if the funds could be obtained, such chairs might soon outlive their usefulness owing to changed industrial conditions.

The establishment of these independent research institutes might prove an extravagant method of conducting much of the ordinary research necessary for colonial development. A central institution, which could call on the university staffs to help with special problems, might be a far more economical method of organising this work. There is already such an institution—the Imperial Institute. The Report does not mention it, though reference is made to its work, for a letter by Lord Milner which is printed with the Report, illustrates the great economic value of scientific investigation by the discovery of the Udi coalfields in Nigeria, which was due to a survey organised by the Imperial Institute under a man whom it enlisted. The Imperial Institute is under the management of the Colonial Office, and its extensive laboratories, staff, and resources should be available for the investigation of problems connected with economic biology, geology, and mineralogy, in any part of the Empire which has not adequate scientific departments of its own. As the Committee was appointed to consider the relations of the universities to research, the Imperial Institute may have seemed outside its province. Its scheme is, however, attended by the danger of overlap of the kind which, as Sir Herbert Read remarks, has already developed not only between different independent departments, but also between all the proposed research institutes and the Imperial Institute, which was founded expressly to investigate the economic resources of the British Empire overseas.

A Monograph on Wheat.

The Wheat Plant: A Monograph. By Prof. J. Percival. Pp. x+463. (London: Duckworth and Co., 1921.) 63*s*. net.

PROF. PERCIVAL'S monograph fills one of the many great gaps in English agricultural literature by providing, for the first time in our language, a comprehensive account of the wheat plant, the most important of the cereal crops. Some idea of the magnitude of the work involved in the production of this book is derived from a statement in the preface that it is based on the study of what is "probably the most representative collection in existence," since it "includes all the races of wheats, numbering nearly 2000 forms derived from almost all wheat-growing regions of the world," whilst a brief glance at any section of the book is sufficient to convince the reader, especially perhaps the reader familiar with the crop, that this study has been peculiarly exhaustive.

Part 1 is devoted to the results of investigations on the morphology, anatomy, development, and growth of the wheat plant. When the importance of the crop is taken into consideration the existing literature on these subjects is singularly scanty, and the detailed accounts, covering some 140 pages, will save trouble to many future investigators. Further information on the cytology of the chief races of wheat and on the

details of fertilisation is still required; but, apart from this, we now possess sufficient knowledge of the minute structure and of the development of the wheat plant for most purposes.

The greater portion of Part 2 consists of a series of chapters dealing with the classification of the numerous "forms," many of which the author has had under observation for as many as twenty years. At the outset two wild species, *Triticum aegilopoides*, Bal., and *T. dicoccoides*, Körn., are recognised, together with eleven "races" or cultivated species. Eight of the latter, the small Spelt, Emmer, Macaroni, Polish, Rivet wheat, Bread wheat, Club wheat, and large Spelt, are well-known races; whilst three, *T. orientale*, Khorasan wheat, *T. pyramidale*, Egyptian cone wheat, and *T. sphaerococcum*, Indian dwarf wheat, are new creations. The first of these consists of a couple of Emmer-like varieties, differing only in awn-colour, which are characterised by the possession of long glumes and grain. The second consists of a group of five Egyptian wheats coming close to the Rivet wheats in most of their characteristics, and in leaf colour, shortness of straw, and ear shape strongly reminiscent of segregates from crosses between *T. turgidum* and *T. vulgare*. The third is an equally small group of round-grained forms coming near *T. compactum*. The further subdivision of these races into "varieties" follows the well-known system in Körnicke and Werner's "Handbuch des Getreidesbau."

But this system is not slavishly adhered to, and here and there noteworthy departures are made from it. For instance, several forms placed by Körnicke in *T. durum* are rightly transferred to the Emmer group, *T. dicoccum*. Persian Black, too—a form which has puzzled more than one systematist—is also placed in this group, to the satisfaction of those interested in the genetics of this important mildew-resisting wheat.

In the smaller groups the sub-division of the varieties into forms is a comparatively simple matter, but difficulties occur in the large races, such as *T. vulgare*. If, by way of example, one takes the first of the beardless varieties of the bread wheats, *T. v. albidum*, one finds detailed descriptions, under either a name or a number, of a dozen forms from various parts of the world, supplemented by excellently reproduced photographs of the more distinct types. But the forms themselves are capable of further sub-division. Under the description of Wilhelmina, for instance, is the statement: "Similar to this is Willem I. from Holland, Victor, Stand Up, Essex hybrid. . . ." Some of these are almost unquestionably synonymous, whilst some are distinct wheats, and a classification failing to differentiate these will disappoint many who grow wheat.

But, whatever the needs of the wheat-grower for a still finer differentiation of forms, one feels that the day for these elaborate descriptions is passing and that it is unlikely that many attempts will be made in the future to bring together and catalogue the world's numerous wheats. Even now, when the subject of wheat-breeding is in its childhood, the geneticist foresees the possibility of an accession of new forms which would reduce Prof. Percival's collection to the dimensions of a dwarf. Such a feature as the winged glume figure in Plate 179 is known to him only in one form. But it is inherited as a unit character, and though scores of forms with similar glumes are in existence at the Plant-Breeding Institute at Cambridge, many more could easily be raised. Much the same is true of that still rarer feature, the purple colour of the grain, seen in *T. d. arraseita*, which has in the hands of the hybridist given rise to a series of purple-grained Macaroni and Polish wheats, in addition to other forms of Emmers. To cope with such a "flora," the systematist of the future will probably have recourse to brief formulæ expressing the genetic constitution of each form—a system which would have many of the merits of that used in the classification of bacteria.

The systematic portion of the monograph is followed by a chapter of considerable interest on the origin and relationship of the races of wheat. Evidence from various sources—archæological, ecological, pathological, genetical, etc.—is skilfully marshalled to show their probable lines of development. The story is too long to discuss within the limits of a review, but Prof. Percival's conclusions on the origin of the bread wheats (*T. vulgare*) are too interesting to pass over. At present, as is well known, no wild species even suggestive of this group has been found. A study of the morphology of the wild and cultivated wheats has led the author to the conclusion that "there is not nor has there ever been a prototype of the bread wheats." And further: "The characters of *T. vulgare* and its allies appear . . . to be those of a vast hybrid race, initiated long ago by the crossing of wheats of the Emmer series with species of Ægilops." It so happens that many crosses have been made between the reputed Ægilops parents, *Æ. ovata* and *Æ. cylindrica*, and forms from practically all the races of wheats; but such crosses yield, at the most, sterile hybrids. The significance of this fact is recognised, but disposed of by the assumption that natural hybrids between the wild Ægilops and the Emmer prototype are more fertile under their native climatic conditions than in Central or Western Europe.

A chapter on yield follows a useful summary of most of the more important literature dealing with the hybridisation and improvement of wheat. In this

the effects of soil, cultivation and manuring, seed rate, variety, time and methods of sowing, and size of grain are considered.

One can but regret that it is not followed by a chapter on quality, in which the effects of these factors on the milling and baking properties of the bread wheats is brought under review. Such a chapter would be peculiarly welcome to both wheat-breeders and millers, even if it did no more than summarise the scattered literature on the subject. It would, moreover, go some way to justify the statement on the wrapper of the book that it is "essential to . . . plant-breeders and millers." Prof. Percival will lay workers on both these subjects under a still greater obligation if such an addition is made when a new edition of this useful volume is called for. R. H. B.

The Subjectivity of Psychology.

The Psychology of Everyday Life. By Dr. James Drever. Pp. ix+164. (London: Methuen and Co., Ltd., 1921.) 6*s*. net.

THE present generation is witnessing a sustained and persistent effort to raise psychology to the status of a science. Hitherto it has been a part of philosophy, and it is felt by psychologists that success depends wholly on their being able to detach it. There is something curiously instructive in the fact that the task is avowedly difficult. It is curious because the data of psychology are more immediate than any other data of science, and for that reason alone we should expect them to be the most easily known and the most susceptible to treatment. But the instructive thing is that this very intimacy of our relationship with the data militates against scientific treatment. All the trouble in regard to the matter arises from the fact that the objects of a science of psychology are more difficult to abstract from the subject of experience, more difficult to reify or set up with an independent status of their own, than are the objects of any recognised science, mathematical, physical, or biological.

This is obvious at once if we compare psychology with its nearest neighbour in the hierarchy, physiology. We have no trouble in presenting the functions of anatomical organs, and the processes of secretion, circulation, innervation, and the like, as objective. They are capable of mechanistic interpretation in complete detachment from anything which depends on the experience of the subject, although we are ready to acknowledge that without such experience the apparent purpose of the mechanism would be wanting. But when we try in the same way to present instincts, impulses, emotions, feelings, memory, wishes, trains of reasoning, we seem to be in a peculiar difficulty, for it is impossible to avoid not merely subjectivity, but a certain vexatious personal and individual subjectivity. Yet there is no obvious reason for this, and the more we reflect the more we are driven to recognise that while we know as matter of fact that it is so, we do not know and are unable to imagine the reason why it should be so.

The difficulty goes back at least to Berkeley. It is quite easy to imagine perfect cubes and circles and other geometrical figures existing entirely independently of the mind which knows them and to found a science on the assumption that they may or do so exist. The same is true in some measure of all the physical and biological sciences. But a wish, a pain, a thought, absolutely refuse to be detached, and will not let us imagine an abstract existence for them independently of the subject. Now Berkeley's contention was that every object of knowledge is in the same case, and therefore the physical sciences have no advantage over psychology. This, however, gives no satisfaction to the modern psychologist, for whatever be the truth of Berkeley's doctrine he knows that physics and biology possess at least a *practical* advantage which is lacking to psychology.

The little manual by Dr. Drever, which is the occasion of this reflection, is an excellent classification and general survey of the nature of the entities with which the modern science of psychology is attempting to deal. What seems to qualify the author for his task is his thorough knowledge of the older and philosophical treatment of the subject, in particular with its treatment in books like Descartes's "Les Passions de l'Ame" and Malebranche's "Recherche de la Vérité." Dr. Drever is in thorough sympathy with the scientific end, and is working towards it, yet with full consciousness and complete understanding of its origin in philosophy.

H. WILDON CARR.

The Study of Earthquakes.

A Manual of Seismology. By Dr. Charles Davison. (Cambridge Geological Series.) Pp. xii + 256. (Cambridge: At the University Press, 1921.) 21*s*. net.

TIME was when the meaning of seismology was clear and unmistakable; it was the study of earthquakes, and by earthquakes was meant the disturbance which could be felt, and, when severe, caused alarm and damage. It was known that there was a central area where the earthquake was most severe, fringed by zones of decreasing violence, until a region was reached where it was insensible to the unaided senses, though still recognisable by suitable

instruments, and when, towards the end of last century, it was found that, at distances far away from the region affected by the sensible shock, disturbances which were clearly connected with great earthquakes could be detected by suitable instruments, it was natural to suppose that the origin was the same for both. Only of recent years has it been recognised that the earthquake proper, caused directly by fracturing of the surface rocks, is but a secondary effect of a more deep-seated disturbance, or bathyseism, which, and not the earthquake proper, is presumably the origin of the disturbance represented in the preliminary tremors of the distant record.

Meanwhile, seismology has developed on two distinct lines, and in reality into two distinct sciences, differing in method, means, and requirements. On one hand, we have the newer seismology of the long-distance record, in which personal observation counts for nothing; some mechanical ingenuity is required for the design of efficient instruments, some care in the maintenance of them and their records, but after that, the discussion and interpretation are purely a matter of the higher mathematics. On the other hand, we have the older seismology, in which there is still much work to be done, even with no further mathematical equipment than an intelligent schoolboy may carry away from a modern public school, but in which the collection of data is entirely dependent on personal observation, and the coincidence of occasion and a competent observer.

With such a difference of scope and methods, it is scarcely possible for one individual to become a master of both branches, and this is illustrated by the existence of two recent text-books, both nominally of seismology; first we have the "Modern Seismology" of the late Dr. G. W. Walker, which appeared some years ago and is an admirable introduction to the newer development of the subject, but scarcely refers, and only incidentally, to the earthquake proper; then we have this book, by Dr. C. Davison, which is called a manual of seismology and devotes only a part of one chapter to the subject of Dr. Walker's book. The difference accounts for, and is indicated by, the fact that one appeared as a Monograph on Physics, the other as part of the Cambridge Geological Series.

The object, as well as the scope, of Dr. Davison's work accounts sufficiently for the fact that he devotes only part of a chapter to the newer seismology, and the treatment is adequate, in so far as it gives that amount of information which a student of the older seismology cannot afford to ignore. As a manual of that older seismology the book fills a much-felt want, for we had no satisfactory introduction to the study of the earthquake proper. Well arranged and clearly expressed, the only adverse criticism which can be made is that the ground is possibly too fully covered, and that some matters which might have been omitted from an introductory text-book have necessarily received too brief a treatment; but this fault—if such it be—is counteracted by the references to other works in which the subject is more fully dealt with. These references to previous literature add very greatly to the value of the work; not large in number, they are very judiciously selected, form a satisfactory basis for advanced study in all branches of the subject, and, without exception, are such that no one wishing for a mastery of the subject could afford to leave them unstudied. R. D. O.

Chemical and Physical Constants.

Handbook of Chemistry and Physics. A Ready-Reference Pocket Book of Chemical and Physical Data. By Prof. C. D. Hodgman, assisted by Prof. M. F. Coolbaugh and Cornelius E. Senseman. Eighth edition. Pp. 711. (Cleveland, Ohio: Chemical Rubber Company, 1920.) 3 dollars.

THIS compact little volume contains a vast array of chemical and physical constants. Since the first publication in 1914 it has passed through eight editions in the United States—a sufficient proof of its utility as "a comparatively comprehensive reference book for use in the laboratory or classroom."

The tables on the properties of inorganic and organic compounds are very complete, and chemists will appreciate particularly the tabular information on the solubility of inorganic salts in water. The data on the "Dehydration of Metallic Sulphates" and the "Decomposition of Anhydrous Metallic Sulphates" are distinctly novel features. In the qualitative analysis scheme it is somewhat difficult to follow out the behaviour of chromium. A very complete table is given of heats of formation and solution, but it is to be regretted that no indication is given as to the sources from which the data have been compiled.

The section devoted to physics is fairly complete, and one notes with pleasure that the table for the reduction of psychrometric observations refers to the ventilated type of wet and dry bulb thermometer only. At the end of the volume eight pages are devoted to problems, the utility of wh ch in a book of data is doubtful.

The book has some blemishes, for the most trustworthy data have not always been chosen. To take one example only, in the table of "Fixed Points for High Temperatures" the melting point of nickel is given as 1427° and that of platinum as 1775°. Ten years ago the Carnegie Institution published a memoir on High Temperature Gas Thermometry, and the values

there given (1452° and 1755°) have since been almost universally accepted. Also, in view of the thorough work of Prof. Callendar on the specific heat of water, it is somewhat surprising to find that the values given are "the mean of various determinations, including Calendar and Blonsfield, 1912"; one frequently observes that the names of observers are misspelt as in this quotation.

It is hoped that before the next edition is issued the various sections will be submitted to expert scrutiny, for the value of the book would be greatly enhanced if the user could feel sure that the most trustworthy data are quoted. E. GRIFFITHS.

Our Bookshelf.

Illustrations of the Flowering Plants and Ferns of the Falkland Islands. By Mrs. E. F. Vallentin. With descriptions by Mrs. E. M. Cotton. Pp. xii+64 plates+text+ii. (London: L. Reeve and Co., Ltd., 1921.) 84*s*. net.

SINCE the publication of Sir J. D. Hooker's "Flora Antarctica" much progress has been made in the study of the Falkland flora and from a taxonomic standpoint it may now be said to be well known. Nevertheless, a well-illustrated compact flora has been a desideratum and it is thus additionally unfortunate that owing to a serious breakdown in health the completion of Mrs. Vallentin's work has been indefinitely postponed. The volume now under notice contains 64 plates illustrating in colour, and with excellent dissections, many of the most characteristic Falkland plants. Each plate is accompanied by a short description of the family, genus and species. It seems a pity that with the space available fuller descriptions and more detailed ecological notes have not been provided. The repetition of the description of the family appears to be unnecessary; thus the same diagnosis of the Compositæ is repeated eleven times.

The work as a whole illustrates many of the essential features of the Falkland Islands flora. The predominance of dwarf herbaceous and subshrubby perennials, especially characteristic of steppe and heath formations, is emphasised both by the plants chosen for illustration and by the small number of therophytes and the absence of phanerophytes, except for a few nanophanerophytes.

We have no doubt that this work will prove most useful to inhabitants of the Falkland Islands who take an interest in the natural history of their country by enabling them to identify easily many of the common plants around them, and that it will also be used in a more general manner by workers in systematic and geographical botany in other countries.

W. B. TURRILL.

The Microscope: Its Design, Construction and Applications. A Symposium and General Discussion by many Authorities. Edited by F. S. Spiers. Pp. v+260 +plates. (London: Charles Griffin and Co., Ltd., 1920.) Price 21*s*. net.

THE addresses and papers given in 1920 at the conjoined meeting of the Faraday, Royal Microscopical, Optical and Photomicrographic Societies and Technical Optics Committee of the British Science Guild are gathered together conveniently in the volume under notice. All the papers are by specialists in their respective branches and the whole constitutes a valuable contribution to microscopical science. The President, Sir Robert Hadfield, in his introductory address traced the history of the development of the microscope, and papers on the earliest steps in the invention of the microscope and on the history and design of photomicrographic apparatus are contributed by Dr. Singer and Mr. Martin Duncan respectively. The future of the microscope is dealt with in suggestive papers by Mr. Barnard and Mr. Schneider, while Profs. Cheshire, Conrady and Porter discuss the mechanical design and optics of the instrument. Many experts in their particular subjects give practical details on the application of the microscope in fermentation industries, in petrology, metallurgy, engineering and metrology. Methods of illumination, the testing of objectives, and optical glass and its manufacture are other subjects dealt with. In addition to the papers themselves, a summary of the discussions following their reading is included and the volume is illustrated with many plates and figures. The work, which has been ably edited by Mr. Spiers of the Faraday Society, is indispensable to any one desiring to follow the trend of the modern developments of the microscope and of microscopical science. R. T. H.

Introduction to the Study of Minerals and Guide to the Mineral Collections in Kelvingrove Museum. By Prof. P. MacNair. Second edition. Pp. viii+94+1 plate. (Glasgow: Hay Nisbet and Co., Ltd., 1921.) 1*s*.

PROF. MACNAIR is to be congratulated on having introduced many improvements in the second edition of his useful guide-book. The figures illustrating the crystal-forms are much more accurate than those published in the first edition, though there are still a few which should have been replaced. The part dealing with crystallography has been much increased and the systems have been subdivided into groups, the introduction of which in place of the classes of the accepted systems of crystallography is rather confusing.

The guide includes a clear account of the optical and other properties of minerals, a glossary of terms, and a list of species in the collection. The book is based very much on the lines of Fletcher's "An Introduction to the Study of Minerals," of which the fifteenth edition is still used as the guide to the Mineral Department of the British Museum (Natural History). It will be noted that Prof. MacNair in Glasgow has produced his book at sixpence less than the price of the British Museum Guide.

The Secrets of the Self. (*Asrár-I Khudi.*) A Philosophical Poem. By Sheikh Muhammad Iqbal. Translated from the Original Persian with Introduction and Notes by Dr. R. A. Nicholson. Pp. xxxi+147. (London: Macmillan and Co., Ltd., 1920.) Price 7*s*. 6*d*. net.

THIS poem has an interest beyond that of its artistic form or æsthetic content, for it reveals the effect on the oriental mind of contact with the culture and philo-

sophy of the West. The writer is a firm and devout believer in Mahomet. He has studied Bradley and Bergson, he has taken degrees at Cambridge and at Munich, and he has returned to Persia, more ardent than ever in the vision of a world-triumphant religion, an Islamic kingdom of God on earth.

Proceedings of the Aristotelian Society. New Series—vol. xxi. Containing the papers read before the Society during the Forty-second Session, 1920–1921. Pp. iv.+246. (London: Williams and Norgate, 1921.) 25*s.* net.

ALTHOUGH the papers in this volume are philosophical in the technical meaning, several of them are of unusual scientific interest, and all of them show how the results of pure scientific research are influencing philosophical speculation.

Prof. Montague's paper on "Variation, Heredity and Consciousness" is described as a mechanist answer to the vitalist challenge. It develops an ingenious theory according to which it is possible to trace the transformation of the potential energy acquired by the brain, through the kinetic energies of sensory nerve currents, into all the phenomena of mind and consciousness. In the whole process no factor is admitted which is not definable in purely physical terms. The Dean of St. Paul's in his Presidential address "Is the time series reversible?" finds it impossible to keep out Einstein and the principle of relativity. Miss Oakeley gives an excellent critical account of the recent work of Prof. Driesch in "Philosophy of Life and Knowledge." Prof. Boodin in a paper on "Cosmic Evolution" deals with the new theories of the origin and evolution of life of the American biologists, Osborn, Willard Gibbs and Henderson. Dr. Dorothy Wrinch's paper "On the Structures of Scientific Inquiry" is abundantly illustrated with examples from modern research in mathematics and physics.

Tables of Refractive Indices. Vol. xi. *Oils, Fats and Waxes.* Compiled by R. Kanthack. Edited by Dr. J. N. Goldsmith. Pp. 295. (London: Adam Hilger, Ltd., 1921.) 25*s.* net.

IT is satisfactory to find a British firm of scientific instrument-makers not content with manufacturing instruments but, in addition, providing facilities for the compilation and publication of data which will facilitate the use, and incidentally lead to the extended employment of their manufactures. Mr. Kanthack has done his work well, and no one who uses his tables is likely to complain that oils of any importance have been omitted or that the figures quoted are badly selected from those available.

The names of the oils are arranged alphabetically, both native names and scientific names of the sources being given. Wherever possible the constants are quoted beside the native names and cross-references placed against the scientific names. This has two disadvantages: native names are variable, being usually merely attempts at phonetic renderings of native pronunciations and they also vary with the country of origin. Further, the method of arrangement fails to bring together oils which are similar in character, a matter of some importance for convenience of reference. It would be difficult if not impossible to devise an arrangement to obviate these disadvantages entirely, but it would probably improve matters somewhat if the scientific names of the sources of the oils were made the backbone of the arrangement and the native names given in a separate glossary.

The value of the tables to the analyst is enhanced by the inclusion, in separate appendices, of refraction constants for glycerol, glycerides and fatty acids, and "hardened" and polymerised oils, with approximate temperature corrections and factors for the inter-conversion of refractive indices and butter refractometer readings. There is also an extensive bibliography.

T. A. H.

The Distribution of Vegetation in the United States as related to Climatic Conditions. By B. E. Livingston and E. Shreve. (Publication No. 284.) Pp. xvi+590+plates. (Washington: Carnegie Institution). 9 dollars.

THE development of ecology has been much stimulated in recent years by the detailed and exact work of American botanists. The book under notice forms in many respects a companion volume to that of Clements on "Plant Succession." Essentially it deals with the delimitation of vegetational areas in the United States and the relation of these to environmental conditions. Prof. Livingston is well-known for his work in plant physiology, as well as in ecological plant-geography, and Dr. Shreve is also a physiological ecologist. So this aspect naturally dominates in their joint work.

The introduction and the first portion of Part II., dealing with environmental conditions, will be read with interest by all ecologists and physiologists since they contain much useful general information and new standpoints for the survey of old questions. That portion of the book which deals directly with American vegetation shows clear indications of an enormous amount of detailed work. The abstraction and preparation of figures and tables illustrating the very varied climatic conditions of the United States and their correlation with vegetational areas must have necessitated much concentrated labour, and co-nationals of the authors will owe a debt of gratitude to them for the results. Numerous outline maps are reproduced to show graphically the distribution of climatic conditions, vegetational types, and even occasionally of single species. One coloured map showing the vegetational areas of the United States, and another the life-zones, accompany the volume, which is also provided with a table of contents but no index.

W. B. T.

Modern Motor Car Practice. Edited by W. H. Berry. (Oxford Technical Publications.) Pp. xii+582. (London: Henry Frowde and Hodder and Stoughton, 1921.) 31*s.* 6*d.* net.

A LARGE amount of information regarding the details of motor cars and their working in practice will be found in this volume. As a rule, each principal detail, such as clutch, steering gear, etc., forms the subject of a separate chapter. Different designs are discussed and their defects and advantages indicated. The book

is profusely and well illustrated, and forms a valuable compendium for car users. The designer will also find it useful from the same point of view, but as the treatment is non-mathematical throughout, its service to him will be somewhat limited. Whilst the volume is for the most part free from errors, there are some statements regarding resiliency on p. 376 which require revision. The book is up-to-date in general, and includes a chapter on the X-ray examination of materials and another on welding repairs.

My Electrical Workshop. By F. T. Addyman. Pp. viii + 249. (London: The Wireless Press, Ltd., N.D.) Price 7*s.* net.

DESPITE the many complete mechanical contrivances now obtainable which enable boys to construct models by simply using a screw-driver, there is still a large number who prefer to make things for themselves. Those who have inclinations towards electricity will find the volume under notice useful in helping them to produce apparatus which will work and can be made from simple materials, provided they possess some measure of handiness with tools. There is a large number of illustrations which assist in making the text clear, and here and there the real article is described as well as a method of making a model having the same principle.

A Manual of Pharmacology. By Prof. W. E. Dixon. Fifth Edition, completely revised. Pp. xii + 468. (London: Edward Arnold and Co., 1921.) 18*s.* net.

SINCE the publication in 1905 of the first edition of Prof. Dixon's "Manual of Pharmacology," the volume has maintained its reputation as one of the foremost works on the subject, a reputation which it gained by the very practical arrangement of the subject matter and the readily intelligible manner in which it was presented. The fifth edition retains those characteristic features. Very little change has been made in the classification of the drugs discussed; they remain as before in pharmacological groups.

The chief alterations that have been made consist in the insertion of new paragraphs where necessary and in the correction of the text so as to give effect to the results of work that has been carried out by the author and others during the last few years. Several drugs, such as agaricin, allantoin, etc., to which attention has recently been directed, are accordingly considered. Chemotherapy, the conception that the protoplasm of the living cell is provided with receptive side chains to which drugs can attach themselves and so bring the poisonous properties of a toxophore grouping to bear, is, in the author's opinion, based neither on chemistry nor on pharmacology. By the slow oxidation of salvarsan in the blood into a substance containing trivalent arsenic a steady supply of efficient parasiticide is thrown into the blood, the action of the salvarsan being thus only indirectly on the parasite. On the other hand, in the treatment of filariasis, bilharzia and kala-azar by the intravenous injection of soluble antimony salts, these apparently penetrate the embryos or adult parasites and so produce their toxic action. Of the value of twilight sleep in depriving labour of its terrors, Prof. Dixon is by no means convinced; in his view it has still to be determined.

The section on antiseptics and disinfectants has been practically rewritten. The action of hypochlorites on proteids and the antiseptic action of chloramines and their sodium compounds as well as of flavine are concisely but very clearly described. The employment of sunlight, ultra-violet rays, X-rays, and radium emanations as remedial agents is also briefly discussed. There is no doubt that to the student and to the practitioner of medicine, as well as to all who are interested in pharmacology, Prof. Dixon's "Manual" will remain indispensable.

Atomic Theories. By F. H. Loring. Pp. ix + 218. (London: Methuen and Co., Ltd., 1921.) 12*s.* 6*d.* net.

RECENT investigations on the structure of the atom and allied studies have proceeded so rapidly that it is difficult for the average reader to keep pace with the advances. The subject is, however, of absorbing interest, and has such an important bearing on all branches of physics and chemistry, that every student feels the need of making himself acquainted with the main features of the new theories. In the case of chemical students, a non-mathematical treatment is, so far as is possible, desired. Mr. Loring's book, which is attractively printed on good paper, will be found of great interest and value in this connection. Particular mention may be made of the accounts of Rutherford's theory in Chapter VIII. and of Bohr's theory in Chapter X. In some cases, notably Chapter IX., on the Quantum Theory, the treatment is too condensed to be clear. The style in many respects is often at fault; the author shows a tendency to wander in sentences, which leaves one with a confused idea of what he is trying to say. The statements on pp. 6 and 15 that fractional atomic weights (O = 16) are due to isotopes cannot be maintained in the face of examples such as iodine and nitrogen.

East Carelia and Kola Lapmark. Described by Finnish Scientists and Philologists. By T. Homén. Pp. xiv + 264. (London: Longmans, Green & Co., 1921.) 21*s.* net.

THE separatist movement in Eastern Carelia dates from the Soviet *régime* in Russia. It has now led, on the one hand, to a Soviet attempt to suppress it by force, and on the other to an appeal by the Carelians to the League of Nations. The present volume, which was originally published in Finnish and later in Swedish, is in a sense a contribution to that movement in so far as it aims, in a series of papers written by experts, to give an account of the country, its products, history, and inhabitants. For this purpose Kola Lapmark, where the Carelians are not in a majority, is included. It was written before the Treaty of Dorpat, 1920, by which a strip of Russian territory ending in Pechenga Gulf was ceded by Russia to Finland, thus disposing effectively of Finnish claims to Kola Lapmark. The propagandist aim of the book, however, does not obtrude and is mentioned only rarely. The volume is a valuable contribution to the geography of Arctic Europe, and is well illustrated by several maps.

R. N. R. B.

Letters to the Editor.

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

Research Degrees and the University of London.

THE question of research degrees in the University of London, which is the subject of a letter by Dr. Morley Davies in NATURE of February 23, p. 238, raises an important matter of principle. The proposal of the sub-committee of the Academic Council of the University to institute a new series of examinations for the M.Sc. degree, appears to have arisen from a desire to secure uniformity in the granting of the degree. Whether it will do so or not is a matter of opinion, but, in any case, many people consider that such uniformity can be obtained only by retrogressive steps, in view of the urgent necessity for the training of research workers.

The examination fever has fortunately died down in recent years. The general raising of the standard of examinations which has accompanied the rapid advances in natural and experimental science has resulted in the Honours B.Sc. Examination becoming not only a searching test of the general knowledge of the principal subject chosen by the candidate, but a severe test of his familiarity with some special branch. Beyond the standard thus set, it is very difficult for an examiner to impose a test without giving a candidate a choice of a large number of highly technical questions either limited in scope or controversial because of the generalities in which they tempt candidates to indulge. Such a type of examination almost puts the examiner at the mercy of an examinee who has the wit to ask in an apostrophic way, "What did Gladstone say in 1876?" or to refer to the rocks of the Amazonian forests or the flora of the Senussi country!

Ostensibly, the undesirability of having four standards of research for the B.Sc. (research), M.Sc., Ph.D., and D.Sc. disturbs the sub-committee. Dr. Davies has dealt effectively with this question. Leaving aside the B.Sc. by research as a qualification granted but rarely and exceptionally, no difficulty as regards the standard for the other three degrees will arise in the mind of many examiners.

May I submit the following as a purely suggestive general scheme of minimum requirements? The candidate should in his M.Sc. thesis show that he is familiar with the literature of his branch of research, and able to summarise and analyse that literature effectively; further, that he has had sufficient originality of mind to pursue a line of inquiry instituted by others, and to extend knowledge in such a direction. For the Ph.D. degree he should be able to make a marked contribution to the advance of knowledge, and to submit a finished account of an investigation or an interim report, complete so far as possible, and containing legitimate deductions, his dissertation bearing evidence of the expenditure of an appropriate amount of time and labour. For the degree of D.Sc., it is desirable that the candidate should display great originality of mind and a capacity for research of a high order. He should be able not merely to use the methods and weapons of others, to extend their fields of investigation and apply their results, but to evolve methods and tools of his own, strike out into new paths, and in turn give a lead to less experienced workers.

If some such distinction as that drawn above is not, even unconsciously, adopted, the matter of the respective standards for the Ph.D. and D.Sc. is likely to become chaotic. If the M.Sc. by examination is instituted an undesirable tendency, already in evidence, for the candidate to proceed direct from B.Sc. to Ph.D. (and there remain) will undoubtedly develop.

As an illustration of an opposite point of view to that taken by the sub-committee, I may perhaps be allowed, without advocating in any way too early specialisation, to commend the scheme adopted in this university of allowing a student (by arrangement of the head of the department concerned) to present, as an alternative to taking one special paper in the Hons. B.Sc. Examination, a report upon some piece of investigation carried out by him.

P. G. H. BOSWELL.

University of Liverpool, March 7, 1922.

Phenological Observations.

THE highly interesting communication of Mr. J. E. Clark in NATURE of February 16 directs attention to some important problems in phenology, and I beg space to indicate one or two that have more especially occurred to me.

First, in the comparison between England S.E. and England S.W., I do not think the earlier flowering of horse-chestnut (*Æsculus hipp.*) around London than in Cornwall is at all a surprising result, inasmuch as the climate of Cornwall with its rough sea gales is notoriously unfavourable to trees (except, perhaps, in the deeper valleys) as distinct from herbaceous plants. It may also be that the more rapid rise of temperature in the south-east of England than in the oceanic south-west peninsula acts as a stimulus to the spring flowering of certain trees.

Secondly, I am anxious to urge the desirability of correlating the autumnal phases with the spring phases of vegetation in studying the effects of climatic conditions upon the seasonal phenomena of plants. Let me illustrate the point by an example, that of our native oak (*Quercus robur*). According to Hopkins's "bio-climatic" law, the oak should burst into leaf and flower a week to ten days sooner in southern than in northern England, and this certainly agrees pretty well with general experience. But is it safe, therefore, to infer that because the oak puts forth its leaves a week or so earlier in the south of England in response to a warmer climate, it will shed them a week *later* in response to the same? Consider the opposing factors that appear to be at work. In studying individual oaks of the same locality in diverse parts of the country I have constantly noticed that those trees in autumn which are in full tint, or are half bare, are usually such as have already ripened their acorns, whereas those of which the leaves are still green have not yet matured the acorns.

Now if one may apply this generalisation to the comparison between the north and south of England it would appear that, on the one hand, colder climatic conditions will tend to cause earlier defoliation in the north, and, on the other hand, that internal biological conditions will tend to delay defoliation in order that the acorns, the flowers of which were ten days behind the south to commence with, may be brought to maturity. But the generally more inclement conditions in the north, with the earlier night frosts, are impatient of any delay in the fall of the leaf, and it becomes a question of the utmost interest how the average dates of defoliation in the north and south of England actually do compare with those of foliation. One knows that the northern limit of the British oak as a flourishing species is set somewhere about the middle of Scotland, and presumably the critical determining fact is a summer too cold and short for fructification.

Thirdly, in the complex study of phenology the influence of factors other than meteorological should ever be borne in mind, as was brought to the attention of the Royal Meteorological Society last year by

Dr. E. J. Salisbury in a paper published in conjunction with the Phenological Report for 1920 (Q.J.R. Meteor. Soc., October 1921).

The average dates of leafing, flowering, etc., of a particular species is the result of *prolonged* adaptation to climate, and whilst the deviations of particular individuals from that date is controlled in part by local conditions of habitat, etc., the deviations of the same individuals in different years are governed not only by the weather of the current season but also by that of the previous season. The deviations from year to year are really kept within remarkably narrow limits, and there can be no doubt that force of habit is all-important in causing the periodic processes of vegetation to occur as near to the same dates year by year as external meteorological vicissitudes will permit. L. C. W. BONACINA.

27 Tanza Road, Hampstead, N.W.3, March 12.

The Resonance Theory of Hearing.

DR. PERRETT will, I hope, excuse me if I have seemed to impute absurdities to him (NATURE, February 9, p. 176). My reason for replying to his letter was because it seemed to me unfair to the resonance theory to leave his criticism unquestioned. But perhaps the consideration of an example will help to bridge the difference of opinion between us. Prof. Millar in his "Science of Musical Sounds" has given, on p. 201, analyses of the intensities of the harmonics of the oboe and clarionet. Whereas the clarionet note has harmonics of which the 8th, 9th, and 10th are the strongest, in the oboe note, on the other hand, the 4th and 5th harmonics have the greatest intensity If, then, the ear heard both these instruments sounding the same tone at one and the same time, it would hear one fundamental accompanied by strong 4th, 5th, 8th, 9th, and 10th harmonics.

Now no musical instrument of which Prof. Millar gives the analysis has these harmonics strongly marked, and the chances are enormously against any *one* musical instrument whatever having precisely the same intensities of the harmonics as those of the oboe and clarionet sounding the same tone together. In other words, there is something quite unique about the harmonics in the case that I have taken, which should enable the observer to say that the sound is to him not like an oboe only, or a clarionet only, but as if an oboe and a clarionet were speaking the same tone at the same moment. Now I do not say that the ear can never be deceived, for Helmholtz himself showed that vowels even, can be imitated by means of tuning-forks, but it seems to me that the characteristic intensities of harmonics do in almost all cases enable an observer to recognise the sounds of different classes of musical instruments even when any two of them are playing the same tone. Let us turn finally to the case which Dr. Perrett mentions, namely, when the voice is accompanied by the same tone produced by the chattering teeth. We know from the works of Helmholtz, Millar, and many others that the voice overtones have one maximum of intensity for the vowels "o" and "a" and two maxima for "e," "i" and "u," other overtones being very weakly represented. We also know that discontinuous sounds, such as those produced by tooth striking tooth, are very rich in overtones, and that these do not occur in maxima in any definite way. We should, therefore, expect the voice and the teeth-sound to have overtones very different in their intensity distribution. Therefore the observer should, so far as one can judge, hear overtones as characteristic on which to base his judgment, as those given out by oboe and clarionet.

I must, therefore, repeat that, in my opinion, Dr. Perrett is mistaken in his objection to the resonance theory. H. HARTRIDGE.

King's Coll., Cambridge.

Snow Furrows and Ripples.

WHILE at Gstaad recently, after a fine fall of snow (about 24 inches), the Föhn blew and rain fell for some hours. The weather then cleared, the temperature falling below freezing-point, and the snow then presented the appearance shown on the accompanying picture (Fig. 1). The peculiar "silloné" appearance of the snow on the slopes is very striking. It

FIG. 1.

looks as though water had run down over the surface, but this did not happen during the rain or afterwards.

As to the origin of the "furrows" (sillons), I think they were caused by contraction of the snow, as the gentle rain wet the fine-grained snow particles and drew them together. I observed afterwards the same development of furrows during fine weather on sunny slopes. These were so shallow that I failed to photograph them, but the whole hillside was covered with them. I also noticed that they occurred on the low-lying flat meadows, although they had no particular orientation in that case and occurred in every direction. This may be discerned in the lower parts of Fig. 1. E. C. BARTON.

I WAS once out on the snow-covered prairie at Moose Jaw, Saskatchewan, when suddenly, the hot chinook wind began to blow, the counterpart of the Alpine föhn. The snow melted away with astonishing rapidity, and very soon there was the sound of trickling water, which I had not heard for months, for the season was late winter. The melting was not uniform, nor did it produce longitudinal furrows, but on the contrary a rippled structure of ridges and furrows transverse to the wind, adding yet one more variety to the many kinds of ripples which I had seen in snows of different consistency.

VAUGHAN CORNISH.

Historical Notes upon Surface Energy and Forces of Short Range.

By W. B. HARDY, Sec. R.S.

THE following notes were completed about fifteen years ago for a purpose not now likely to be fulfilled. They seem worthy of publication because the early history of the subject, which is to be found in Clerk Maxwell's essay on "Capillary Action,"[1] and is based upon a report made by Challis to the British Association in 1834, seems to be wrong in material points. Challis does less than justice to the eighteenth-century philosophers.

According to Poggendorff, Leonardo da Vinci must be considered as the discoverer of capillary phenomena, but a fact so patent to all can scarcely have been discovered by a single man. The ascension of water and other liquids in capillary tubes was "noticed by the Academy del Cimento at Florence early in the seventeenth century, but seems not to have been much regarded in the sequel."[2] Communications to that academy were anonymous. Probably Leslie's authority was "une anecdote curieuse qui a été publiée par M. Nelli (' Saggio di storia letteraria,' etc., p. 92) sçavoir que le véritable auteur de cette expérience fut Nicolas Aggiunti, mort le 6 décembre, 1635 . . . l'un des Fondateurs de l'Académie del Cimento."[3]

The beautiful volume issued by the Academy in 1667 is devoted mainly to experiments in a vacuum. Amongst these is a demonstration of the rise of fluid in a capillary tube *in vacuo*.

The phenomenon was still novel when Boyle demonstrated capillary rise "to the no small wonder of various mathematicians."[4] Boyle tried, but failed, to observe whether the rise took place in a vacuum, and he also inquired why the capillary surface should be concave with water and convex with mercury.

If Leslie is to be trusted, the revival of the subject was part of that great revival of physical experiment which followed the promulgation of the Newtonian system at the close of the seventeenth century. At any rate, though Hauksbee was the first whose published work needs consideration, he was not the first to make experiments, for he writes of many attempts to "solve this Appearance. . . . Some have argued from the impeded or diminished Action of the Air,[5] others from the Innixion or Resting of the Parts of the Fluid on the Pores and Asperities of the Glass; others again from the Congruity and Incongruity of the Parts of Matter one to another."[6]

Argument was direct and frequently personal in the pamphleteering times of the eighteenth century, and Hauksbee goes on to say that the "First two ways of solving the Difficulty have this advantage above the other, that they are perspicuously False; whereas this latter is more mysteriously so . . . because of the hard Words of Congruity and Incongruity."

Nothing tangible has survived from these earliest discussions, and we begin the subject with Hauksbee, whose merit was twofold; he was an exact experimenter, and he succeeded in interesting Newton in the problem. His first paper appeared in the Philosophical Transactions for 1709. This led Newton himself to make experiments, and it is a nice question how far the speculations concerning the constitution and intimate forces of matter which appear in the incomparable[7] thirty-first query are owing to his attention being thus directed to the problem of cohesion. The thirty-first query appeared for the first time in the second edition of the "Opticks" of date 1718. Be this as it may, though exact experiment and induction begin with Hauksbee, what may be called in eighteenth-century phrase the philosophy of the subject begins with Newton.

Hauksbee experimented with capillary tubes and also on the rise of fluid between planes of glass, marble, and metal. As fluids he used water, alcohol, and various oils. He noticed that the phenomenon of the rise of fluid in small spaces is not peculiar to one fluid or one solid, and that it is not due to the presence of air, since the rise occurs in a vacuum. His most important experimental result was that the height to which fluid rises is the same in two tubes of the same diameter, but one "at least ten times as thick as the other." Comparing this with the magnet, which can be broken into smaller and smaller pieces each of which will exert the force, he argues that the attraction of the solid for the fluid is limited to the surface of the solid.

There the matter was allowed to rest so far as the paper of 1709 is concerned. In the paper of 1711 the movements of a drop of oil of oranges between two glass planes inclined to one another at an angle are rightly referred to variations in the area of the surface of contact between fluid and solid, but the statement that the power of attraction must increase in proportion to that surface cannot now be defended. His papers of 1712 and 1713 are devoted to careful measurements of the curves which the surface of water forms when enclosed between glass planes. Brooke Taylor in 1712 had already pointed out that the curve was an hyperbola.

There is little theory in Hauksbee's papers. He was essentially an experimenter,[8] but in his book he draws certain definite conclusions from his experiments for which he has not received due credit.

"That very great Man, Sir Isaac Newton (the Honour of our Nation and Royal Society), has set both these Laws of Attraction in a very clear Light"—namely, that amongst the greater bodies of the universe the attraction decreases reciprocally as "the Squares of the Distances do encrease," and that the smaller portions of matter tend to each other by a law very different and unknown, but one according to which the "attractive Forces do decrease in a greater proportion than that by which the Squares of the Distances do encrease." Hauksbee then goes on to make this

[1] "Encyc. Brit.," 9th edition.

[2] Leslie, Tilloch's *Phil. Mag.*, vol. 14, p. 194, 1802. This academy was perhaps the first such body devoted to natural science, though it is stated by Vasari and others that da Vinci founded one at Milan. It was active in Florence during the years 1657–67, and deserves remembrance for the quality of its work.

[3] *Journal des Sçavans* (Amsterdam), November 1768, p. 74.

[4] "New Experiments, Physico-mechanical." (London, 1682.)

[5] [*E.g.* Hooke.]

[6] Hauksbee, "Physico-mechanical Experiments," p. 156. (London, 1709.)

[7] "Our Incomparable President," Jurin, 1718. Also Halley wrote concerning the "Principia" in 1686, "an incomparable treatise on motion."

[8] "There's no other way of Improving Natural Philosophy but by Demonstrations and Conclusions, founded upon Experiments judiciously and accurately made."

perfectly definite statement that "the attractive Power of small Particles of Matter acts only on such Corpuscles as are in contact with them, or removed but infinitely little Distances from them," thus anticipating Segner by nearly half a century.[1]

Obviously, it follows that (in anticipation of Clairaut) the water in the interior of capillary tubes is held up by the attraction of the particles of the walls of the tube, to those particles of water at the surface which are "urged strongly towards the Glass." Lastly, Leslie was not the first to show that the attraction is everywhere normal to the surfaces of the solid, as Maxwell states, for Hauksbee says: "The Parts of the Liquid adjoining to the concave Surface of the Tube are strongly attracted by it, and that in a Direction perpendicular to the sides of the Cylindrick Glass."

A comparison of contemporary references with the actual writings of Newton leads to the conclusion that much which is attributed to him was made public verbally during the discussions at the Royal Society. An interesting instance is furnished by the note to Dr. Jurin's paper.[2] At any rate, the hints scattered through the Queries to his "Opticks" as to the existence of forces acting between the particles of matter "which reach to so small distances as hitherto to escape observation," and which sprang in the first instance from his study of the diffraction of light, became a compact body of doctrine accepted in England before 1720. Hauksbee, as we have seen, wrote in 1709, nine years before the thirty-first Query was published, of intermolecular forces of insensible range, which fall off according to some higher power than the square of the distance, and Jurin in 1719 speaks of the "universally acknowledged" attractive force between the particles of a fluid (water), and refers to the sphericity of drops of rain, and the fusion of drops of water when in contact, as examples of the operation of the force; in both cases reference is made to Newton.

This doctrine, which, I believe, was shaped by the discussions at the Royal Society, may be embodied in a series of propositions as follows:—

(1) That, in addition to the force of attraction which acts between larger bodies and varies in intensity according to the inverse square of the distance, there is another attractive force which acts between the ultimate particles of matter, has a range of insensible magnitude, and varies inversely according to some power of the distance higher than the square.

(2) At distances less than a certain minute value this attractive force gives place to a repulsion.

(3) The attractive force "performs the Chymical Operation"; it is the source of cohesion, and cohesion brings about the movement of fluids in small spaces.

(4) Heat is a quality of matter, not a substance. It is the agitation of the particles of matter, and if "the Heat is big enough to Keep them in (adequate) Agitation, the Body is fluid."

(5) The ultimate particles of matter are of definite shapes—not always spheres—and are impenetrable.

Dr. Jurin, secretary of the Royal Society during a portion of Newton's term as president, was led to the subject of capillarity by "an ingenious Friend" who proposed a plausible method for "making a perpetual Motion" founded upon Hauksbee's experiments. The method is of little interest, but Jurin was led directly by it to the discovery that the height to which fluid is raised is determined by the "periphery of the tube to which the upper surface of the water is contiguous," and he argues that, as this is the "only part of the tube from which the water must recede upon its subsiding," it is consequently "the only one which by the force of its cohesion or attraction opposes the descent of the water." Hence the rise must be inversely proportional to the diameter of the tube. Newton and Machin pointed out that Jurin's "'periphery' . . . is really a small surface, whose base is that periphery (of the tube), and whose height is the distance to which the attractive power of the glass is extended."[3]

In the interval between Jurin's papers a book appeared "by a very learn'd and ingenious member of this [the Royal] Society," whose name I have not succeeded in tracing. It deserves mention because in it the effect of the attractive power of the water for itself is exactly considered. Jurin demonstrated the attraction in a striking manner when he showed that if the tube at the lower part of a funnel is drawn out to capillary dimensions and the funnel inverted with the open mouth under water, then if it be filled by drawing water up into the capillary it will remain full. The experiment succeeded in a vacuum. He infers that the lower mass of water in the funnel must be suspended by its cohesion to the column within the capillary. At the end of the memoir is a series of propositions, of which Nos. 4 and 6 assert that the particles of water are more strongly attracted by glass than by each other, but the particles of quicksilver are attracted more strongly by each other than by the glass—hence the rise of water and the depression of quicksilver in a tube.

Though the theories of Hauksbee and Jurin were generally adopted—as, for instance, in the memoirs of Bilfinger[4] and Weitbrecht[5]—there was a body of opinion which contested the existence of attractive forces of cohesion.[6]

The cause of this widespread interest and discussion of capillary phenomena in the eighteenth century cannot be better stated than in the words of the astronomer, de la Lande[7]: "Many phenomena are regarded as allied to those of capillary tubes, . . . *e.g.* the suction of sugar and of sponges, the origin of springs in elevated sites; the secretions in the human body seem to be due to the same cause. . . ." These phenomena illustrate the general attraction of matter, contested too long. "Capillary tubes put into our hands an obvious example of the generality of this law, which is the keystone of physical science." But M. de la Lande's attempts to explain the phenomena were not very illuminating!

In the eighteenth century the force of cohesion was so closely identified with chemical action that Guyton

[1] Maxwell therefore is wrong in saying that "these early speculators . . . do not distinctly assert that this attraction is sensible only at insensible distance."

[2] Phil. Trans., 355, p. 739, 1718.

[3] Phil. Trans., 1718, p. 747.

[4] *Mémoires de l'Acad. de St-Pétersbourg*, vols. 2 and 3, 1727–28.

[5] *Ibid.*, vols. 8 and 9, 1736–37.

[6] *E.g.* Paulian, "Traité de paix entre Newton et Descartes," vol. 3, p. 199; Gerdil, "qui a fait un Livre tout entier contre l'attraction des Tubes Capillaires"; Abat and others. Mairan, who explained cohesion as being due to electrical action, etc.

[7] *Journal des Sçavans* (Amsterdam), vol. 35, November 1768, p. 75. De la Lande, in his system of astronomy, incorrectly refers his own paper to the October number.

de Morveau, for example, in 1773, in his examination of the nature of chemical affinity, attempted to determine the relative affinities of a variety of substances from the force required to detach small plates of glass from their surfaces.[1] The experimental method was investigated mathematically by Laplace and Duprè, and used widely as a means of measuring surface tension.

Though the range of the force of cohesion was recognised as being insensible by these earlier writers, nowhere, so far as I know, did they draw the conclusion that the surface layer of a fluid must be the seat of special forces, though a strong hint appears in Newton's comments upon Hauksbee's experiments. The enunciation of the secondary principle of surface tension was reserved for Segner.[2] Segner appears to have had little or no acquaintance with other work on the subject; he refers only to Clairaut (" Figure de la Terre," 1743), whose book, however, he could not obtain (" quesitum nancisci non potui "): " Cupiebam autem inspicere, propter articulos quasi episodicos . . . rotunditatem guttarum . . . elevationemque et depressionem fluidorum in tubis capillaribus, spectantes. Ea ergo qualia sint, quantumque cum meis consentiant, dicere nequeo." The subject matter of Segner's paper is, in the first instance, the equilibrium of drops of fluid; the equilibrium in tubes is treated from the point of view of the curvature of the free surfaces. The important theorems are Nos. 2 and 3, which assert that if in any drop the volume be divided into a shell, the thickness of which is that of the range of the force of attraction, and an interior mass, the forces on any particles in the latter contribute nothing to determining the form of the drop, but only those forces on any particles in the surface shell which can be resolved along the normal to the surface and in the tangent plane. In his calculations of the effects of the surface tension so produced Segner made the mistake, afterwards corrected by Laplace, of taking account only of the curvature of a meridian section of the drop, neglecting the effect of the curvature in a plane at right angles to this section. To Segner, however, belongs the credit of being the first to deduce the phenomena of capillarity from the surface tension.

The existence of a surface tension was demonstrated objectively when Leidenfrost showed, in 1756,[3] that a soap bubble tends to contract. In 1787 Monge[4] applied the principle to explain the apparent attractions and repulsions between bodies floating on a liquid.

Reference is made by Leslie (see later) to experiments on the subject made in Holland by Musschenbroek. I have not succeeded in tracing these. The only reference in his " Cours de Physique " of 1769 is to the experiments of Hauksbee, and theory is limited to the statement that " l'explication se présente naturellement à l'esprit " ![5]

Leslie, in a curiously polemical and pedantic paper,[6] attempts to replace Jurin's " explication " of the rise in capillary tubes, which " is almost universally adopted. It is repeated in all the elementary books of natural philosophy." The attraction of the glass, everywhere normal to the surface and of narrow range, gives rise to an increase in pressure in the layer of water next to the surface of the glass. The result of this pressure is that a drop of water tends to spread out over the surface of the glass and consequently to mount upwards in a tube. " But why should the mere tendency of the water to the surface of the glass occasion a dispersive motion? The reason is that the external particles could not approach without spreading themselves and extending the film: and analogy will instruct us, that the attraction of water to glass must increase in proportion to the proximity of its approach." The liquid film flows up the walls of the tube, carrying with it water which adheres to it, and equilibrium is reached when the weight of the column balances the force by which the film spreads itself over the glass. " This explanation of the action of the solid is equivalent to that by which Gauss afterwards supplied the defect of the theory of Laplace, except that, not being expressed in terms of mathematical symbols, it does not indicate the mathematical relations between attraction of individual particles and the final result."[7] Maxwell gives to Leslie the credit of being the first to explain correctly the rise of fluid in a capillary tube. " He [Leslie] does not, like the earlier speculators, suppose this attraction [of the solid] to act in an upward direction so as to support the fluid directly." Yet a few pages further on Maxwell himself speaks of the tension of the solid as though it intervened actively as an upward pull!

On few subjects has more been written than on capillarity, and yet the exact way in which the attractive forces act in causing the rise of fluid in capillary tubes and the spreading of fluids over solid or fluid surfaces is still obscure. Leslie's account is probably the best, and if true it carries an important corollary—namely, that the layer of fluid attracted by the glass is at least two molecules in depth. Recent writers, if I understand them rightly, would restrict the influence to a layer only one molecule deep.

Leslie's paper is original and powerful, and even now very little out of date. It includes many observations which are still of great interest; of these the only one I have space to mention is the discovery of the fact that the " assimilation " of fluid by porous bodies is accompanied by a rise of temperature. He was, I believe, the first to detect this fact.

In the early years of the nineteenth century the subject received attention at the hands of two remarkable men—Dr. Thomas Young and the Marquis de Laplace. Their methods were entirely dissimilar. Young founded his theory on the principles of surface tension, or " superficial cohesion," as he calls it. " Since the time of Segner," he says, " little has been done in investigating accurately and in detail the various consequences of the principle." He begins by making two assumptions—the first, which he attributes to Monge " and others," that the cohesive attraction of the superficial particles causes the free surface of fluids to " be formed into curves of the nature of linteariæ which are supposed to be the results of a uniform tension of a substance "; and the second, " which appears to be new," that the angle of contact

[1] He used " la méthode du Docteur Taylor [Brooke Taylor] . . . qui, par le choix des matières employées, peut servir à faire connoître que l'attraction que les Chymistes nomment affinité a nécessairement quelque part à cette adhésion," *Jour. de Physique*, vol. 1, p. 172, 1773.

[2] " De Figuris Superficierum Fluidarum," Comm. Soc. Reg. Sci. Gottingensis, vol. 1, p. 301, 1751.

[3] " De aquae communis nonnullis qualitatibus tractatus." (Duisburg.)

[4] *Mémoires de l'Acad. des Sciences*, p. 506, 1787.

[5] Pencilled on the margin of my MS. is the note " Not altogether just." At this distance of time I cannot elucidate the remark.

[6] Tilloch's *Phil. Mag.*, vol. 14, p. 193, 1802.

[7] Clerk Maxwell, art. " Capillary Action," " Encyc. Brit.," 9th edition.

of a liquid surface and a solid is constant and characteristic of any given pair of liquids and solids.

If a curved line is equally stretched, the force that it exerts along the normal at any point is directly as its curvature, and the same is true of a surface of simple curvature—*e.g.* a cylindrical surface. When the curvature is double, each curvature has its appropriate effect, and the normal force will vary as the sum of the curvatures. As this sum is the same for all perpendicular directions, the normal forces will be proportional to the sum of the greatest and least curvatures. Since the force is always directed to the centres of curvature it will elevate the fluid in a capillary tube when the surface is concave, and depress it when convex. When the surface is cylindrical and therefore curved only in one direction, as when water rises between two glass plates, the curvature must be everywhere as the height of the volume of fluid. When the curvature is double, the sum of the curvatures must be as the ordinate. This is the relation expressed by Laplace's fundamental equation, and Young's essay[1] contains the solution of most of the cases afterwards solved by Laplace. Peacock, Lowndian professor at Cambridge from 1836 to 1858, the editor of the Works of Young, appends the following note: "In the original essay the mathematical form of this investigation and the figures were suppressed, the reasoning and the results to which it leads being expressed in ordinary language; even in its altered form the investigation is unduly concise and obscure." Clerk Maxwell says of Young's methods of demonstration that, "though always correct and often extremely elegant [they] are sometimes rendered obscure by the scrupulous avoidance of mathematical symbols."

The phrase "scrupulous avoidance" is quoted from Challis and is applicable only to the earlier essays. In the article on cohesion of 1816 and the "Elementary Illustrations of the Celestial Mechanics of Laplace," mathematical symbols are freely used, the analysis being by the method of fluxions. Owing to a charming devotion to Newtonian tradition, English mathematics was at its lowest ebb when Young was a student at Cambridge; the reforms which Woodhouse, of Caius, within a few days of the same age as Young, initiated in the Cambridge School in 1803 bore fruit only in 1817, through the action of Herschel, Babbage, and Peacock. A poor training in antiquated methods and a certain vanity in his powers of "clear and simple explanation,"[2] may account for the way in which Young concealed his mathematics. His spirited indictment of the "algebraical philosophers, who have been in the habit of deducing all these quantities from each other by mathematical relations, making, for example, the force a certain function or power of the distance, and then imagining that its origin is sufficiently explained," and of the geometricians who "convert the formulæ into a curve with as many flexures and reflections as the labyrinth of Dædalus," is of the earlier period[3] and probably traceable to his personal irritation with Laplace, whom he never forgave for a real or fancied appropriation of his (Young's) ideas.

[1] Phil. Trans., 1805.

[2] *Cf.* the sentence, pregnant with personal character, which closes the essay of 1804.

[3] Lecture 49 of the "Natural Philosophy," the preface date being 1807; p. 471 of the edition of 1845.

Young proceeds to consider the "Physical Foundations of the Law of Superficial Cohesion." This he finds in the nature of the forces of cohesion. Young's work, and especially his "wonderful speculation," as Rayleigh calls it, as to the magnitude of the pressure in the interior of water due to corpuscular forces, which he puts at 23,000 atmospheres, and the calculation based on this estimate of the range of the cohesive force and the size of molecules, are fully dealt with by that writer.[4]

The beginnings of Laplace's well-known theory are to be found more than half a century earlier in the work of Clairaut.[5] Clairaut, like Laplace, was an astronomer, and his treatise on the figure of the earth consists of a mathematical analysis of the condition of equilibrium of fluid masses. This leads to the proposition that "all the particles of a mass of fluid can be in equilibrium amongst themselves when the force which acts on it is the sum of the attraction which they exercise on one another, (namely) gravity, and the attraction of any body which touches the mass." Capillary phenomena are treated as a special case of the proposition. Clairaut's analysis of fluid equilibrium is based upon a consideration of the forces acting upon an infinitely narrow canal of any figure which traverses the mass. The value of the method is that it leads very directly to equipotential surfaces. In the special case of the rise in a capillary tube the canal starts from the meniscus and ends on the general surface of the fluid.

The force of attraction of glass for water is assumed to be the same function of distance as that of water for itself, and to differ only by coefficients of the intensities. Since the range of the force is small (not insensible), only the integrals of the attractive forces about the ends of the tube need be considered. The sum of these must balance the difference in the weight of the limbs of the capillary tube.

The integral of the forces acting on that end of the tube which is at the general surface of the fluid will clearly be equal and opposite to that of the forces on the fluid below the tangent plane to the meniscus; therefore the weight of the column within the capillary is supported by the whole attraction of the fluid of the meniscus above the tangent plane, and of the lower end of the glass tube on the parts of the canal within its range. This result differs from that of Laplace because, though Clairaut assumed the range of the force of attraction to be small, he did not make it insensible. Had he done so he would have got rid of the attraction of the lower end of the capillary tube on the axial canal and have arrived at substantially the same result as Laplace.

Many workers contributed to the subject in the nineteenth century. The curious may find a brief summary of their experiments and conclusions in the papers by Charles Tomlinson which appeared, mainly in the *Philosophical Magazine*, between the years 1870 and 1880. Specially interesting are the speculations from those of Volta onwards as to the cause of the movements of particles of camphor and of other volatile solids on water. Challis's account of Gauss's important memoir cannot be bettered. The substance of it is reproduced by Clerk Maxwell in the article on capillarity which he wrote for the "Encyclopædia Britannica."

[4] Rayleigh, *Phil. Mag.*, vol. 30, 1890, p. 285.

[5] "Théorie de la Figure de la Terre." (Paris, 1743.)

Parasitic Worms of Man and Methods of Suppressing Them.

By MAJOR F. H. STEWART, Indian Medical Service (Retired).

ONE of the most interesting and important groups of the animal kingdom is that of the parasitic worms or helminths; interesting from the point of view of pure science on account of the intricate and varied nature of their life-histories and biological relationships, and important from the effects which they produce on the health of man, domestic animals, and cultivated and useful plants. In the present article a summary is attempted of the results of modern research on the helminths attacking man alone.

The more important helminths attacking human beings can be grouped as follows: (1) the intestinal worms, such as the roundworm and the hookworms, (2) the trematodes or flukeworms, and (3) the filarias and their allies, which live in the connective tissues.

The roundworm (*Ascaris lumbricoides*) and the hookworms (*Ancylostoma duodenale* and *Necator americanus*) live in the small intestine of man. The former is an animal of considerable size, from 20 to 35 mm. in length, while the latter two are smaller, 10 to 13 mm. long. The sexes are separate in all of them, and the females pour out a stream of eggs which are passed out of the human body in the fæces. The eggs ultimately find their way to the surface of the soil, and if the conditions are favourable—*i.e.* if the ground be moist and the temperature not less than that of a European summer (for Ascaris) or of an Egyptian summer (for Ancylostoma)—a small embryonic worm appears within the tough shell. The hookworm larvæ now hatch and lead a free life in mud or in small puddles or pools. Their attack on man is direct and active, for, should the hands or unshod feet come into contact with the mud or water which they inhabit, the little needle-shaped larvæ are roused to great activity. They bore their way through the skin into the subcutaneous tissue, and are carried in the lymph-stream and blood through the heart to the lungs; from the lungs they swim up the air passages and down the œsophagus, so reaching the small intestine. This remarkable life-history was worked out by the Austrian zoologist Looss in Cairo, and, although at first received with some scepticism, it has now been fully confirmed.

In the roundworm, on the other hand, the egg must be swallowed before it will hatch, and this accident (unfortunate from man's point of view) takes place through the consumption of vegetables grown on infected soil, on which eggs have been splashed, or as the result of eating with unwashed hands after working on contaminated land. When the egg arrives thus passively in the small intestine of man, it hatches, and a little larval worm emerges. Until recently it was supposed that this larva remained in the small intestine and simply grew to adult size without further adventure, but the present writer has been able to show that this is not so. The larva bores into the wall of the bowel, enters a vein, and, passing through the liver and heart in the bloodstream, reaches the lungs; from the lungs it migrates to the intestines by a route similar to that adopted by the hookworm.

In the hookworm one object of the migration is obvious, since the larva is merely taking the most sure and direct route to its goal—that is, from the first point at which it comes into contact with man, be this the skin of hands or feet, or of any other part of the body, to the small intestine. It is true that from the finger-tips it might be carried to the mouth and so reach the intestine directly, but only a small percentage of those larvæ which have succeeded in finding man could count on this fortunate chance. By skin penetration, on the other hand, a high percentage should succeed, and it must be remembered that only a few of all the larvæ which have hatched ever succeed in finding man, while only a few of the eggs reach such favourable surroundings as allow the larvæ to form or to hatch.

There is, however, a second object for the migration of the hookworm, the one which is the only motive in the case of Ascaris—namely, that the young larva is not adapted to survive among the strong digestive juices. The young Ascaris lacks not only a stout cuticle, but also that power of chemical defence by which the older parasite resists digestion by its host. Both cuticle and constitutional resistance are developed during the migration, while the larva is being nursed by the blood and lymph, by the bland and nourishing juices of its host. It seems that direct invasion through the skin was the line of attack by the primitive ancestral parasitic worms, and that the present physiological necessity of the migration is due to inheritance.

In geographical distribution *Ascaris lumbricoides* is cosmopolitan, occurring in all lands both temperate and tropical. The hookworms are also very widely distributed, being absent only from the colder parts of the temperate zones. Even there they occur sporadically in artificially warm situations, such as mines and tunnels; the well-known outbreaks of "miners' anæmia," both in the mines of England and the Continent, *e.g.*, in the St. Gothard tunnel, were due to this cause. The proportion of the population affected, especially in the tropics, is extraordinarily high, figures of from 40 to 98 per cent. having been recorded in various countries from the examination of large numbers of the populace. The degree of infestation is highest in the Far East—in China, Indo-China, the Dutch East Indies, and particularly in the tropical Pacific islands. The West Indies and tropical South America also return high percentages, while the southern States of the American Union yield figures which prove that it is not only among dark-skinned races that the parasites become very numerous. Even in Europe 20 per cent of the adult population of Italy and one-half of the children of Central Europe carry the roundworm.

The flukes are flattened oval worms which live in the veins of the abdomen (Bilharzia), in the bile-ducts and gall-bladder (Clonorchis), and in the tissues of the lungs (Paragonimus). Bilharzia occurs over large areas of the tropics and sub-tropics. Three species are known from man, one of which occurs in Mesopotamia, Egypt, and East Africa, the second in Central and South America, the West Indies, and West Africa, and the third in Japan, China, and the Philippines. The association of the West Indies and South America

in one geographical area with West Africa also occurs in the distribution of *Necator americanus*, but is due, not to an old Atlantic connection between the two continents, but to the spread of African parasites to America by the slave trade. In Egypt more than one-half of the population are affected by Bilharzia. Clonorchis and Paragonimus are limited to the Far East—Indo-China, the Philippines, China, and Japan.

The life-histories of all the flukes are similar. The eggs are passed out with the fæces, and if they reach water, the embryos which they contain emerge and swim about actively in search of some particular small mollusc (the intermediate host) into which they must penetrate in order to undergo their first metamorphosis. The intermediate hosts are different in various countries, and for the several worms concerned; for Bilharzia, in the Far East, it is the small water snail, *Katayama nosophora*. This fact was first established by Miyairi and Suzuki, and was confirmed by Leiper and Atkinson; later Leiper and his colleagues identified the intermediates in Egypt as *Bullinus contortus*, *B. Dybowski*, and *Planorbis Boissyi*. From the snail Bilharzia escapes as a more advanced free-swimming larva, which can bore through the skin of man should he venture into infected waters, and, once within the body, it migrates through the tissues to the veins of the liver and abdomen.

For Clonorchis and Paragonimus the first intermediate host is also a small snail, *Melania libertina*. They do not transfer themselves directly and actively from this animal to man, but to a second intermediate—Clonorchis to various species of carp, and Paragonimus to freshwater crabs. In these animals, the second intermediate hosts, they remain passive until they are swallowed by man in food.

The filarias are long, threadlike worms which live in the connective tissues of various regions of the body. They are associated with the disease known as elephantiasis. Geographically they are spread throughout the whole of the tropics. The larvæ circulate in the blood in enormous numbers, and are taken up by blood-sucking insects, in which they grow in size; after the lapse of several days they wander into the proboscis, from which they are injected into the skin of man when the infected insect again feeds. The pioneer work on this subject was done by Manson, and later extended by Low, James, and Leiper. The most important species are *Filaria Bancrofti*, the larvæ of which are carried by various mosquitoes (Culex, Anopheles, and Stegomya), and *Loa loa*, carried by the mangrove fly Chrysops.

The guinea-worm, *Dracunculus medinensis*, is common in India, Turkestan, Persia, Arabia, and tropical Africa. It lives under the skin, and when mature gives rise to a small ulcer, generally on the leg or foot, from which one end of the worm projects. A stream of larvæ is discharged through this ulcer into water when the patient bathes. The next stage of its life is passed in a water flea, Cyclops, and it is by drinking water containing these minute crustacea that man is infected.

Apart from local disease such as abscesses, elephantoid swellings, hæmaturia, etc., the more important helminths produce generalised disease of a very important nature which is surprisingly uniform, whatever be the causal animal. The primary symptom is always anæmia, and the secondary symptoms are such as accompany this condition, namely, general weakness, inability for work or any exertion, disturbance of the heart and circulation, and finally dropsy and death. In mild cases, which fortunately are the most common, the anæmia is not great, and the patient is merely reduced to a lower level of activity, happiness, and efficiency. But when we consider the enormous prevalence of these pests, we can realise the extent of the harm inflicted on mankind by them. It must also be remembered that in most tropical countries the people live only just above starvation level, and that any additional burden will quickly depress them below it. The means by which this anæmia is produced is not clearly understood, but recent work points to the formation of poisonous secretions, toxins, by the worms, which damage both the blood and the blood-forming organs. Bedson has shown that the injection of worm extracts produces acute inflammation of the thyroid, suprarenal capsules, and spleen.

Our armament for offence and defence against these enemies is at present incomplete, but it is becoming more effective. Offensive measures consist in attacking the parasites directly in the bodies of their human hosts, and the main advances have been in the use of oil of Chenopodium against the intestinal worms, Ascaris and Ancylostoma, and the intravenous injection of tartrate of antimony against Bilharzia. The former drug can be used on an enormous scale with great safety and efficiency, and if the inhabitants of a badly infected country can be educated to the point of undergoing treatment *en masse* once a year, a great reduction of disease should result. The second discovery, which we owe to Christopherson, has, at least in theory, entirely changed the future of whole nations. A disease which was previously incurable, and in Egypt, for instance, affects one-half of the people, can now be cured with certainty in a few months. In dealing with ignorant and suspicious native races, however, the rapid adoption of such strange and terrifying methods cannot be expected.

For defensive measures reliance is placed on improvements in sanitation and in the personal cleanliness of the people, advances which will necessarily be slow. No practical means of destroying eggs or larvæ on a large scale in the outer world have yet been discovered. Where an intermediate host exists a reduction of the disease would follow wholesale destruction of, or protection against, the intermediate. In this connection, mosquito destruction has of course already been carried out on a large scale in anti-malaria work in many regions, and it may be extended with the additional object of fighting worm disease. For the destruction of the snails associated with fluke disease periodical drying of canals and irrigated fields has been advocated by Leiper. The knowledge that Clonorchis and Paragonimus are introduced in food should also make the avoidance of these parasites easy.

Three things are above all necessary for the conquest of these plagues: (1) Continued and intensified research into the many points of the intricate life-histories of these parasites and their intermediate hosts which are still obscure; into new methods of destruction, chemical and physical, of both these groups of animals, whether as eggs, larvæ, or adults; and into

new methods of medical treatment for infected man. (2) Systematic instruction and tactful control of the peoples affected. This will be the duty of the medical and teaching professions of the stricken countries. Anyone who has watched the increase of well-taught and capable physicians in such a country as India during the last twenty years will base great hopes on the growth of this influence. (3) And most important, a common and indignant consciousness that these plagues are not inevitable, that by combined effort they can be cast off, and that it is a disgrace to humanity that one-half of its members should be harbouring these loathsome parasites.

The Theory of Relativity in Relation to Scientific Method.[1]

By DR. DOROTHY WRINCH, Fellow of Girton College, Cambridge.

SOME interesting criticisms of the theory of relativity have been advanced recently by M. Paul Painlevé, in two papers in the *Comptes rendus de l'Académie des Sciences de Paris*.[2] M. Painlevé attacks the theory as it at present stands, on grounds which are of general scientific interest. He criticises the expression for ds, the element of length adopted by Einstein,

$$ds^2 = dt^2(1 - a/r) - r^2(d\theta^2 + \sin^2\theta d\phi^2) - dr^2/(1 - a/r),$$

on the ground that it is one of a very large number of forms which satisfy the Einstein conditions. He cites some of the other possible forms for the relation between the length element and the four co-ordinates (r, θ, ϕ, t), and indicates the various consequences which ensue according to the particular form adopted.

At this point we encounter, as M. Painlevé points out, a serious difficulty; but it is a difficulty which is present in all scientific investigations. The botanist plotting on paper the results of experiments which were designed to discover the relation between two variables, x and y, is faced by the same problem when he decides on the method to be adopted in interpolation. For his experiments merely tell him that, whatever the relation between the variables may be, the function connecting them must be such that when $x = x_r$, we also have $y = y_r$, where (x_1, y_1), (x_2, y_2) . . . (x_r, y_r) . . . (x_n, y_n) represent, roughly speaking, the results of his experiments. But the number of his observations is necessarily finite; and it is evident that there are at least as many functions satisfying these conditions as there are points in the mathematical continuum. This difficulty of choosing between a set of functions all of which satisfy the data of the problem presents itself at several critical points of the Einstein theory. It is entirely plain that if science is to be possible, some further principle is required.

The Simplicity Postulate.

In the face of this difficulty, it has been the practice of scientific writers to choose the simplest function available. The question of what constitutes simplicity, or rather the question of when one function is simpler than another, is a difficult one, but in ordinary scientific work, and especially in biology, the term is considered to be well understood. In selecting the simplest alternative, no one, of course, would hold that the other alternatives are impossible. Indeed, the simplicity criterion arranges the various possibilities in serial order. If the first of this set afterwards proves unsuitable, the next one is taken, and so on. Thus, in outline, we may say that the procedure of science is to attach probabilities to the various functions in such a way that the probabilities of functions arranged in order of simplicity decrease rapidly to zero, so that there is little probability of any of the more complicated functions which could be devised being the correct one.

In criticising this procedure from a logical point of view, it will be of no avail to demand, at the outset, a definition of the relation involved in the proposition that one function *is simpler than* another. Common sense uses the notion of simplicity, and we cannot go behind common sense. The business of the logician is to interpret it and relate its various beliefs *inter se*, eliminating when necessary the less fundamental beliefs in favour of those which are held more firmly and the deductions which can be drawn from these beliefs. But this absence of definition makes it important to consider the way in which the simplicity postulate is used in relativity theory. M. Painlevé discusses some of the alternative forms for the length element, to which he sees no objection. He shows that some of them carry with them consequences as to the change in dimensions of a moving body which are mutually inconsistent and in direct contradiction to the Einstein theory. It may therefore be possible to make a choice between some of them by means of data of this kind, and consequently to settle the controversy as to the form of ds, at least to the extent of eliminating those forms which give certain types of change in the dimensions of bodies in motion. M. Painlevé states that he considers some of his forms to be as simple as the form adopted by Einstein. In the absence of a decision being reached by means of further data, the objection of M. Painlevé will fall to the ground only if it is established that the form which Einstein has used for the length element is the simplest one which fits the facts of the external world.

The Value of Comprehensiveness.

There is another logical property which enables us to assign a value to rival scientific theories. In choosing between various ways of relating facts *inter se*, we shall evidently prefer theories which group together the largest number of facts under one set of assumptions. Comprehensiveness is, indeed, an important test of the value of a theory, for as the number of facts which are linked together by a theory increases, the theory grows in importance as a

[1] Paper read before the Congress of Philosophy in Paris on December 29, 1921.

[2] "La Mécanique classique et la théorie de la relativité," October 24, 1921; "La Gravitation dans la mécanique de Newton et dans la mécanique d'Einstein," November 14, 1921.

hypothesis, and is of greater value as a guide to the selection of future researches. The recent developments of the theory of relativity due to Profs. Weyl and Eddington are of considerable importance as examples of the value of increasing the range of a theory. Weyl has generalised the geometry used by Einstein in order to produce a function which can conveniently be made to represent the electro-magnetic energy tensor; and Eddington, in accordance with the methodological considerations mentioned above, has suggested still more radical generalisations, with the view of producing, if possible, some function which can be used as an electronic energy tensor. By this we mean a function which contains at least analogues of the main properties of the electron. Towards this very important result Eddington has taken several significant steps, though the physical aspect of this part of the energy of a system, associated with the non-Maxwellian forces, is by no means clear at present. It will obviously be a matter of the greatest importance if it proves possible to cover the electronic phenomena as well as the gravitational and electro-magnetic by a few perfectly definite general assumptions of the same type as those already introduced in relativity theory.

Among the results obtained by Eddington, we may direct attention to the fact that a natural unit of action has made its appearance in terms of which both the energy tensor and the electro-magnetic tensor can be expressed. It appears that this unit of action is 10^{114} times the quantum required in the quantum theory, but the fact that the two energy tensors, which so far have been treated on the lines of world geometry, can be given in terms of the one unit of action may well suggest further developments which may accomplish ultimately the introduction of a tensor to represent the electronic or non-Maxwellian forces.

But let us consider how these advances have been brought about. On Weyl's theory, it is possible that comparisons of length at different times and at different places may yield discordant results according to the route of comparison. In fact, a particular standard of length should apparently be used only at the time and place where it is, for in general, a vector will change its value on describing a circuit. The fundamental apparatus required for measurement is therefore no longer, as in the days before relativity, a unit standard, or indeed, a set of standards, one for each point of space, but a set containing a unit for each point of the fourfold manifold of space and time. Such a system of measures, comprising a fourfold series, is called a "gauge system" in Weyl's theory. In this analytical scheme, however, zero length is unique, and involves no specification of route. But Eddington, with his idea that it may be possible to introduce non-Maxwellian forces into the schema, further generalises this theory by allowing that zero length may not be unique.

In allowing the generalised idea of measurement of Weyl, and of course, still more in countenancing the suggestion of Eddington, we are abandoning a well-established belief in common sense; and indeed, this is the crux of the matter from the point of view of ordinary life. But this is, of course, not the first time that the theory of relativity has asked us to throw away the beliefs of everyday life. These theoretical developments—and, in fact, the whole of relativity theory—have attained so great a degree of complexity that they have far outstripped the powers of deduction possessed by naïve common sense; and this is so in spite of the fact that they, in common with all other branches of physics, started from ordinary common-sense data. The difficulties, from a common-sense point of view, of the theory of relativity, of which we unfortunately hear so much, are due in great measure to the fact that, owing to the extensive analytical development, the postulates from which it starts have no obvious connection with the physical facts which the theory is designed to correlate. Tensors, for example, involve quantities to which no simple physical significance can at present be attached. But even the concept of energy, which has long since taken its place as a physical idea, must at one stage of history have been a difficult idea to the natural philosopher previously limited to concepts such as force. The concept of *action*, as used in the quantum theory at the present time, is scarcely one which the physicist, left to himself, would readily employ, unless it is regarded as being invariably an angular momentum. The Lagrangian idea of *generalised co-ordinates* in dynamics is another case of the same kind. The concepts employed in relativity are at present remote from physical ideas in exactly the same way, though perhaps to a greater extent.

The Theory of Relativity and Common Sense.

In mathematical theories, not infrequently the logical links between the premises of the problem and the results deduced from them are so many in number that no connection can at first sight be seen between them. In fact, the greater the number of links the more valuable the theory becomes. The purely mathematical background of the theory of relativity consists largely of developments which belong to highly specialised domains; and it is not to be expected that common sense can foresee the results obtainable from specified assumptions which the data of common sense have been found to require. Indeed, we might point out that it is apparent from the mere fact that the tensor theory has been built up into an extensive branch of mathematics (which, of course, happened long before its applications were dreamed of) that the connection between the premises and the results is too complicated to be dealt with without the aid of a specially elaborated technique. It is therefore impolitic to advance common-sense criticisms of the various assumptions as to length which may provisionally be advanced in the theory of relativity with the definite object of effecting further comprehensive correlations of physical facts. For common sense, having provided the jumping-off ground, has a severely restricted part to play in the more technical analysis which the logical development of these assumptions requires; and it is at once the marvel and the allure of the science of our day that mathematics, which is but the child of common sense, has been able, owing to the masterly researches carried on by the pioneers of the nineteenth century, to transform the crude views of her parents into the triumph of modern physics.

Current Topics and Events.

THE Rothamsted Experimental Station has taken over the Stackyard field, Woburn, which for many years was held by the Royal Agricultural Society of England, and proposes to continue the experiments on wheat and barley in close association with the work at Rothamsted. Although the Royal Agricultural Society thus gives up its experimental farm, it is gratifying to know that the Society does not intend to break its connection with scientific research; it has set up a Research Fund and a Committee to initiate or receive schemes for investigation, and it proposes to carry out its experiments on the farms of its members. In the first instance four problems will be studied:—(1) The value of ground mineral phosphates, more particularly in the improvement of pasture. (2) The use of various forms of lime on grass and tillage crops. (3) The use of wild white clover, wild red clover, bird's-foot trefoil, etc., in laying down land to grass. (4) The profitable utilisation of whey. We welcome this further evidence of the recognition now widely accorded by farmers to the necessity for further research work in agriculture, and we trust that fruitful means of carrying out such work will be found. There are certain difficulties which should be pointed out. Unless the programme of work and the actual experiments are closely supervised by scientifically trained men, there is great danger that the results may be incomplete, giving much less information than might otherwise be obtained. Without a carefully-drawn-up programme something vitally important is liable to be left undone, or some observation omitted, and in agricultural investigations lost opportunities rarely recur. Moreover, there is a real danger of overlapping; at the present moment there are already two separate bodies studying the effects of mineral phosphates on grassland; fortunately they have co-ordinated their efforts. Neither of these difficulties is insuperable and we have little doubt the Committee will be able to overcome them.

SCARCELY any department of scientific research is of such general interest as that which concerns prehistoric man, his development during the Ice Age and the changes then taking place in the conformation of land and sea. Yet, with the exception of the Institute of Human Palæontology in Paris, which was generously endowed by Prince Albert of Monaco, there has been hitherto no special centre for the investigation of this deeply interesting and important period. A public institution for study of the Ice Age has now been established in Vienna in connection with the Natural History Museum of the Austrian Republic, and every effort will be made to investigate the phenomena of the Ice Age on a broad scientific basis. The geographical position of Vienna renders it well adapted for this purpose, since the land structures associated with the glaciation can be studied in the near vicinity and observed in their ancient relations to the environment of pre-historic man. Lower Austria has already furnished a rich store of ancient stone implements and weapons. The Vienna Institute is under the able leadership of Dr. J. Bayer, director of the anthropological and ethnographical collections. Dr. Bayer's papers, in which he demonstrates the existence of no more than two distinct periods of glacial conditions, may be said to have created a new basis for this field of research. Dr. Bayer is assisted by a distinguished group of colleagues, and it is hoped to extend the circle of workers to include those in other countries who are devoting themselves to research on this period. Any such are freely invited to enter into communication with Dr. Bayer at the Natural History Museum, Vienna, who will be pleased to give fuller information as to the present activities of the Institute.

THE *Daily News* for March 3 contained an article of three columns by W. B. W. on the constitution of the atom according to the nuclear theory and the disintegration of the atoms of the lighter elements which has been effected recently by Sir E. Rutherford and Dr. Chadwick. The results of their work were recorded in the November issue of the *Philosophical Magazine*, and Sir E. Rutherford gave an account of them in his address to the Chemical Society a few days ago. We welcome the appearance of articles on scientific subjects in the daily press, as they furnish one of the best means of keeping the public acquainted with the interesting work which is being done. There is a tendency, however, in such articles to represent each development as a sensational one, and the public gets the impression that the foundations of science are overturned every month or two. It is not in the interests of science that such a false impression should be produced, and we see no reason why a sensational turn should be given to an article on a scientific subject while an archæological discovery is allowed to speak for itself. There is room in the daily press for a regular series of articles on scientific subjects to maintain the tradition established by Lord Rayleigh and Sir Ray Lankester a dozen years ago.

THE British Non-Ferrous Metals Research Association has just issued its second annual report. During the past year the membership of the Association has increased very largely, the principal trade associations having joined it. The programme of research work which has been undertaken is very extensive and has been divided among various university and national laboratories and individual firms having the necessary equipment. The influence of impurities on copper, the polishing of metals, atmospheric corrosion and methods of joining metals, are among the subjects now being investigated, and considerable progress has been made in dealing with some of them. At the second annual meeting, held in Birmingham on March 3, and preceded by a luncheon, the progress of the Association was surveyed. Vice-Admiral Sir George Goodwin, Dr. Rosenhain, Sir Henry Fowler, and Sir Frank Heath were among the speakers, who emphasised the importance of co-operative research of this kind to the metal industry. The policy of the Association is not confined to the solution of imme-

diate works problems, but involves a thorough study of the fundamental properties of the principal non-ferrous metals and alloys. In the adoption of such a far-sighted policy it is certain that the Association has taken a wise step, since the more important advances in industrial progress are usually the result of research on fundamental problems rather than on the overcoming of minor difficulties.

AN explanatory statement on the Navy Estimates has been issued by the First Lord of the Admiralty as a White Paper (Cmd. 1603). In a detailed account of the reductions in the various votes which go to make up the estimates, Lord Lee announces that the expenditure on education and scientific services in the Navy is to be reduced by 122,000*l*. The Admiralty is of opinion that a more drastic reduction would be undesirable at a time when it is hoped that the Navy will make up in quality of *personnel* and superiority of technique for the lead that has been surrendered in respect of *matériel*. The importance, and the previous inadequacy, of scientific research was clearly demonstrated during the War, and the Admiralty is convinced that the measures which it has taken are not more than sufficient to maintain research and experiment on a sound though economical basis.

THE Summer-Time Bill was read for a second time in the House of Lords on March 9. The measure provides that summer-time shall begin on the night of the last Saturday in March (unless the next day be Easter Sunday), and come to an end on the first Saturday in October. This year, therefore, summer-time will come into force at 2 o'clock G.M.T. on the morning of Sunday, March 26, and will continue until 2 o'clock G.M.T. on the morning of October 8. The French Chamber of Deputies on March 9 voted against the adoption of summer-time, but afterwards accepted an amendment to introduce it this year on account of arrangements already made with Great Britain and Belgium. The Senate agreed on March 14 to adopt this course, but prefects are to have local option of following the old time.

PROF. M. PLANCK has been elected a foreign member of the Swedish Academy of Sciences, Stockholm.

SIR ERNEST RUTHERFORD, Cavendish professor of experimental physics in the University of Cambridge, has accepted the nomination of the council of the British Association to be president for the annual meeting to be held at Liverpool next year.

ON Tuesday next, March 28, at three o'clock, Dr. J. W. Evans will begin a course of two lectures at the Royal Institution on "Earth Movements." The Friday evening discourse on April 7 will be delivered by Sir Ernest Rutherford on "The Evolution of the Elements."

WE record with deep regret the death on March 19, at sixty-one years of age, of Dr. G. B. Mathews, formerly professor of mathematics, University College of North Wales, and for many years a much esteemed contributor of reviews and articles on mathematical subjects to our columns.

DR. O. STAPF, who has been keeper of the Herbarium and Library at the Royal Botanic Gardens, Kew, since 1908, retired on February 28, having reached the age limit. He is succeeded as keeper by Mr. A. D. Cotton, formerly a member of the Herbarium staff and lately mycologist to the Ministry of Agriculture and Fisheries.

THE following were elected fellows of the Royal Society of Edinburgh at the Ordinary Meeting on March 6:—Mr. C. L. Abernethy, Prof. G. Barger, Sir Dugald Clerk, Dr. F. A. E. Crew, Dr. W. O. Greenwood, Mr. W. A. Guthrie, Prof. R. K. Hannay, Prof. E. Hindle, Dr. C. F. Juritz, Prof. J. C. Meakins, Mr. M. Macgregor, Dr. Bijali Behari Sarkar, Prof. H. W. Turnbull, Dr. J. Walker, Mr. J. Wilson, Mr. J. M. Wordie.

THE Anglo-Swedish Society has awarded its travelling scholarships for this year to Miss Joan Evans, librarian at St. Hugh's College, Oxford, to enable her to study the collections of early gold work in the Swedish museums; and to Mr. W. N. Edwards, of the Geological Department of the British Museum, to enable him to study the fossil plants in the museums of Stockholm, Upsala, and Lund.

A COMMITTEE has been appointed by the Minister of Health to advise on the preliminary steps to be taken in regard to the site and planning of the School of Hygiene, in London, towards the building and equipment of which the Rockefeller Foundation recently promised a gift of two million dollars. The members of the Committee are:—Sir Arthur Robinson (chairman), Sir Frank Baines, Dr. H. H. Dale, Sir Walter Fletcher, Sir William Leishman, Sir George Newman, Sir Cooper Perry, Sir Herbert J. Read, and Dr. H. Meredith Richards (secretary).

AT the annual general meeting of the Ray Society on March 9 the following officers were re-elected:—*President*, Prof. W. C. McIntosh; *Treasurer*, Sir Sidney F. Harmer; *Secretary*, Dr. W. T. Calman. Dr. B. Daydon Jackson was elected a vice-president. and Mr. E. T. Browne, Prof. E. B. Poulton, and Dr, A. Smith Woodward were elected new members of council. In the report of the council regret was expressed that it had not yet been possible to issue the first part of the fourth volume of Prof. McIntosh's "British Marine Annelids," due to subscribers for 1920, owing to delay in the execution of the coloured plates. It is hoped to publish it in the near future, and the second part of the volume, which will complete the work, will be taken in hand at once and will form the issue to subscribers for 1921.

AT the meeting of the Royal Geographical Society on March 20, the president announced that H.M. the King has approved the award of the Royal Medals as follows:—*The Founder's Medal* to Lieut.-Colonel C. K. Howard-Bury for his distinguished services in command of the Mount Everest Expedition of 1921; *The Patron's Medal* to Mr. Ernest de K. Leffingwell for his Surveys and investigations on the coast of northern Alaska. The Council has awarded *The Victoria Medal* to Mr. J. F. Baddeley for his great work on the Historical Geography of Central Asia; *The Murchison Grant* to Mr. Charles Camsell

for his Explorations and Surveys in northern Canada; *The Back Grant* to Khan Bahadur Sher Jang for his Surveys on the Indian Frontier and in adjacent countries; *The Cuthbert Peek Grant* to Mr. F. H. Melland for his Explorations in Northern Rhodesia; and *The Gill Memorial* to Mr. A. A. R. Boyce for his triangulations in the Sudan.

AT the Annual General Meeting of the Optical Society, held on February 9, the following officers and members of council were elected:—*President*: Sir Frank Dyson. *Vice-Presidents*: Prof. F. J. Cheshire, Mr. T. Smith, Mr. R. S. Whipple. *Treasurer*: Maj. E. O. Henrici. *Secretaries*: (*a*) *Business Secretary*—Prof. Alan Pollard, Imperial College, South Kensington. (*b*) *Papers Secretary*—F. F. S. Bryson, Glass Research Association, 50 Bedford Square, W.C.1. *Librarian*: Mr. J. H. Sutcliffe. *Editor of Transactions*: Dr. J. S. Anderson. *Council*: Dr. J. S. Anderson, Instr.-Comdr. T. Y. Baker, Mr. L. Booth, Mr. R. W. Cheshire, Dr. R. S. Clay, Dr. J. W. French, Mr. W. Gamble, Mrs. C. H. Griffiths, Mr. J. Guild, Mr. L. C. Martin, Dr. R. Mullineux Walmsley, Prof. A. W. Porter, Mr. J. Rheinberg, Mr. A. Whitwell. Prof. A. A. Michelson, of the University of Chicago, and Dr. M. von Rohr, of Messrs. Carl Zeiss, Jena, were elected Honorary Fellows of the Society.

THE Annual Report of the Delegates for Forestry at Oxford shows a large number of students in this subject during 1921, no less than 52 (including 2 ladies) having been awarded the Diploma in Forestry. Of these 45 obtained Government appointments. Practical work was carried out by the students in the Crown woods of Dean, Tintern, and High Meadow and in Bagley wood near Oxford. The list of published papers by members of the staff shows research mainly in insect and fungus pests.

THE annual report of Livingstone College for the year 1920–21 has recently been issued. The College is doing excellent work in training missionaries in the elements of medicine, and 36 students entered for varying periods during the session. There is now an accumulated deficit of 1021*l.* on the working of the College, and subscriptions are earnestly asked for, There is great need for bursaries of about 50*l.*, which could be offered to missionary societies or to suitable candidates to enable students to enter for the full course of the College.

IN the January number of *The Fight against Disease*, published by the Research Defence Society, an account is given of the Nottingham outbreak of smallpox down to November 21 last. The number of cases was 81, none of which proved fatal. Of these, 65 occurred in unvaccinated persons, and in none of the others had vaccination been performed within thirty-three years of the attack. All members of the Hospital and Health Department staffs in contact with the smallpox cases—some 120-130 in number—were recently vaccinated, and no member of these staffs contracted the disease.

MESSRS. BURROUGHS WELLCOME AND CO., of Snow Hill Buildings, E.C.1, have just issued another booklet, which may be had free on application. "The Right Way in Photography" gives instructions that reduce the process of taking photographs to a mere matter of routine. The booklet will prove of interest and use to those who do not need elementary instruction by reason of the various tables it contains, showing the times of development required at various temperatures, using various tanks, and various strengths of solutions; and a very long list of plates, classified according to the multiplier of the time indicated that is necessary for each.

THE *Journal des Débats* states that during a visit to the National Porcelain Factory at Sèvres the President of the Republic and Mme. Millerand were shown the operation of an experimental oil-fired porcelain kiln. Hitherto the kilns have been fired by wood (oak for the small and birch for the large furnaces), but it is pointed out that the Copenhagen factory has, for some time past, been using oil-fuel, which affords better control and necessitates only one man per kiln instead of two. The results of the experiments at Sèvres have been fully satisfactory, and although fuel oil is costly in France at present, it is thought that its application to pottery and porcelain firing may sooner or later revolutionise the ceramic industry.

THE Spanish NATURE (*Iberica*) continues to make rapid strides, and the recent double number (January 21-28) is a remarkable production in every way, many of the advertisements being excellently produced in colours. Among the contents may be mentioned a full description, well illustrated, of the new commercial university at Deusto, which is laid out and equipped on modern lines. Another interesting description is that of the largest quicksilver minefield in the world at Almadén, in the province of Ciudad Real, which comprises to-day twelve separate mines having an annual output of some 20,000 bottles of mercury of 11·5 kilos each. There are notes on the New Metropolitan Railway in Madrid; an interesting article, illustrated in colours, on geometrical anaglyphs and stereoscopic vision; a brief historical account of developments in locomotive design; some notes on the progress of railway electrification in Italy; and the usual notes from foreign sources.

WE have received a circular announcing the publication in Italy of an Encyclopædia of Science and Arts. The work, which will be entirely new and contain twice the number of articles of the present edition of the "Encyclopaedia Britannica," is to be under the direction of Prof. Giorgio Giuseppe Ravasini da Buie d'Istria, and will be prepared in collaboration with the foremost scientific authorities in Italy. Articles and information from private individuals will be welcomed and paid for, according to their value and number, in money or in one or more subscriptions to the complete work. The encyclopaedia will be copiously illustrated by ordinary and coloured plates, maps, plans, etc. The publication of the work is being undertaken by the publishing house of the Accademia "Scienze ed Arte," and all inquiries regarding subscriptions or contributions should be addressed to Accademia "Scienze ed Arte," Sezione Enciclopedia, Via Ugo Foscolo 2, Trieste (Italy).

Our Astronomical Column.

THE APPROACHING OPPOSITION OF MARS.—Mars will be closer to the earth next June than it has been since 1909; the opposition of 1924 will, however, be still closer, the distance being then almost the absolute minimum. The high south declination next June of 26°, making its meridian altitude at Greenwich only 12°, will prevent any useful work from being done in this country. The nearest approach to the earth, 0·45 astronomical units, is on June 18; a week later the autumnal equinox of the northern hemisphere will occur, so that both polar caps should be visible. The earth will remain to the north of the Martian equator till mid-September.

PLANETARY OBSERVATIONS AT SÉTIF.—M. Jarry-Desloges established an Observatory at Sétif, N. Africa, specially for planetary and lunar observations, and he has lately published a large illustrated volume containing studies of the moon and all the planets. Mercury was found a fairly easy object by day, the spots being nearly as well-defined as those of Mars. The results confirm those of Schiaparelli and Lowell, making the period of rotation 88 days, equal to that of revolution. Other observers have concluded that the low albedo, and the absence of an external ring of light when the planet is entering on the sun in transit, negative the idea of an appreciable atmosphere; this volume, however, supports the presence of occasional mist or cloud veiling some of the markings and altering their aspect. It is pointed out that the light and heat received from the sun at perihelion and aphelion are in the ratio of 9 to 4, which would make much difference in the precipitation or dissipation of cloud. Most of the markings are broad, curved, dusky streaks, some 60° in length; there are a few larger spots. The colour of the disc was generally rosy.

Drawings of Uranus show markings not unlike those of Saturn; there is a bright equatorial belt, and fairly bright belts in each temperate zone, with darker regions between them and round the poles. The markings are much inclined and curved, but exact measures are not given. It was noted that the direction of the belts changed during the night, showing that they cannot be quite parallel to the equator. Dark belts were also seen on Neptune, making in 1914 an angle of some 40° with the east-west line, and slightly curved. Neptune's satellite Triton was generally easier to see than Mimas; two fainter stars were seen on February 15, 1914, between Triton and Neptune.

There are also interesting drawings of Saturn, showing notches in the outline of the Cassini division, and in that of the crêpe ring. The markings seen on Venus were so vague and difficult that no deduction was made of the rotation period.

STARS OF CLASS A IN THE SOLAR CLUSTER.—Both Sir J. Herschel and Dr. Gould noticed a zone of bright stars, the medial line of which makes a small angle with the Milky Way. Later on, the local cluster of B stars studied by Prof. Charlier was found to mark out nearly the same great circle. Dr. Harlow Shapley and Miss Annie J. Cannon, in Harvard Circular No. 229, describe the distribution of the stars of spectral type B8, B9, A0, A2, A3, of magnitude 6·5 or brighter. The stars, 2450 in number, are plotted in galactic co-ordinates on an equal-area projection. The median galactic latitudes of the stars in each 10° of longitude are then found and marked with crosses. The resulting smoothed curve shows maxima and minima as follows: long. 50°, lat. +5°; long. 195°, lat. −6°, long. 300°, lat. +7°; long. 335°, lat. −4°. These results are considered to confirm the existence of the local cluster, but also to show the presence of some disturbing factor, possibly a separate cluster about the region of Corona Austrina. It is intended to pursue the investigation with stars of "later" spectral types, for which spectroscopic parallaxes can be found.

THE PERTH SECTION OF THE ASTROGRAPHIC CATALOGUE.—The publication of Zone −35° of this catalogue by Mr. Curlewis was noticed in this column a few weeks ago. Zone −33° has followed it after a very short interval, the arrangement being in all respects similar. It appears in 4 parts, each containing 6 hours of R.A.; they contain respectively 7393, 25,882, 21,163, and 16,365 stars. The variation in star-density with galactic latitude is again very striking; it will be remembered that the south galactic pole is in Decl. −29°, so that these zones embrace practically all galactic latitudes. The ratios of the numbers of stars in each volume to those given in the same areas in the Cape Durchmusterung are 3·5, 5·7, 5·7, 4·6 respectively. Actually the extreme ratios are 2 in poor fields near the galactic pole and 8 in rich galactic fields.

The places of the reference stars have been taken from the recent Perth Catalogue; the tables for reduction from rectangular co-ordinates are in the same form as those in the Oxford Astrographic Catalogue.

THE LIGHT-CURVE OF NOVA CYGNI, 1920.—An exhaustive discussion both of the light-curve and of the colour variation of this Nova is given in Publications of Urania Observatory, Copenhagen, 2nd Series, No. 3. The Nova was of special interest from its comparatively slow rise to maximum and its early visual detection, which enabled observations to be made on the up-slope of the curve: two photographs taken before discovery, at Kvistaber, by Mr. Tamm, and at Harvard, fully confirm the leisurely nature of the increase of light. The apex of the curve, at mag. 1·8, is very sharp. The fall of light was at first very rapid, amounting to 2½ mags. in ten days; it then became slower but still uniform for 3 months. Here it began to be oscillatory; after another 3 months the oscillations grew larger and the diminution of light slower; in the year ending 1921 Sept. the mean magnitude fell from about 8·6 to 9·7.

The colour determinations are much less consistent than those of magnitude, but they suffice to indicate that at discovery the colour was less than 2, while three months later it rose to 6 or 7, on a scale extending from 0 (white) to 10 (red). The colour at maximum was yellow. A table of photographic magnitudes for the first six months is also included in this publication. This indicates a fall of light from magnitude 2·12 (at maximum) to magnitude 10; a comparison of this table with that giving the visual magnitudes fails to indicate the rapid increase in redness after maximum which the observers noted.

SLIDES OF PHOTOGRAPHS TAKEN AT YERKES OBSERVATORY.—The beauty of the slides taken with the 40-inch refractor at Yerkes Observatory is well known, and a selected list of a hundred slides is now being offered for sale. The price asked is 62½ dollars in addition to carriage; 75 cents is charged for single slides, and double this amount for coloured slides.

Research Items.

THE BULL ACROBATS AT KNOSSUS.—In the Journal of Hellenic Studies (vol. xli. part 2) Sir Arthur Evans describes a remarkable bronze group from Knossus in Crete, representing an acrobat jumping over a galloping bull in the arena. The high action and skilful modelling of this animal are altogether unique among the relics of Minoan metallurgic craft, and for vigour and beauty this far exceeds two representations of such feats discovered by Schliemann and others. The full stretch of the bull's legs conforms to what is known as the "flying gallop" scheme, and the small figure of the acrobat, apart from the conventional attenuation of the waist, is finely executed, and even his features, though abnormally diminutive and incompletely brought out by the casting, with the sinewy development of form, due to athletic training, are well indicated. In other examples of feats of this kind the performer is usually a girl, but there can be no doubt that this figure is a male. In a representation of the same class on the bull *rhyton* it is clear that at the epoch to which it belongs, that is, about 2000 B.C., the long-horned Urus breed of cattle had been already introduced into Crete. The earlier indigenous variety, a form of shorthorn, *Bos Creticus* of Boyd Dawkins, was not well adapted for such a form of sport.

THE PALÆOLITHIC AGE IN INDIA.—The discovery of stone implements in India began with an implement found by Mr. Le Mesurier in 1861, and since that time many specimens have been found. But only two cases are known in India where stone implements have been found associated with the remains of extinct animals, in the Nerbudda and Godavari valleys, and further evidence of their occurrence in strata, the date of which can be established, is much to be desired. In the March issue of *Man* Mr. T. H. Vines reports the discovery of flint workshops in hills overhanging the North Indus valley. These consist of cores and broken chips, with a yellowish-brown fabrication and lustre. In the ravines of these hills flint knives and other tools of a white or whitish colour are found in considerable numbers. Mr. Vines suggests that the strata in which these implements are found correspond with the area in Egypt where implements of the same type have been discovered by Prof. Seligman (Journal Royal Anthropological Institute, vol. li. p. 115). The area to which Mr. Vines refers well deserves examination, as its geological character may form the basis of fixing an approximate age for manufacture of these implements.

MAN IN THE PACIFIC.—At the meeting of the British Association held in Australia in 1914 the desirability of fuller knowledge of the Pacific was advocated. In response to this appeal the Legislature of Hawaii appropriated funds to be used by the Pan-Pacific Union in defraying the cost of a Pan-Pacific Commercial and Educational Congress to be held at Honolulu in 1920. The Bernice P. Bishop Museum has now issued, as No. 7, Part I., of its publications, a full report of the Proceedings of the Congress, which are of peculiar interest. The papers now published are devoted to the question of Race Relations. In a valuable paper on "Man in the Pacific," Dr. Clark Wissler remarked on the need for such investigations as "the old Polynesian is passing the last mile-post of his career." "First, we need a geological survey of the several island groups; for the backbone of man's chronology is geological chronology. Further, we need data upon the fauna and flora of the respective islands. It is the realisation of this inter-relation of problems that underlies the conception of this congress and is its only excuse for being. You tell us the history—a relative chronology—of such plants as taro, breadfruit, the paper mulberry, etc., and the story of such mammals as the pig and dog, and of the chicken, in the islands of the Pacific, and we will soon fill in the gaps in the chronological scheme for the Polynesians."

THE AMERICAN INDIANS' KNOWLEDGE OF THE MASTODON.—In *Natural History*, the Journal of the American Museum of Natural History (vol. xxi. No. 6), Mr. J. L. B. Taylor, under the heading: "Did the Indian know the Mastodon?" describes a bone bearing an incised elephant-like figure, found in the Jacobs Cavern, Ozark Country, near Pineville, Missouri. Dr. Clark Wissler, who has examined this bone, regards the work as what might have been expected from the hand of an American native; three attempts to represent living forms, apparently by the same artist, are identified—"Two have the distinctive lines of elk and deer, while the lines of the third characterise elephant kind, and this favours the interpretation that an elephant, mastodon, or mammoth was intended. At once the objection will be raised that the bone is recent. Though the mastodon and the mammoth are characteristic of Pleistocene time, it is not known when they became extinct: for all that is known to the contrary these great mammals may have held out within 3000 years ago. . . . No one in authority seems now prepared to deny that man was in America 3000 years ago." Dr. Wissler regards this discovery in Jacobs Cavern as of great importance; "it is to be hoped that at last we are on the trail of early man in America."

BEHAVIOUR OF STOMATA.—In a significant paper on the behaviour of stomata (Carnegie Institution of Washington, Publ. No. 314) Mr. J. V. G. Loftfield has made important additions to our knowledge of the action of stomata in relation to the environmental and physiological conditions of the plant. He used the method of fixing strips of the epidermis in alcohol, supplemented by direct microscopic observation of the living, attached leaf. Many of the observations were continued every hour throughout the day and night, microphotographs showing the condition of the stomata on the upper and lower epidermis of leaves being ingeniously arranged in circles for comparison with the corresponding continuous circular records of light, temperature and humidity. Many plants were studied under different climatic conditions, and it was found that while illumination affects the action of stomata, as has long been known, yet weather conditions also control the size of the openings, and with varying water supply the stomata may change their behaviour from day to day. Some of the movements were quite rapid, from fully open to closed in less than an hour. Low morning temperatures caused the stomata to open very gradually, and even moonlight affected the size of aperture. The great majority of the stomata on a leaf behaved alike, but about 2 per cent. were functionless and 3 per cent. superfunctional, opening to twice the normal maximum. The plants studied fell into three groups. In cereals the stomata are very sensitive and never open at night. In another group, as conditions become less favourable the stomata open at night and close for a time about midday. In the potato and other plants the stomata are normally open at night and close only under conditions of high evaporation or low water-content. Light induces the opening of stomata by causing the conversion of starch in the guard-cells into sugar and so increasing their osmotic pressure. This work

shows that stomata are regulatory in their action, a fact on which earlier investigations had thrown some doubt. It indicates that there are considerable fluctuations in the water-content of a normal leaf, and that the regulation of water-loss by the stomata is very effective when they are nearly closed.

SILK WEAVERS AND THEIR OUTPUT.—In Report No. 17 of the Industrial Fatigue Research Board, Mr. P. M. Elton analyses the differences in the output of individual silk weavers. Silk weaving is a highly skilled occupation, and it takes at least two years to teach a girl to weave quickly and well. Hence it is very important that unsuitable girls should not waste their own time, and that of their employers, in undergoing training. Training has often been faulty in the past, and in consequence bad methods of work are acquired which are never eradicated. So important is the human factor for success in silk-weaving that the quickest operatives consistently produce about twice as great an output as the slowest. Mr. Elton analyses the causes of these wide variations in detail, and his report should be of great value to those engaged in teaching young weavers. A weaver has to have good eyesight, be dexterous with both hands (for in weaving both hands are simultaneously employed on very different operations), and have a delicate sense of touch. Mr. Elton has not endeavoured to determine the most suitable tests for would-be apprentices to the weaving industry, but there should be no difficulty in the choice of some of the necessary tests. A thoroughly adequate selection can only be made gradually, after much experiment, but few more fertile fields for the application of the principles of "vocational selection" can offer themselves than that of weaving.

ELECTRICAL PRECIPITATION IN INDUSTRY.—In the Journal of the Society of Chemical Industry for February 15, Dr. H. J. Bush gives an account of the industrial applications of electrical precipitation. In 1884–86 Sir Oliver Lodge carried out experiments on the electrical deposition of fog and smoke, and patents were taken out in England and other countries during those years. In 1884 Dr. Karl Moeller, in Germany, obtained an independent patent. In 1906, Dr. F. G. Cottrell, Director of the United States Bureau of Mines, then professor of physical chemistry in the University of California, repeated Lodge's experiments in connection with the removal of acid mists, and in his hands the process has been largely developed. During the war a very large Cottrell plant was in operation at the Queen's Ferry works, and an installation was designed by the Lodge Fume Co. for cleaning blast-furnace gases. Dr. Bush gives an account of these and other plants. The principle is very simple. An insulated wire hangs inside a metal tube, both being connected with a high voltage transformer, or special electrodes are hung between metal plates. The fume passes through the apparatus, and the electric discharge brings about its precipitation. The mechanism of the process appears to be somewhat obscure, and the account given by Dr. Bush is very empirical. Further scientific work will probably throw light on this interesting process. Electrical precipitation has a large field of possible applications.

SEPARATION OF ISOTOPES OF MERCURY.—In the January number of the Journal of the American Chemical Society, Prof. W. D. Harkins and R. S. Mulliken describe the experimental separation of mercury into isotopic fractions by evaporation in a vacuum. A difference in density of 133 parts in a million was obtained. A theoretical discussion of the resolution of isotopic mixtures by diffusion and similar processes is given, and equations are obtained showing the rate of separation to be expected in such processes. This work supplements previous results by other workers given in NATURE, vol. cvi. p. 144; vol. cviii. p. 209.

AMMONIA OXIDATION.—During the war the oxidation of ammonia was studied in England with a view to its application in the State factory for the fixation of nitrogen. Although the other parts of the chain of operations leading from atmospheric nitrogen to nitric acid never materialised, the process of ammonia oxidation was brought to the stage of technical application, and was taken up by different firms in connection with the supply of oxides of nitrogen to sulphuric acid chamber plants. In the Journal of the Society of Chemical Industry for February 28, Messrs. C. S. Imison and W. Russell, of the United Alkali Company, give a very interesting and detailed account of the improved process now in operation. They remark that, so far as their experience goes, there is little difference in cost between this and the old retort processes for making strong nitric acid with nitre and ammonia at present prices, but if the published estimates for the cost of synthetic ammonia are realised in this country, the balance will turn strongly in favour of the oxidation process. They also point out that the oxidation process is an integral part of the process for the fixation of atmospheric nitrogen, which, in conjunction with a fixation process for ammonia, would render this country independent of overseas supplies of nitre in the event of another war. It seems strange that, among so much legislation for "key industries," the absolutely vital problem of nitrogen fixation has never been mentioned.

RADIUM MINING.—In a circular issued by the Colorado School of Mines, entitled "A World Storehouse of Rare Metals, Radium, Uranium and Vanadium, the Paradox Field of South-western Colorado," interesting information is given of the present conditions prevailing in what is undoubtedly the richest radium region of the world. The ore mined is carnotite, a potassium uranyl vanadate of the composition $K_2O,2UO_3,V_2O_5,3H_2O$, occurring in sandstone in the San Miguel, Dolores, Mesa, and Montrose counties of S.W. Colorado. The ore, as mined, contains usually from 1·4 to 1·8 per cent. of uranium oxide, averaging some 4 milligrams of radium to the ton and 4 or 5 per cent. of vanadium oxide. Of a total of 52,000 tons produced in the U.S.A., Colorado has produced 48,700 tons, of which 38,000 tons were mined by one company, the Standard Chemical Co. of Pittsburgh. Smaller quantities have been produced also in Wyoming and Utah. The ore is prospected for by diamond drilling to a depth of some 40 feet and mined by inclined shafts and gravity tunnels. The deposits occur in sedimentary rocks, and so far are confined practically to what is known as the M'Elmo formation. Though easily recognised as outcrops, the deposits of carnotite are exceedingly variable and obey no law of deposition. They are often associated with fossil wood as "logs," in which the mineral has replaced the trunks of trees embedded in the rocks. It is concentrated *in situ*, if of less than 2 per cent. U_3O_8 content, and furnishes not only the largest present source of radium but also an important source of the vanadium, now so largely employed in the manufacture of special steels. The Colorado School of Mines maintains a special well-equipped radioactivity laboratory for the estimation and evaluation of these ores.

Growth and Sex-Factors of Racial Character.

AT a meeting of the Royal Anthropological Institute held on February 28, Dr. W. H. R. Rivers, president, in the chair, Miss R. M. Fleming read a paper on "Growth and Sex-Factors in Racial Analysis." Her results were based on a large number of measurements made, for the most part, in Wales, the measurements in the case of the children having been repeated at regular intervals.

Miss Fleming said periodic re-measurement of children during growth shows that—

1. Boys and girls have different growth cycles as regards features used in racial analysis;
2. Head breadth commonly increases more than head length, so the cephalic index usually rises during growth. Cephalic index of girls rises most quickly between the third and eighth years, while in boys it does so especially after the tenth year. Changes of one unit in one year were general, and larger changes frequent;
3. The frequent darkening of hair and eye seen in both sexes shows the same difference of period, and also confirms the results of Pryor's work on ossification of wrist bones;
4. There are clear correlations between facts of physical growth and mental development, and these correlations should influence educational methods.

British women show more development of pigment, brachycephaly, and prognathism than do men. Sixty per cent. of any normal sample of men have cephalic index 75-79; nearly the same proportion of women have indexes 77-81. Men outnumber women under 75 and women enormously outnumber men over 84. Men have the glabella stronger and women the occiput larger in most cases, but this does not account for the difference, which is one of growth.

Among the types noted are the following:

a. Dark-haired, dark-eyed women, head length 181-193, head breadth 143-154, cephalic index 77-81, calvarium rather low, prognathism slight or absent, forehead usually full, occipital prominence marked and low.

About 50 per cent. of the sample of women studied possessed most of these characters, and they were very marked among the Welsh people. This group corresponds with Fleure's group of men of indexes 75-79, dark colouring, but the women show greater heterogeneity;

b. Dark-haired, dark-eyed women, head length 187-199, head breadth 137-148, cephalic index 76 or less. Bony development more marked and head height greater than in "*a*," forehead more often receding, prognathism often marked. A remote hill country pedigree is common for this type, and one often finds flattened nostrils, deep-set eyes, hair low on the forehead. A few are darker in youth than later on. Intellectual distinction is frequent.

c. Light-haired, light-eyed women, head length 180-192, head breadth 145-153, but measurements a little lower in general than in "*a*" and "*b*." Prognathism absent or very slight, bizygomatic breadth small, face long, calvarium finely arched, forehead often retreats, bones strong, stature averages 3 inches more than in "*a*" and "*b*." Type less frequent than "*a*" and "*b*" among purely Welsh peoples.

d. Fair longheads, very narrow, breadth about 132-137, low foreheads, slight build, low vitality.

It is not suggested that this group has any historical or racial significance. The fair and dark broadheads have not yet been examined in sufficient numbers to warrant discussion, especially as the analysis of male broadheads has not yet proceeded very far.

A discussion followed the reading of the paper, in the course of which Prof. Parsons pointed out that Miss Fleming's work corroborated the results which he himself had obtained both as regards the conclusion that the breadth of head of women was greater than that of men in the corresponding series, and that women were darker. Prof. Fleure said that Miss Fleming's work represented a real advance in the attempt to provide a sure foundation for physical anthropology, while it showed that the conclusions of Prof. Boas as to the change in head form of immigrants in the United States were unsound. Several speakers emphasised the importance of Miss Fleming's results for the educationist in connection with the classification and grading of children of both sexes.

Mortality Tables.

THE Privy Council Medical Research Council has published as the sixtieth of its Special Report Series a valuable memoir by Dr. Brownlee, the director of statistics of the council, on the use of death-rates as a measure of hygienic conditions (H.M. Stationery Office, 1922, 80 pp., 3*s*. net). Some of the methods employed for that purpose are likened by Dr. Brownlee to those of the tailors of Laputa. He divides the subject into two parts: (1) death-rates in general and (2) mathematical treatment, and illustrates it by 30 tables and 16 diagrams. On special points he has had recourse to Sir Alfred Watson, whose great experience in the construction of mortality tables must have been valuable.

The crude death-rate on a large population requires adjustment and correction. When applied to sections of the population, as to those dwelling in certain districts or those engaged in specified occupations, the liability to error is greatly increased. The method by which these are corrected is called "standardising."

For the purpose of life-tables the death-rate is taken to signify the ratio of the number of deaths of persons above any defined age, to the number living above that age, in a stationary population. They show some disadvantage in using standardised death-rates. So far back as 1875 the late Dr. Wm. Farr was sensible of this difficulty, and devised a method for meeting it, which Dr. Brownlee considers to present great advantages. Prof. Karl Pearson held that causes of death might be specially grouped to correspond with periods of life. Dr. Brownlee gives a re-drawing of Prof. Pearson's diagram (Trans. Roy. Soc., 1894) representing the curves for infantile mortality and the mortality of childhood, youth, middle age, and old age respectively.

The tables of Dr. Farr, based on returns from 1861 to 1870, provide information as to causes of death for selected districts according to sex and age. Later tables calculated by Mr. George King, the eminent actuary, show that the same conditions still hold. Dr. Brownlee supplies a table giving a summary of observations in various districts from 1838 to 1912, and comparing the standardised death-rates with the life-table rates for each observation. Though a life-table death-rate is the criterion of ultimate

importance, he arrives at the conclusion that there is a direct relation between it and a standardised death-rate. This is confirmed by some calculations made by Mr. Finch. Applying the death-rates at each quinquennial period of age to a standard population adjusted so as to be in arithmetical progression, for which purpose the mean population for the decade 1891–1900 was adopted, the errors appeared to be remarkably small.

Dr. Farr held that density of population and death-rate were closely connected. The difficulty has arisen in applying the two to London, which possesses a greater absolute healthiness than its density would suggest. May we not infer that this is partly due to good management and sanitary conditions?

It is less easy to get trustworthy generalisations where the numbers are small. Dr. Brownlee supplies a valuable series of tables of the numbers living and the expectation of life in selected healthy and unhealthy districts for use in calculating the death-rate from various diseases. He infers from them that persons who died at the age of fifty-one years in the average environment might have had a life of seven years longer in the mean had they lived in the country.

Proceeding to the consideration of the effect of particular diseases, Dr. Brownlee takes (1) Phthisis. The age at which phthisis causes death is shown to vary greatly in different districts. (2) Sarcoma and cancer. Here for an equal number of deaths the age at death is shown to be later where the conditions are healthier. (3) Valvular disease of the heart. This seems to behave in much the same way. (4) Diabetes. Here, whether a person lives in a rural district or in a county borough, the commonest age at death is the same. (5) Nephritis. This is much less prevalent in rural than in city districts. (6) Pneumonia. Deaths from this are least in rural districts. Care has to be taken in dealing with the three elements of the problem, age, environment, and disease.

In pt. 2, relating to the mathematical treatment of the subject, Dr. Brownlee seeks to give directions for calculating life-table data by short and easy methods. Those desirous of making inquiry into health conditions will, however, have to bear in mind the many pitfalls that they may meet in so delicate an investigation. Dr. Brownlee's authoritative and suggestive report will enable them to avoid the danger of hasty conclusions.

Population Maps.

THE possibilities of the quantitative representation of geographical data as regards population distribution are discussed in some detail by the originator of a new method, Mr. S. de Geer, in the *Geographical Review* for January. Mr. de Geer has already applied the method in the recently published atlas of the distribution of population in Sweden. In the ordinary map the position and size of cities and smaller centres are shown by dots. A further development is to show relative density by shading or colour-tints of varying depths. The chief defect of such maps is that, as a rule, they show only the average over large areas such as counties or parishes.

The dot method of Mr. de Geer offers the possibility of combining a clear representation of situation and a mass of population within wide limits. The dot represents a unit of population of fixed value; the larger the scale of the map the smaller the unit. On a scale of 1 : 100,000 a dot might represent ten persons; on one of 1 : 80,000,000 perhaps a million persons. The unit-dots are considered as small spheres, and should be shaded as such, but this involves expense and difficulties in printing; they are therefore drawn solid black. Small towns are shown by groups of dots arranged in squares, rectangles, or other figures corresponding roughly with the extent of the settlement. Such regular arrangements at once differentiate urban centres from rural communities. Large centres cannot well be shown by dot-nets because of the space required. Urban populations about a certain number, varying with the dot-unit chosen, are shown by large spheres the volume of which is proportional to the unit-dot and decided by the population of the centre. Thus in the Swedish map the unit-dot, representing 100 persons, has a radius of 0·57 mm., and the sphere representing Stockholm (371,000 inhabitants) has a radius of 8·9 mm. These large spheres are shaded to give a spherical appearance. As the quantitative value of the larger sphere is not readily estimated, it is expressed in units printed on or beside it.

Much geographical judgment must be used in the placing of the dots, especially in rural districts. The population of isolated farms and small hamlets has to be gathered into groups of 100 if that is the unit chosen. The dot is placed either at that place with more than half this number of inhabitants or, if there is no such place, near the centre of gravity of the group. Due regard must also be had to the density of neighbouring groups, particularly near administrative boundaries. The map is further improved by tints of colour distributed to show relative density of population. Mr. de Geer rightly claims that such a population map has many practical applications in questions of the readjustment of administrative boundaries, of the establishment of public institutions, of lines of communications, of the location of educational facilities, of the stationing of officials, and in other directions.

The International Fishery Investigations.[1]

THE International Council for the Exploration of the Sea met at Copenhagen in July last, and the official account of the proceedings is now available. An unofficial report, with some criticisms, has also been published by M. Ed. le Danois. At this meeting Belgium, Denmark, Finland, France, Great Britain, Holland, Norway, and Sweden were represented, and negotiations are in progress for the inclusion of Spain, Portugal, Esthonia, and Lettonia. The Governments of Canada, Newfoundland, and the United States have meanwhile adopted a joint scheme of oceanographical investigations, and contemplate "establishing contact" with the European organisation.

The official report summarises the proceedings of the council, the sections, and committees; the latter relate to investigations on the herring, cod and haddock, plankton, hydrography, limnology, statistics, the Atlantic slope, the Baltic, and the plaice. Programmes of the researches contemplated in each of these subjects are given, and there are indications of the share taken by each country and of the limited progress that has been made. So far little has been published. M. le Danois's unofficial report is, in part,

[1] Rapports et Procès-Verbaux des Réunions: Conseil International, Exploration de la Mer, vol. 27, Copenhague, December 1921.
Notes et Mémoires, No. 11, Office scientifique et technique des Pêches Maritimes, Paris, December 1921.

critical. He finds the methods that have been adopted by the council much too theoretical and too purely scientific. He hopes much from the British delegates, who also wish to see the work directed more strictly towards the treatment of practical problems. These reflections are very interesting.

The first practical outcome of the fishery investigations is the report of the Plaice Committee. For twenty years the question of the depletion of the plaice-stock of the North Sea has been under investigation, but the study of the post-war conditions has now hastened consideration of all the evidence. The workers associated with the International Council hold that a progressive impoverishment was in progress up to the year 1914, and that the great restrictions on fishing due to the war arrested this decline and restored the plaice population of the North Sea. They ask that restrictions on fishing should be imposed so as to prevent the recurrence of the pre-war overfishing. They recommend that the North Sea between latitude 52° and 56° and within the Continental coast and the 12- or 15-fathom contour line be closed to steam trawlers and high-power motor vessels for the whole or part of the year. They also recommend transplantation of small plaice from this closed area to the Dogger Bank.

The fishing industry strongly opposes any restriction on fishing outside the three-miles limit, and it is now evident that this objection will be fatal to the adoption of the recommendations of the Plaice Committee. Any restriction of this kind is bound to lead to decreased profits or earnings at the time of its imposition. As a rule traders take a very short view of the circumstances in question, and are not inclined to make personal sacrifices in order that future generations of traders may obtain advantage. They hold that the evidence available does not justify the Government in accepting the recommendations noted above. Would *any* evidence bring about such industrial altruism? It is doubtful. In the present case, however, the evidence that is available has either not been published or it is presented in such a way that it does not easily appeal to the owners of fishing vessels. Obviously, such restrictions as are indicated must be made and enforced against the strong opposition of the fishing trade and with the approval of the public, and if that is to be so, the fullest publicity should be given to all the data on which the recommendations of the Plaice Committee are based. It is understood, however, that the passion for economy on the part of the Treasury and Stationery Office is now preventing the publication of expensive official scientific reports, and, that being the case, the attitude of the trade is, perhaps, quite justifiable. J. J.

Gametic and Zygotic Sterility.

A FORM of pollen-sterility in which the anthers are aborted and the flowers fail to open is described by Dr. Bateson and Miss Gairdner (*Journal of Genetics*, vol. 11, No. 3) in flax. Some flowers produced a little pollen, and when self-fertilised gave rise only to male-sterile plants. This male-sterile form appeared as 25 per cent. of the F_2 of a cross between a procumbent variety of *Linum usitatissimum* and the pollen of a common flax. Later it was found that the sterility was determined by the pollen of this flax, the procumbent variety being genetically hermaphrodite on both the male and female sides.

In the same periodical Mr. Rudolph Beer makes a study of the cytology and genetics of Fuchsias, in which partial sterility of pollen and supernumerary pollen-grains are well known to occur. He finds that a pure species, *F. arborescens*, produces a large proportion of sterile pollen, while a cross between the distinct species *F. pumila* and *F. alpestris* shows regular pollen-development and very few bad grains. Such results have an interesting bearing on the hypothesis that bad pollen is in itself a criterion of hybridity. Some of the crosses result in "false hybrids" similar to those obtained in strawberries.

An interesting case in which ratios are altered through zygotic sterility, or rather weakness in development of a zygotic type, is described in the same journal. Mr. Bungo Miyazawa describes a dwarf type of barley which apparently arose as a mutation, and without exceptional care is capable of surviving only in the heterozygous condition. Thus dwarf plants when self-pollinated gave 2 dwarfs : 1 tall, but by careful germination of the seeds the homozygous type was enabled to survive, and was found to be an extreme dwarf which was sterile, producing no flowers.

Prof. E. M. East (*Genetics*, vol. 6, p. 311) has studied the partial sterility in hybrids between *Nicotiana rustica* varieties and *N. paniculata*. Nearly all the F_2 plants resemble *rustica*, a few are almost identical with *paniculata*, while many expected combinations of the parental characters are missing. The sterility varies from almost complete abortion of pollen and seeds to nearly complete seed fertility. This followed a condition of high sterility in F_1, in which only about 3 per cent. of the ovules were functional and only 35-55 per cent. of the seeds would germinate. The pollen-sterility of F_1 plants is even higher, probably not more than 0·1 per cent. of the possible grains from the pollen mother-cells reaching functional maturity. Many break down in the reduction divisions, and many apparently perfect grains dry up when the anther opens. Nearly all the F_2 plants show an increased fertility. The results are explained in terms similar to Goodspeed and Claussen's hypothesis of reaction systems. In brief, certain chromosome combinations are non-viable or produce offspring in which again only certain recombinations can survive. Prof. East suggests that many cultivated plants have originated from similar crosses in which a high degree of sterility has been followed by greater fertility in certain surviving strains.

Further light has been thrown on the sterility in wheat hybrids by the fact that the different types of wheat fall into three groups, which appear to have multiples of 7 as their chromosome numbers. Dr. Karl Sax (*Genetics*, vol. 6, p. 399) finds that the pollen-grains show a corresponding increase in size, the average relative volumes being 72 for Einkorn, 94 for Emmer wheats, and 114 for *T. vulgare*. This is to be expected with an increase in chromosome-content. The results of many investigations indicate that, in general, there is fertility in crosses within each group where the chromosome numbers are the same, but more or less sterility in crosses between forms belonging to different groups. Dr. Sax finds that in fertile crosses of wheat species the F_1 grains (endosperm) are larger than in the parent—a phenomenon of hybrid vigour—but in crosses which are partly sterile the grains are small and wrinkled. The degree of sterility may be determined by the amount of grain set, or by the amount of aborted pollen. There is much variability in the size of pollen in partly sterile F_1 hybrids, which is probably due to irregular chromosome distributions. R. R. G.

Some Aspects of Cotton Growing.

THE great importance of the cotton crop in certain countries has led to special attention being paid to the deterioration in yield and quality that occurs in certain areas and to methods whereby improvements may be effected.

In Egypt (Bull. Imperial Inst. 19, No. 2) the decline in yield may be attributed chiefly to degeneration of the productive power of the soil, the ravages of insect pests, and to agrarian disturbance. To give satisfactory crops cotton, should be grown only once in a three-year rotation, but this limit has frequently been exceeded, with the natural result that the soil ingredients have been drawn upon unevenly, thus upsetting the balance of fertility. This could have been remedied by the judicious use of fertilisers, but for various reasons this has not been carried out. Even where manures have been used much harm has been done by the introduction of noxious substitutes by unscrupulous dealers. Excessive cotton cultivation has also been encouraged by the practice of leasing land for short three-year periods, the highest rents being paid to landowners who permit the greatest amount of cotton to be cultivated within the period of the lease without insisting on the re-establishment of the fertility of the soil for future tenants.

Another harmful factor is the prevalence of water-logging. Since the Assuan Reservoir came into use, more water has been available for irrigation, and in addition the water table has risen, so that the drainage is now imperfect, and the roots of the cotton plant suffer from asphyxiation due to the consequent lack of air supply. The damage is aggravated by harmful salts which are now brought into solution near the soil level, and by surface evaporation remain within the area of growth of the cotton roots.

Until about 1912 the cotton worm was the most serious insect pest, but was eventually brought under control. Of recent years the pink boll-worm, first discovered near Alexandria in 1911, has become of paramount importance owing to its rapid spread through nearly all the cotton-growing countries of the world. Its life-history and habits rendered impossible the production of late-maturing cotton, as the late-formed bolls are badly attacked and the lint rendered useless for spinning purposes. Legislative measures are now in force for the uprooting and burning of the cotton plants before the end of the year, and for the treatment of the seed by hot air, whereby the resting worms are destroyed while the germinating power of the seed is not affected. It is hoped that the attacks of each pest will thus be reduced, and that the yield of cotton will, in consequence, be increased.

Agrarian disturbances have also caused much trouble, as the cultivators joined in the destruction of the means of transport, whereby difficulties arose in marketing the cotton and also in connection with seed distribution for the next season's crop.

Deterioration of quality has been considered in the case of Cambodia cotton (*Gossypium hirsutum*) grown in India (*Agric. Journ. India*, vol. 16, part 3). For some years after its introduction in 1907 the quality of its lint was good, but of late years it has been asserted that the lint is shorter, weaker, and much more stained than was the case at first. The weakness and staining are attributed to attacks of the pink boll-worm, and the loss can only be cured by the reduction of the pest. The shortness of staple, however, is due to the fact that the first seed distributed included a mixture of types. The early and more vigorous types, with poorer quality staple, were the better suited to the climate and to the rather haphazard methods of cultivation, and therefore flourished at the expense of the better quality types with longer staple. The line of improvement it is proposed to follow is that of isolation of types by means of single-plant selection and self-fertilisation, followed at a later stage by hybridisation to produce a type combining in itself all the most useful characters. If a more productive type can thus be produced and the loss caused by insect pests be controlled, considerable increase of yield per acre may be secured.

In this connection attention may be directed to an article on the commercial utilisation of cotton stalks (Bull. Imperial Inst. 19, No. 1). Enormous quantities of stalks are available after the crop is harvested, and as they afford harbourage for insect pests their destruction is of much importance. Locally the stalks are used as fuel, and in some districts supplies would not be available for other purposes. A fibre resembling that of jute, however, can be obtained from the bark, and possibly the longer fibre might be used as a substitute for the lower grades of Indian jute, and would probably realise rather less than half the price of Bengal jute.

Preliminary paper-making trials indicate that when treated by the caustic soda process, Indian cotton stalks yield paper pulp of fair quality which can be bleached to a pale cream tint, and the results are promising enough to deserve further consideration on the spot in India. Distillation experiments have also been carried out both in Egypt and England; good quality methyl alcohol and acetate of lime have been produced, but the charcoal and tar are of less value. In India the feasibility of distilling cotton stalks successfully would depend upon finding local markets for the products, particularly the charcoal and tar.

The Geographical Distribution of the Palm Pritchardia.

THE Bernice Pauahi Bishop Museum of Honolulu has recently issued (Memoirs, vol. 8, No. 1) an elaborate monograph of the palm genus Pritchardia by the late Prof. Odoardo Beccari and Prof. Joseph Rock. It is mainly the work of Prof. Beccari, and forms part of a larger monograph which he had prepared for later publication in the Annals of the Calcutta Botanic Garden. The material for the monograph has been largely supplied by Prof. Rock, who has discovered twenty-one of the thirty-three species described.

The study of the genus is of special interest from the point of view of geographical distribution. It is one of the most characteristic genera of palms of the Polynesian flora, but has attained its greatest development in the Hawaian Archipelago, where it is the only palm found. It also supplies one of the most interesting problems in the geographical distribution of the family in the existence of a single species in the New World, namely, in Cuba and the Isle of Pines. This may be compared with the presence in South America of a representative of the African genus Raphia and of the solitary representative of the typical American Cocoineæ, namely Jubæopsis, in South Africa. How the fruits of the progenetrix of the Cuban species were enabled to cross the wide space of ocean between the nearest Polynesian islands and the American continent is a mystery. Prof. Beccari suggests the possibility of the transfer of fruits by means of the violent volcanic phenomena which

must have occurred during the elevation of the Andean ranges; at such a time a water communication may have been established between the two oceans and the fruits of a Polynesian Pritchardia deposited on an island in the Caribbean Sea.

The fruits, which are plum-like in structure, but with comparatively little flesh, vary in the different species from the size of a large pea to that of a date. The smaller ones would attract pigeons, which, though now unknown in Hawaii, may at some time, when greater land connections existed between the remoter islands of eastern Polynesia and those of Papuasia and western Polynesia, have contributed to stock the islands of the Hawaian group. But there is still the difficulty of explaining the presence of large-fruited Pritchardias on the most inaccessible summits of the mountains of Hawaii. Prof. Beccari suggests that these represent a surviving element of the vegetation which covered the plains before the cataclysms which resulted in the elevation of the present mountains and broke into fragments the originally much more extensive land area. The monograph is illustrated by twenty-four plates, mainly reproductions of photographs taken by Prof. Rock.

Agricultural Experiments at Ithaca, N.Y.

THE Report of the Agricultural Experiment Station of Ithaca, N.Y., for 1919 contains a number of memoirs of considerable interest, especially from the botanical and entomological points of view.

Work on the stimulation of growth by various chemical compounds indicates that treatment with potassium permanganate may result in a very marked increase in the root-growth of various woody cuttings. Other compounds of manganese, iron, and boron may show at times a slight stimulating effect, but nutrient solutions are, as a rule, injurious to the root-growth of cuttings. In another paper the effect of manganese compounds on soils and plants is discussed. The general conclusion reached is that with wheat, manganese salts presented in high concentrations exert a toxic effect, but in lower concentrations a marked stimulation is observable. When added to soil, manganese salts were found to form manganese dioxide in proportion to the basicity of the soil and to develop a power to oxidise organic matter.

In genetics two papers deal with chlorophyll inheritance and aleurone colour in maize, and another with the weak awn in certain Avena crosses. In some crosses of awned and awnless varieties (as Burt and Sixty Day) there is an almost complete dominance of the awnless condition, the factor for awning being apparently prevented from operating by an inhibition which is closely linked with the factor for yellow colour in the variety concerned. Environment seems to affect the production of awns, and observations suggest that an increase in the moisture-content of the soil and of its organic matter and nitrogen tends to decrease the number of awns.

Soil conditions are dealt with in memoirs on the translocation of calcium and on the reversibility of the colloidal condition of soils. In the first case it was found that the translocation of calcium through a clayey silt loam soil with a rather large lime requirement is extremely slow, since in the experiment no upward or downward movement of this element was perceptible twelve months after various amounts of calcium salts had been applied to the soil. In the second case it was demonstrated that drying a surface soil once produces as much effect in the colloidal material as repeated dryings alternated with moistenings, the drying producing a change in the colloidal material from which it does not immediately recover on being wetted. The drying indirectly affects the reversibility of its colloidal condition, the change being directly produced through biological and chemical action.

On the bacteriological side attention is directed to the effect of low temperature on soil bacteria and to the number and types of bacteria found in ice-cream during storage. In the soil there appears to be no change in the bacterial flora due to freezing, the bacterial activities being influenced only in so far as the physical properties of the soil are affected. The concentration of the medium, the length of time of exposure, and the degree of cold are the three important factors that determine the power of resistance of the bacteria to low temperature. The death of the bacterial cell when exposed to low temperature seems to be due to the withdrawal of water from the semi-permeable membrane or outer layer of the cell.

An outline is given of the life-histories and methods of control of various insects injurious to the hop in New York, special attention being devoted to the hop grub (*Gortyna immanis*, Guenee) and the hop redbug (*Paracalocoris Hawleyi*, Knight). The hop grub causes considerable financial loss, and in years when the insects are plentiful they may cause an almost total loss to some growers. The larvæ damage various parts of the vine, working in the buds, stem, and roots, thus weakening the plants in various ways. For control, clean cultivation is advised, with a ploughed border several yards wide round the field. The use of carbon bisulphide as an insecticide is unsatisfactory, but paradichlorobenzine has been successful when added to the soil of each hill in May.

The plant-lice injuring the foliage and fruit of the apple (*Aphis pomi*, de Geer, *A. sorbi*, Kaltenbach, and *A. avenæ*, Fab.) are described and fully illustrated, and the first part of a detailed systematic account of the crane-flies of New York is issued, dealing with the distribution and taxonomy of the adult flies.

W. E. B.

The Lhota Nagas.

AT a meeting of the Royal Anthropological Institute held on March 14, Dr. W. H. R. Rivers, president, in the chair, Mr. J. P. Mills, of the Indian Civil Service, read a paper on the Lhota Nagas of Assam. He said that in spite of its long contact with the plains of Assam, this tribe has retained its primitive dress and customs. It occupies a portion of the Naga Hills lying to the S.E. of the Brahmaputra Valley, and numbers some 18,000 souls. Like the Angamis, the Lhotas trace their origin to a mythical hole in the earth near the Kezakenoma stone. In dress they resemble closely their neighbours, the Aos, the men wearing a small apron and body cloths of various patterns, and the women a small skirt of very dark blue, with a light blue median band. Warriors in full dress wear human hair tails, elaborate baldricks with fringes of goat's hair dyed scarlet, and bear's hair wigs ornamented with hornbill feathers.

The villages, which are permanent, may contain any number up to 300 houses and are built on the tops of the ridges. The highest is at about 5000 feet. Each village contains one or more "bachelors' halls" in which boys and unmarried men sleep. In the middle of the village stands the head-tree, usually a *ficus*, on which heads taken in war were hung. Under it are

kept the "luck-stones" of the village, to which the Lhotas attach great importance. Other "luck-stones" are kept in the "bachelors' halls" and in the houses or granaries of individuals. Cultivation is of the shifting type known as *jhuming*, and there are numerous ceremonies connected with it.

The tribe is composed of three *phratries*, each of which contains a number of clans, which are in turn often subdivided into kindreds. Formerly a man was forbidden to marry a woman of his own *phratry*, but now intermarriage in the clan is often allowed provided the parties are of different kindreds. The classificatory system of relationships obtains. Inheritance is in the male line. Each village is run as a separate unit by an informal council of old men, and has an old man duly qualified who takes the lead at religious ceremonies. They believe in no Supreme Being, but in a world of godlings above the earth. The underworld is occupied by the dead, and elaborate precautions are taken at funerals to ensure that the soul goes there in comfort. Each male Lhota tries to perform the full series of feats of merit, and, like the Angami, sets up a monolith to mark their completion. A man's cloth varies according to the stage which he has reached in the series.

The Development of Ceylon.[1]

CEYLON has large and successful agricultural industries, and in 1916 a Commission was appointed to consider the development of existing industries and the establishment of new ones, in other branches of activity. The report of the Commission has just been issued, and is a very practical document, fully recognising that scientific knowledge is only one item, and that not the chief, in ensuring success. Many industries, desirable in themselves, do not offer sufficient financial prospects to attract any one away from the established agricultural and other trades.

The report goes on to say, "We have been profoundly impressed by the importance of scientific research in the progress and development of most of the industries we have examined"; and this theme is developed at some length, the final recommendation being that as private individuals can rarely afford the cost of the necessary research, this should be largely the affair of the Government, which is urged to establish a Bureau of Industry and Commerce, that should aim at a greater degree of co-ordination between the various scientific departments, and prevent overlapping of work. It should also establish a central Economic Museum, collect and collate statistics, foster new industries, aid them with scientific and other advice, and do other things. This would involve the establishment of a staff of research workers, and it is to be hoped that they may be generously paid, for, as it has been said, "A paternal Government may desire investigations to be made on some defined subject, and may duly engage an explorer to map that bit of country. . . . Then the poor sportsman, if he is to carry out his part of the agreement, is no longer free. And in that case he deserves good pay for the surrender of his freedom."

It is first pointed out that industries cannot be established without power, and as Ceylon has no coal this power must be hydro-electric. There are indications, however, that some scheme of utilisation of the considerable amount of water power that runs to waste in the hills may soon be put in hand.

Various possible industries are then considered, in which, bearing in mind the above considerations, it is conceivable that success might be attainable. Cement, for example, is considered to have little prospect, inasmuch as Ceylon could not consume the whole output of a factory large enough for proper efficiency. Spinning and weaving, on the other hand, offer good prospects, if the cultivation of cotton can be extended, for there is a large local demand, and the excellent wearing capacity of the cloth made from the short-stapled Indian cotton has already been fully proved.

The possibility of providing the wood used for the making of the vast numbers of chests used for packing tea, rubber, etc., is then considered, and it is thought that, with proper attention to seasoning, Ceylon should be able to supply all her own material, provided that the requirements of the grower of the wood, the maker of the box, and the user of the same, can be properly harmonised—a matter which would fall to the suggested Bureau.

For the encouragement of home industries, such as weaving, silver and brass work, embroidery, and the like, the establishment of a central School of Arts and Handicrafts is recommended.

The question of the fisheries is then dealt with, and it is pointed out that while there is more fish available in the sea than the island requires, it nevertheless imports to the value of about Rs.6,000,000 yearly. It is suggested that a Department of Fisheries be established, in place of the Marine Biological Department so ably carried on by the present Director of the Colombo Museum in addition to his other duties. This new department should attend, among other things, to increasing production, to improvement in methods of curing, to canning (for example, of sardines, which are plentiful), to the manufacture of fish manure and oils, to freshwater fisheries, pearl fisheries, chank, window-pane oyster, and bêche-de-mer fisheries, to encouragement of research, and other things, in all of which there seems to be great opening.

It is further suggested that experiments should be made with such industries as the manufacture of glass, cyanamide, paper, soap, etc.; and the improvement of the mining industry is also considered.

In conclusion, stress is laid upon the necessity for wise action by the State in regard to provision of power, and establishment of the Bureau above mentioned, when it is considered that industries dependent upon forestry and fishing would show the most promise. It is also urged that the youth of Ceylon be given the opportunity, by technical training, etc., of taking part in any future industrial development. The whole report is of a practical and statesmanlike character.

[1] Report of the Industries Commission, Ceylon. (Sessional Paper 1 of 1922.)

University and Educational Intelligence.

CAMBRIDGE.—The Allen Scholarship has been awarded to J. C. Burkill, Trinity College.

The annual report of the Appointments Board shows a total of 349 men placed in the past year, the highest figure for the past nine years. In view of the prevailing conditions in the industrial and commercial world, this is a satisfactory report. The chief subjects in which men have been placed by the Board are: Educational appointments, 143; administrative appointments in commerce and industry, 65; manufacturing and technical appointments, 47.

OXFORD.—Mr. A. L. Dixon, Fellow and Tutor of Merton College, has been appointed Waynflete Professor of Pure Mathematics in succession to Prof. E. B. Elliott.

THE honorary degree of Doctor of Science has been conferred on Sir Thomas Muir by the University of Cape Town, in recognition of his researches in mathematics and mathematical history. Sir Thomas Muir was Superintendent-General of Education for

Cape Colony from 1892 to 1915, and for the greater part of that period he served as a member of the council of the University.

THE Royal Academy of Belgium announces that a triennial prize of 2500 francs, to be known as the Prix Joseph Schepkens, for the best experimental work on the genetics of vegetables, has been established.

THE Research Chair of Medical Psychology in the University of Queensland, Brisbane, has been filled by the appointment of Dr. J. P. Lowson, University Demonstrator in Experimental Psychology at Cambridge. It is expected that Dr. Lowson will arrive in Brisbane early in this month.

THE Hull Corporation recently endeavoured to purchase nineteen acres of land on the outskirts of the city, adjoining the Hull Training College, for the purpose of a Technical College, the present building, near the centre of the city, being too small and inconvenient. The Board of Education, owing to national financial stringency, turned the matter down. The Rt. Hon. T. R. Ferens, formerly M.P. for East Hull, has now purchased the land for ten thousand pounds and presented it to the Hull education authority. Mr. Ferens has previously given about 40,000*l.*, for the erection of a new Art Gallery, 10,000*l.*, for the purchase of pictures, besides other amounts for the erection and endowment of almshouses, and in numerous other ways has placed the citizens of Hull under a deep debt of gratitude.

THE interest in the eighth report of the Carnegie United Kingdom Trust for the year ending December 31, 1921, centres round two schemes to which the Trust has definitely committed itself—(*a*) to provide facilities for reading in the rural districts, and (*b*) to supplement the resources of library authorities throughout the United Kingdom by regional centres of book distribution. The launching of these two schemes was preceded by a very careful survey of the whole question of library policy, the results of which are beginning to bear fruit. There are now 39 county schemes in operation in Great Britain, *i.e.* schemes administered from county headquarters, from which boxes of books are circulated to the village centres—the distributing agent in the village being usually the local teacher. Thus the county library and education authorities are brought into direct connection—the local teachers working under the direction of the county librarian. This method has worked satisfactorily. Past experience, however, teaches that little value is to be placed on initial success. When the novelty of the experiment and of the books circulated wears off, the interest of readers wanes and the system falls into disuse. Against this the Trust has wisely provided by the provision of regional book stores—of which three centres are already established in London, Dunfermline, and Dublin—the last named being still in its embryo stage. In Wales the National Library at Aberystwyth has for some years supplied this want. In these centres a large and well-selected stock of books has been accumulated which should go far toward satisfying the requirements of serious readers not only in the villages but also in the smaller borough and urban districts. Thus equality of opportunity now exists throughout Great Britain for self-education, and this result has been secured with a minimum expenditure on the machinery of administration. Amongst the miscellaneous grants we note with pleasure that a generous, though final, donation has been made to the Library Association in respect of its "Subject Index to Periodicals." We understand that the Class List "Science and Technology" for 1917–19 is in the press and will be issued shortly.

Calendar of Industrial Pioneers.

March 23, 1875. Thomas Lloyd died.—Trained as a shipwright at the School of Naval Architecture at Portsmouth, Lloyd was detailed by the Admiralty for duty with the early naval steam vessels, and ultimately became the first Engineer in Chief of the Navy, a post he held from 1847 to 1869. He was born in 1803, and his services extended from the introduction of steam into the Navy to the development of the first mastless steam ironclad, H.M.S. *Devastation*.

March 24, 1879. Karl Karmarsch died.—Born in Vienna in 1803, Karmarsch founded, and for forty-five years directed, the Polytechnic at Hanover, and wrote valuable works on mechanical technology.

March 25, 1864. Francis Baird died.—Second son of Sir Charles Baird, the founder of the well-known works at St. Petersburg, Baird for many years was sole proprietor of the establishment, and as such carried out numerous important contracts for the Russian Government.

March 25, 1905. Bruno Kerl died.—A distinguished German metallurgist, for thirty years a professor at the Berlin School of Mines, Kerl was the author of valuable treatises, and for thirty-eight years edited a mining and metallurgical journal.

March 25, 1912. Antonio Pacinotti died.—One of the pioneers of the dynamo, Pacinotti was educated at Pisa, where his father was a professor. He served in the Garibaldean wars, and on his return to Pisa in 1860, at the age of 19, constructed the ring-armature dynamo, a form of dynamo re-invented ten years later by Gramme. Though unnoticed at first, Pacinotti's work ultimately received recognition and he was awarded various honours. He held professorships at Florence, Cagliari, and Pisa, where he died.

March 26, 1865. Thomas Hancock died. — The great pioneer of the British rubber industry, Hancock took out his first patent in 1820. He afterwards perfected a process of mastication, and in 1843, having seen samples of the "cured" rubber of Goodyear, patented a method of "vulcanising" rubber by sulphur, and was the first to make vulcanite or ebonite. With his brothers he founded the firm of James Lyne Hancock. In 1857 he published his "Personal Narrative of the Origin and Progress of the Caoutchouc or Indiarubber Manufacture in England."

March 26, 1858. John Seaward died.—In 1824, after experience in many branches of engineering, Seaward opened the Canal Ironworks at Millwall, and became one of the principal builders of marine engines for the Navy. Assisted by his brother Samuel, he made many improvements in paddle-wheel machinery, and introduced the "Gorgon" type of direct-acting engine.

March 28, 1919. Henry Wilde died. — Left an orphan at 16, Wilde began life as an engineering apprentice in Manchester. In 1856, at the age of 23, he set up in business as a telegraph and lightning conductor expert, achieving his first success with an alphabetical telegraph. In 1863 he began his work on the dynamo, which with his electro-chemical discoveries laid the foundation of his fortune. He retired from business in 1884, devoted much time to scientific research, and became well known for his generous gifts to scientific institutions.

E. C. S.

Societies and Academies.

LONDON.

Association of Economic Biologists, February 24.—Sir David Prain, president, in the chair.—J. **Rennie**: The present position of bee-disease research. There is a general similarity of symptoms in all adult bee diseases. With the recognition of the parasite, *Nosema apis*, in association with bee disease there has been at the same time a failure to appreciate a preponderance of cases of disease from which this organism was absent. Recent work at Aberdeen has shown that there are at least three adult bee diseases of importance prevalent in this country—all of which have hitherto been called Isle of Wight Disease. Besides Nosema disease, there are Acarine disease and Bee Paralysis. At the present time Nosema disease is less common than Acarine disease, but appears to be maintained to some extent by the importation of foreign bees, a proportion of which contain the parasite, *Nosema apis*. Acarine disease is the more formidable malady; its causal agent is a Tarsonemid mite which breeds in the thoracic tracheæ and feeds on the blood of the bee. An important feature in this disease, which has hitherto rendered control measures difficult, is the long period of infestation while the mite is being established in the colony, during which time the presence of the parasite is unsuspected. The systematic examination for this parasite of all stocks should be the first step in control. Bee paralysis, described by the Swedish investigator Turesson as an intoxication due to phenolic acids developed in the combs and pollen by the growth of various moulds, has also been recognised in Great Britain.—J. **Rennie**: Polyhedral disease of tipula species. Larvæ of *Tipula paludosa*, the fat body cells of which contain polyhedral bodies in the nuclei, do not complete their development; they die before pupation. This affection, known in various Lepidopterous larvæ, has not hitherto been observed in Diptera. The polyhedra appear to be developed in association with a virus. Infection by feeding is readily produced, and polyhedral bodies develop within the fat body cells in some six or seven days.

Linnean Society, March 2.—Dr. A. Smith Woodward, president, in the chair.—R. E. **Holttum**: The flora of Greenland. During the summer of 1921 a visit was paid to Disko Island and parts of the west coast of Greenland. The most widely-spread vegetation is a low heath of *Empetrum nigrum*, *Cassiope tetragona*, etc. In specially protected localities a scrub of *Salix glauca* was found, which may reach eight feet in height, accompanied by herbaceous plants of southern type. In unfavourable situations there are isolated plants of resistant herbaceous and woody species. The flora of the whole of Greenland consists of 416 species of vascular plants, of which 18 per cent. are high arctic in type, 22 per cent. widely distributed, and 60 per cent. of southern type.—J. **Walton**: The ecology of the flora of Spitsbergen. The largest number of species in Spitsbergen occurs where continental conditions are approached; *e.g.* at the head of Klaas Billen Bay, near the centre of West Spitsbergen, an area of about 5000 square kilometres contains 90 per cent. of the species of vascular plants occurring in Spitsbergen. Three vegetational zones appear: raised shingle beach, alluvial land between mountain and beach, and scree slopes. The development of the flora of the two former can be traced to an intertidal zone which resembles the salt-marsh formation of lower latitudes.—Sir W. A. **Herdman**: Spolia Runiana—V. Summary of results of investigation of the plankton of the Irish Sea during fifteen years. The spring phytoplankton maximum ranges from March to June, and is chiefly composed of diatoms which vary greatly from year to year in maximal haul, up to over 200 millions. This immense diatom curve can be resolved into an earlier crest in April or May, chiefly formed of *Chaetoceras*, and a later in June, chiefly formed of *Rhizosolenia*. The Dinoflagellate maximum follows about a month later than the diatoms, and varies in our records from May to July (rarely August). The Copepod maximum is later again, and ranges from June to October. The largest hauls of plankton are obtained, during daylight, at a level of from 5 to 10 fathoms. The Irish Sea plankton contains from 30 to 60 per cent. of Oceanic forms, the rest are Neritic. Mid-winter and mid-summer are more oceanic in character than the intervening months. A comparatively small number of genera of Diatoms and Copepoda are the dominant organisms of the plankton, and these are the important food-matters for the nutrition of higher animals in the sea. It is probably impossible to draw numerical conclusions as to the population of large sea-areas from few and small samples of the plankton, for series of vertical hauls taken at the same spot in rapid succession show variation up to 50 per cent. The distribution of plankton in the sea is not uniform, and many animals such as Copepoda are present in swarms or patches. As suggested by Hjort, the survival of newly hatched food-fishes in early spring, upon which the prosperity of future commercial fisheries may depend, is possibly determined by the amount of phytoplankton present at the time.

Institute of Metals, March 8.—G. D. **Bengough**: Notes on the corrosion and protection of condenser tubes. Specific recommendations are made for the guidance of manufacturers of tubes and condenser plants.—F. **Adcock**: The internal mechanism of cold-work and recrystallisation in cupro-nickel. Cast cupro-nickel, annealed until homogeneous, can withstand considerable cold working and yet be sufficiently hard to permit of rapid preparation for micro examination. Material subjected to reductions of 50 per cent. and 88 per cent. by cold working was examined to investigate the nature and direction of certain strain planes passing through most of the crystal grains of the distorted metal. Cold-worked specimens annealed for fixed periods at progressively higher temperatures were also examined. The effect of annealing is at first the accentuation of the "strain" markings, followed at higher annealing temperatures by the appearance of new crystal grains, which, if on the sites of the "strain" lines, are frequently elongated in the direction of these lines. The Brinell hardness of the cold-worked metal did not begin to fall appreciably until the annealing temperature was such that new crystal grains were readily discernible under the microscope.—Research Staff of the **General Electric Company** (London): The effect of impurities on recrystallisation and grain growth. Tungsten wires were prepared containing known quantities of thoria, alumina, silica, lime and the alkali metal oxides, in various proportions, and changes in crystal structure on annealing at 2500° were followed. The refractory oxides, which ultimately segregate in the grain boundaries, exert a definite resistance to grain-growth. The alkali metal oxides have no influence upon grain-growth, but an exaggerated growth takes place on annealing tungsten containing a few tenths per cent. of both a refractory oxide and an alkali metal oxide. Single crystals occupying the entire cross-section of the wire, and three hundred times as long as their diameter, are formed on annealing for a

fraction of a minute. Crystal growth and recrystallisation in metals probably depend on a difference in vapour pressure between neighbouring crystal grains. This explains the known phenomena in relation to the effect of strain, grain-size, and temperature in regulating recrystallisation and grain-growth on annealing.—H. **Moore** and S. **Beckinsale**: Further studies in season-cracking and its prevention: condenser tubes. The properties of various condenser tubes were determined before and after annealing at temperatures in the range 250°-325° C. By annealing experiments on flat strips of condenser-tube brass elastically bent to an arc of a circle and thus initially stressed to a known amount the effects of initial hardness, initial stress, time, and temperature, on the reduction of initial stress by low-temperature annealing were determined quantitatively. The rate of reduction of stress at the lower temperatures is rapid, but slows down when the stress has been considerably reduced. The higher the initial stress the higher is the remaining stress in brass of the same hardness, and the higher the hardness the lower is the remaining stress for a given initial stress. A temperature of 250°-275° C. is very effective in restoring elasticity in the overstrained material. Treatment at 280°-300° C. for 30 mins. reduces initial stress to a safe limit without injury to, and in some cases with marked improvement in, the strength of the tube.

March 9.—W. **Rosenhain**: Some cases of failure in "aluminium alloys." Some "aluminium alloys" undergo distortion and disintegration; they usually consist mainly of zinc and are not properly described as aluminium alloys. Such alloys, consisting largely of zinc and also containing aluminium and copper, are unstable at ordinary temperatures and liable to changes of dimension and disintegration. True light alloys of aluminium (consisting mainly of aluminium), if properly prepared are free from any risk of serious growth or disintegration.—F. C. **Thompson** and E. **Whitehead**: Some mechanical properties of the nickel-silvers. The effect of annealing at different temperatures, and the different rates of cooling after annealing, upon the tensile properties, the Arnold alternating stress values, and the Erichsen values of hard-rolled alloys containing 10, 15, and 20 per cent. nickel were examined. Changes occur at about 300° C. and 550° C. Annealing at 300° C.–400° C. results in a material of very low ductility. The best annealing range for the 10 per cent. nickel alloy is 725° C.–825° C.; for the 15 per cent. nickel, 700° C.–800° C.; and for the 20 per cent. nickel alloy, about 800° C. As the nickel content is raised the tensile strength is raised, while the maximum ductility is considerably reduced. As regards Brinell hardness almost the whole of the softening takes place in the first two hours. The greatest ductility and the highest Erichsen values are obtained after annealing for 1½ hours for small samples. There is little to choose between annealing for a short time at a high temperature and for a longer time at a low temperature. The alloys can be heated to a high temperature without deterioration, especially when the sample is protected from oxidation. The Erichsen tests show good results even after annealing at 850° C.—D. **Hanson** and Miss M. L. V. **Gayler**: A further study of the alloys of aluminium and zinc. Alloys containing 70, 60, 50 per cent. of zinc when slowly cooled to 284° C., after prolonged annealing at 420° C. and quenched are duplex in structure. A redetermination of the solidus from 81-20 per cent. zinc showed that the line representing the peritectic reaction extends to a composition of 70 per cent. zinc as against 40 per cent. zinc in previous diagrams. Microscopic examination of alloys, following special heat-treatment, disproved the existence of the compound Al_2Zn_3, and showed that the nature of the change in the alloys at 256° C. in Rosenhain and Archbutt's diagram is identical with an ordinary eutectoid transformation, the decomposition of the β-phase leading to the "pearlitic" structure commonly found in the alloys. Below 256° C. the solubility of the α-constituent in the γ-constituent decreases with the temperature. Alloys containing the β-constituent harden spontaneously at room temperature after being quenched from above 256° C.; those containing the γ-constituent showed the same property in a much less marked degree.—A. **Westwood**: The assay of gold bullion. The assay sample is not cupelled but is melted and balled up under steam or an inert gas. For the usual inquartation copper is recommended in place of silver.—C. A. **Edwards** and A. J. **Murphy**: The rate of combination of copper and phosphorus at various temperatures. When using ½-inch copper rod the maximum rate of increase of phosphorisation in phosphorus vapour for a given rise of temperature occurred at 640° C. Phosphorisation at this temperature is quick and safe, and the operation can be controlled so as to prevent the formation of any liquid, while it is impossible to obtain an alloy containing more than the percentage of phosphorus which is required commercially.

CAMBRIDGE.

Philosophical Society, February 27.—Mr. C. T. R. Wilson, vice-president, in the chair.—G. F. C. **Searle**: (1) An experiment illustrating the conservation of angular momentum. A horizontal board is suspended by a practically torsionless silk thread. Attached to the board is a vertical pivot about which an inertia bar turns balanced by a suitable counterweight. The inertia bar is held by a thread in a definite position against the action of a spring and then the thread is burned. The spring turns the bar until its motion relative to the board is arrested by a stop and the board turns in the opposite direction. The ratio of the angles turned through by board and bar is equal to the ratio of the moments of inertia of the bar about its pivot and of the whole system about its axis. This ratio is found by means of a torsion wire. (2) A focal line method of determining the elastic constants of glass. Light from a collimator, with cross-wires in one focal plane, falls on the surface of a bar of glass. The reflected beam falls on a converging lens system which is adjusted so that the origin point on the surface is in one focal plane. A ground-glass screen on an optical bench is adjusted to be in the other focal plane. When the bar is bent, the cross-wires are set horizontal and vertical and the position of the focal lines of the reflected beam is determined. When the bar is twisted, the cross-wires are set at $\pm 45°$ to the horizontal and similar measurements made. The glass bar is replaced by a concave spherical mirror and the measurements repeated. Young's modules, Poisson's ratio and the rigidity can be calculated.—G. **Stead** and E. C. **Stoner**: Low voltage glows in mercury vapour. The effect of varying pressures and filament temperatures on the glow potential of mercury vapour, and on the current changes accompanying the appearance and disappearance of the glow were investigated. The glow could be obtained in a dome-shaped form of variable length. At higher pressures the glow point occurred below the ionisation potential.—E. V. **Appleton**: An electric wave detector. The thermionic current of a diode vacuum tube in which the electrons move with very small velocity is deflected by the direct action of electromagnetic radiation.

The resulting reduction in the thermionic current is used to indicate the field strength.—E. B. **Ludlam**: An attempt to separate the isotopes of chlorine. Hydrogen chloride at a pressure of about two centimetres of mercury was passed over (*a*) a water surface, (*b*) ammonia gas, so that a small fraction was retained uncombined. The chlorine was weighed as silver chloride. Any increase in weight could be attributed to experimental error.—M. H. **Belz**: The measurement of magnetic susceptibilities at high frequencies. A heterodyne beat method is described, in which changes in inductance are produced by insertion of the specimen inside one of the oscillating coils. Susceptibility is calculated from the change of beat note. The range of frequency employed was 3×10^5 to 4×10^5 per second, and the results show that, up to this point, frequency has no effect.—G. H. **Henderson**: Note on an attempt to influence the random direction of a particle emission. On applying a magnetic field to radium emanation no change could be detected in the ionization due to beams of α rays parallel and perpendicular to the field.—J. E. P. **Wagstaff**: Determination of the coefficient of rigidity on a thin glass beam.

DUBLIN.

Royal Dublin Society, February 28.—Dr. J. A. Scott in the chair.—J. **Joly**: A new method of finding the discharge of rivers. This is a modification of the method of chemical hydrometry. A small quantity of uraninite in solution and diluted to a suitable volume is supplied into the river at a uniform rate for a period of 15 or 20 minutes. At a point lower in the river samples of water are taken. These, after a suitable interval, are examined for radium emanation. A river of 10^4 litres per second would require about 300 grams of pitchblende for a measurement aiming at an accuracy of one per cent. Ordinary chemical hydrometry would be much more costly and troublesome.—J. G. **Rhynehart**: On the life-history and bionomics of the flax flea-beetle (*Longitarsus parvulus*, Payk.), with descriptions of the hitherto unknown larval and pupal stages. This flea-beetle is a serious flax pest in Ireland. The adults feed on the leaves of the flax seedlings in May and early June and often destroy large areas. From eggs laid in the soil by over-wintered females are hatched minute larvæ which burrow into and feed upon the roots of the flax plants. Pupation occurs in the soil after about a month of larval life, and a new brood of beetles emerges during the last week of July and the first week of August. Various suggestions for controlling the pest were discussed, and the results of field experiments point to the fact that Bordeaux mixture tends to repel attacks.—E. J. **Sheehy**: The influence of feeding on milk fat. An investigation into the effect of increasing or decreasing the ration of three experimental goats indicated that the percentage of butter fat in milk may be increased to a maximum figure, or may be decreased, according to the mode of feeding. Fat, starch, or protein, when added to a poor ration, may raise the percentage of butter fat.—L. B. **Smyth**: On a variety of Pinite occurring at Ballycorus, Co. Dublin. A mineral occurring at the edge of the Leinster Granite is shown to be a hitherto undescribed variety of Pinite.

EDINBURGH.

Royal Society, March 6, 1922.—Prof. F. O. Bower, president, in the chair.—Prof. J. G. **Gray** and Capt. J. **Gray**: Solutions of the problem of the vertical on moving vehicles with special reference to aircraft: —The Gray Gyroscopic Stabilisers. Prof. J. G. Gray communicated this paper on the action of various forms of the Gray Stabiliser, an instrument which was brought to the notice of the British Government early in 1915, and was adopted by the Royal Naval Air Service in 1917, and in 1918 received the approval of the Research Council of America. In 1918 Prof. Gray was invited by the American Government to visit America with a view to developing the instruments to the utmost for use in the American Aerial Services. Unfortunately, for reasons which cannot now be given, the instruments were not used by the British Services over the German lines. The Gray stabiliser does not aim at stabilising an aeroplane as a whole, but provides means whereby instruments of precision used on aircraft, such as horizon mirrors, bombsights, navigational sights, cameras, etc., may be stabilised with respect to the vertical and the horizontal, against both pitching and rolling motions of the aeroplane or airship. This stabiliser finds and maintains the true vertical (the direction assumed by the thread of a simple pendulum as set up in a room) with the utmost exactness on an aeroplane, and is thus available for trimming the aeroplane during cloud flying. The instrument consists of a main stabilising gyroscope, or gyroscopes, attached to the aeroplane by means of a gimbal frame and two sets of pivots. The instrument to be stabilised forms part of the pivoted system. Also forming part of this system is an erector consisting of a member which rotates slowly, on a vertical spindle, in the direction of spin of the main gyroscope, or gyroscopes. This member is provided with a set of compartments, each of which contains a solid spherical steel ball. The compartments are so shaped that, when the pivoted system is inclined to the vertical, the balls automatically arrange themselves so that the device is erected into the vertical by gyroscopic action, when the balls then automatically arrange themselves as a balanced system. An explanation was given of the various forms of erectors which had been devised; and it was shown how in each case the device was given a sense, so to speak, of the true vertical, but was rendered blind to the apparent vertical during curved flight. A bombing aeroplane, just previous to running up to a target, executes a rapid turning movement. The Gray stabiliser permits of all such manœuvres being carried out without the introduction of errors. The pioneer instruments, as tested on aeroplanes by R.N.A.S. officers in 1917, using sun-shadow methods of testing, methods which permitted of the accuracy of the instrument being ascertained beyond dispute, were found to have an accuracy of $\frac{1}{10}$th of a degree, or for bombing purposes an accuracy of about 25 feet on the ground from a height of 15,000 feet. The instruments were absolutely undisturbed by pitching and rolling motions of the aeroplane, even when the flying was carried out with the aeroplane side-on to half a gale of wind. The authors of the paper had been working continuously with a view to perfecting these gyroscopic inventions and were in a position to construct stabilisers, for use on aeroplanes and battleships, which would yield for navigational purposes, and for purposes of bombing and gunnery, an accuracy of one or two minutes of angle at the outside. Gray stabilisers for use with cameras are being constructed for use in the U.S.A. In conclusion Prof. Gray expressed his thanks to the War Committee of the Royal Society of Edinburgh, which in 1915 encouraged his researches in every possible way.—H. W. **Brolemann**: Myriapods collected in Mesopotamia and N.-W. Persia by W. Edgar Evans, B.Sc., late Capt. R.A.M.C. Seventeen species—twelve Chilopoda (centipedes) and five Diplopoda (millipedes)—mostly collected around Amara on Tigris and Ruz, N.-E. of Baghdad, are recorded. Five species and three

sub-species are described as new, and a new genus, *Calyptophyllum*, is erected for the reception of two of the Millipedes.

PARIS.

Academy of Sciences, February 27.—M. Emile Bertin in the chair.—M. E. I. Fredholm was elected Correspondant of the Academy for the section of geometry, and M. Henri Jumelle Correspondant of the Academy for the section of botany.—T. **Carleman**: The series $\Sigma \frac{A_\nu}{z-a_\nu}$.—S. **Sarantopoulos**: A theorem of M. Landau.—E. **Cartan**: A generalisation of the notion of curvature of Liemann and torsional space.—P. **Fox**: Measurements of stellar parallaxes at the Deadborn Observatory (United States). A table of the parallax of 34 stars, supplementing earlier lists given in 1919 and 1921.—T. **Moreux**: A new theory of the formation of the spiral nebulæ and of the solar system.—G. **Perrier**: Compensation of the differences of altitude of a chain of triangles of the first order. Application to the triangulation of the meridian arc of the equator.—M. de **Laroquette**: Measurement of the mean penetrating power of a bundle of X-rays by a new radio-chromometric method. Ten holes are bored in a sheet of lead, and these receive in turn known fractions (from 1 to 50 per cent.) of the total exposure. Twelve other holes are made in the same plate, and in these sheets of metal are placed discs possessing filtering power expressed in millimetres of aluminium, up to 66 mm. The scale thus obtained has been compared with Benoist degrees and possesses advantages over the latter in having a wider range and in being applicable to all radiations.—P. de la **Gorce**: The measurement of power by the differential dynamometer.—M. **Chapas**: The solubility of the isomeric toluic acids in the three xylenes. The para-acid is very slightly soluble in the three xylenes; the meta-acid is more soluble, but the differences from the ortho-acid are insufficient to form a method of separation.—A. **Poucholle**: Contribution to the study of tempering.—P. **Job**: The electrometric study of electrolysis, under the action of baryta, of some complex amine cobalt compounds.—J. B. **Senderens** and J. **Aboulenc**: The catalytic preparation of the cyclohexanetriols. Pyrogallol in alcoholic solution is rapidly reduced by hydrogen in the presence of nickel under a pressure of 40 to 50 kilograms at a temperature of 140° C. The reduction is complete and the product consists of a mixture of two isomeric pyrogallites (trihydroxy-cyclohexanes). Phloroglucinol, in aqueous solution, undergoes reduction to phloroglucite under similar conditions.—M. **Godchot** and P. **Brun**: Some derivatives of suberone. The products of reduction of suberone by calcium hydride are described and also the preparation of dibromosuberone.—E. **Grandmougin**: The halogen derivatives of the isatins.—A. **Schoep**: Dewindtite, a new radioactive mineral. This mineral is found mixed with chalcolite in the Belgian Congo. It is a lead phospho-uranate of the composition $4PbO, 8UO_3, 3P_2O_5, 12H_2O$.—C. **Jacob**: The structure of North Annam and Tonkin.—J. **Savornin**: Stratigraphical and tectonic observations at the north-east frontier of Morocco.—J. **Thoulet**: The neutral lines of submarine coast sediments. The agitation of the sea sorts out the minerals of the sea floor and the results are permanent, as the same results are always obtained in the same locality.—A. **Němec** and F. **Duchoň**: A new indicating method for evaluating the vitality of seeds by the biochemical method. The method is based on the assumption that the activity of the catalase present is a measure of the vitality of the seed. The catalase is determined by measuring the amount of oxygen evolved by the action of hydrogen peroxide. A table of results for seeds of various dates between 1891 and 1920 comparing the catalase found with the percentage of germination proves the utility of the process.—MM. **Warcollier** and Le **Moal**: The progressive disappearance of free sulphurous acid in preserved apples.—L. **Mercier**: Contribution to the study of the regression of an organ; the vibrating flight muscles of *Apterina pedestris* during nymphosis.—L. **Roule**: A rare genus of deep-sea Japanese fish, rarely found in the North-African Atlantic Ocean.—T. **Monod**: The morphology of the buccal parts in the male of *Akidognathia halidaii*.—A. **Policard** and G. **Mangenot**: The action of temperature on the cellular chondriome. A physical criterion of mitochondrial formations.—H. **Grenet** and H. **Drouin**: A bismuth compound of the aromatic series and its therapeutic activity. An account of the therapeutic action of a phenol derivative containing bismuth, concerning the preparation and composition of which no details are given. Its antisyphilitic action is comparable with that of the arsenobenzines.

Official Publications Received.

Koninklijk Nederlandsch Meteorologisch Institut. No. 106: Ergebnisse aerologischen Beobachtungen, 8, 1919. Pp. xi+113. No. 108: Seismische Registrierungen in De Bilt, 6, 1918. Pp. xiii+84. (Utrecht: Kemink & Zoon.)

Thirty-fifth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1913–1914. In two parts. Part 1. Pp. 794+xi. (Washington: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, 1920, No. 30: State Laws relating to Education, enacted in 1918 and 1919. Compiled by Wm. R. Hood. Pp. 231. (Washington: Government Printing Office.)

Agricultural Experiment Station of the Michigan Agricultural College. Chemical Section. Regular Bulletin, No. 291: Fertilizer Analyses. By Andrew J. Patten and others. Pp. 109. (East Lansing, Mich.)

Smithsonian Institution: United States National Museum. Bulletin 100, vol. 4: Contributions to the Biology of the Philippine Archipelago and Adjacent Regions. Foraminifera of the Philippine and Adjacent Seas. By Joseph A. Cushman. Pp. 608+100 plates. (Washington: Government Printing Office.)

Canada. Department of Mines: Geological Survey. Memoir 127. No. 108, Geological Series: Beauceville Map-Area, Quebec. By B. R. MacKay. Pp. iii+105 (including 13 plates). Memoir 128. No. 109, Geological Series: Winnipegosis and Upper Whitemouth River Areas, Manitoba; Pleistocene and Recent Deposits. By W. A. Johnston. Pp. ii+42. (Ottawa.)

Report of the Department of Mines for the Fiscal Year ending March 31, 1921. (Sessional Paper No. 26.) Pp. iii+47. (Ottawa.) 5 cents.

Diary of Societies.

FRIDAY, MARCH 24.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Prof. H. E. Armstrong: The Indigo Situation in India.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Prof. N. Bohr: The Effect of Electric and Magnetic Fields on Spectral Lines (Guthrie Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Capt. R. P. Stanford: Cheap Transport: Heat and Power, with Special Reference to the D. J. Smith Gas Producer.

INSTITUTION OF PRODUCTION ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—E. Fairbrother: Inspection Methods.

JUNIOR INSTITUTION OF ENGINEERS, at 8.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. J. Brownlee and Dr. M. Young: The Epidemiology of Summer Diarrhœa.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. F. G. Donnan: Auxiliary International Languages.

SATURDAY, MARCH 25.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (4).

MONDAY, MARCH 27.

INSTITUTE OF ACTUARIES, at 5.—G. W. Richmond: Austrian National Life Tables.

ROYAL SOCIETY OF ARTS, at 8.—G. Radcliffe: The Constituents of Essential Oils (Cantor Lectures), (2).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—A. Livingston: The Experimental Production of Arthritis.

TUESDAY, MARCH 28.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. J. W. Evans: Earth Movements (1).

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. Feiling: The Interpretation of Symptoms in Disease of the Central Nervous System (Goulstonian Lectures), (3).

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. O. Heath: The Natural Cure of a Common Cold.—Dr. T. I. Bennett and Dr. Dodds: Observations of Cases involving Disorders of Secretion in the Upper Alimentary Tract.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—E. A. Evans: Petroleum and Lubrication.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. C. Banfield: The Trist Three-colour Exposure Camera.—General Electric Co., and Ilford Ltd.: Two papers dealing with the "Osglim" Lamp and its uses for photographic purposes.

ILLUMINATING ENGINEERING SOCIETY (jointly with the Royal Institute of British Architects) (at Royal Society of Arts), at 8.—Discussion on The Lighting of Public Buildings; Scientific Methods and Architectural Requirements. (*a*) An Account of Experimental Work and Results, presented by Dr. E. H. Rayner, J. W. T. Walsh, and H. Buckley. (*b*) Some examples of the Lighting of Decorative Interiors.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—H. J. E. Peake: Bronze Swords and the Aryan Problem.

WEDNESDAY, MARCH 29.

PREHISTORIC SOCIETY OF EAST ANGLIA (Annual London Meeting) (at Society of Antiquaries), at 2.15.—O. G. Crawford and H. J. E. Peake: A Flint Factory at Newbury Sewerage Outfall Works, Thatcham, Berks.—Miss Nina F. Layard: Presidential Address: Prehistoric Cooking Places in Norfolk, with a brief account of Heating Stones, their History and Significance.—L. A. Armstrong: Further Discoveries of Engraved Flints and Implements at Grimes' Graves.—Dr. A. Smith Woodward: Description of the Rhodesian Skull.—E. J. Wayland: Palæolithic Types of Implements in relation to the Pleistocene Deposits of Uganda.

INDUSTRIAL LEAGUE AND COUNCIL (at Caxton Hall), at 7.30.—Major I. Salmon: The Necessity for Educating the Worker in Industrial Economics.

ROYAL SOCIETY OF ARTS, at 8.—Sir Thomas Oliver: Alcohol in Relation to Industrial Hygiene (Shaw Lecture).

THURSDAY, MARCH 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. M. Hind: Landscape Etchers: New and Old (1).

CHEMICAL SOCIETY (Annual General Meeting), at 4.30.—Sir James Walker: Presidential Address. At 8—Informal Meeting.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Prof. H. E. Roaf: The Acidity of Muscle during maintained Contraction.—The late Dr. W. G. Ridewood: Observations on the Skull in foetal specimens of Whales of the Genera *Megaptera* and *Balaenoptera*.—Dr. W. L. Balls: Further Observations on Cell-Wall Structure as seen in Cotton Hairs.—L. T. Hogben and F. R. Winton: The Pigmentary Effector System. I. Reaction of Frog's Melanophores to Pituitary Extracts.—Dr. Agnes Arber: The Development and Morphology of the Leaves of Palms.

NEWCOMEN SOCIETY (at Institute of Marine Engineers), at 5.—Eng.-Comdr. E. C. Smith: The Centenary of Naval Engineering: A Review of the Early History of our Steam Navy.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. H. Mackenzie: Diseases of the Thyroid Gland (Lumleian Lectures), (1).

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Capt. G. de Havilland: Design of a Commercial Aeroplane.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—R. B. Matthews: Applications of Electricity to Agriculture.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—K. M. Walker: Renal Infections, with an account of experimental work on the ascending route.

FRIDAY, MARCH 31.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Dr. W. L. Balls: Advantages and Defects of Team Work in Economic Biology.—Dr. F. Kidd: Problems of Fruit Storage.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. H. H. Jeffcott: The Milling of Screws, and other Problems in the Theory of Screw-threads.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 7.—J. S. Highfield: Presidential Address.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—D. P. Dickinson: The Steel Melting Shop.

SATURDAY, APRIL 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (5).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

FRIDAY, MARCH 24.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (10).

KING'S COLLEGE, at 5.30.—Dr. G. Cook: Some Recent Advances in our Knowledge of the Strength of Materials.

SATURDAY, MARCH 25.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: Science and the Food we Eat.

MONDAY, MARCH 27.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. P. Duval: Données actuelles de la chirurgie intra-thoracique.

TUESDAY, MARCH 28.

UNIVERSITY COLLEGE, at 5.30.—Col. W. M. St. G. Kirke: Imperial Defence as affected by the War (3).

WEDNESDAY, MARCH 29.

HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (10).

THURSDAY, MARCH 30.

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. L. D. Barnett: The Hindu Culture of India (5).

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. E. Stilgoe: Water (2), Its Distribution and Use (Chadwick Public Lectures).

SATURDAY, APRIL 1.

POLYTECHNIC (Regent Street, W.1), at 10.30 A.M.—Prof. H. E. Armstrong: The Wonders and Problems of Food.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. W. A. Cunnington: Woman's Sphere in Savage Africa.

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