Nature

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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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SATURDAY, JULY 5, 1924.

CONTENTS.

The Imperial Institute Bill.

A GOVERNMENT Bill to effect the reorganisation of the Imperial Institute has been introduced into the House of Lords by Lord Arnold and there passed its second reading. This Bill will be welcomed, as it should help the development of that Institute to a position worthy of the group of museums and scientific institutions at South Kensington. The Colonial Office Committee of Enquiry into the Imperial Institute in 1923 recommended the abolition of its galleries, the limitation of the work of its laboratories to preliminary investigations of raw materials, and the reduction of the Institute to a clerical bureau. This scheme was approved by the Imperial Economic Conference, some members of which were unacquainted with the facts, as one of them has since stated. If the majority report of the Colonial Office Committee had been promptly carried into effect, the Imperial Institute collections would have been scattered and the galleries occupied by a War Museum, which, however desirable, would have been out of place in South Kensington on a site allotted to the development of the industrial arts and science by the Commissioners for the Exhibition of 1851. The majority report of the Committee was opposed by a strong minority, and has since been widely condemned.

The Bill, in agreement with the minority report, is based on the retention of the Imperial Institute galleries and the amalgamation of the Mineral Resources Bureau with the Mineral Department of the Institute. The Bill proposes the transfer of the management of the Institute from the Colonial Office to the Department of Overseas Trade, which is a branch of the Board of Trade, and the establishment of a new Board of Governors consisting of representatives of the Dominion of Canada, Australia, New Zealand, South Africa, the Irish Free State, Newfoundland, and India, and representatives of the Treasury, the Board of Trade, the Colonial Office, the Ministry of Agriculture and Fisheries, the Department of Overseas Trade, and the Department of Scientific and Industrial Research, and not more than ten scientific and commercial representatives, including one from the Royal Society and not less than three Governors of the Mineral Resources Bureau.

The property would be vested in six Trustees, all of whom would be members of the Government. As the Imperial Institute was erected and endowed largely by public subscription and its main service would be to the smaller colonies, it is desirable that some of the Trustees should be unofficial, and one of them should represent directly the Empire overseas. More confidence in this Board of Trustees would be felt if only three of them were members of the Government, and the other three included a representative of the Dominions, the president of the Association of the British Chambers of Commerce, and some such authority as the Governor of the Bank of England or the president of the Institution of Mining and Metallurgy.

The Board of Governors would act through a Managing Committee which would be aided by various advisory councils or committees, including one on minerals, and would be associated with a Laboratory Committee, including representatives of the Department of Scientific and Industrial Research and of the Royal Society.

This Bill renders possible the development of the Imperial Institute as a great museum and research institution for the investigation of the natural resources of the British Empire overseas. The reconstituted Institute might develop into an organisation capable of giving important help in the investigation of the economic geology and mineral resources of the Empire outside Great Britain. The Bill is, however, unsatisfactory in two respects in which the terminology of the abandoned majority report has passed into the Act. That report recommended the appointment of a Laboratory Committee, the functions of which would render the Institute laboratories futile. The Laboratory Committee, according to the resolution of the Imperial Economic Conference, was proposed "to ensure that the reconstituted Imperial Institute may in future undertake in its laboratories only preliminary investigations of raw materials for the purpose of ascertaining their possible commercial value. . . ." If any more extensive research or investigation be required, it would be the duty of the Laboratory Committee to see that the material were sent to some other authority in Great Britain or "elsewhere within the Empire."

This proposal would, if carried into effect, seriously lessen the usefulness of the Institute. Many of the most interesting materials it might expect to receive would be submitted in confidence, which would not be felt if the material were to be distributed to University or public laboratories for investigation. The various Departments of the Institute would doubtless include experts in some branches of its work, and they would sometimes have to send on material for investigation to people less competent to deal with it than themselves.

The scheme would probably also involve risk of trouble between the several committees of the Institute. The Managing Committee and the Mineral Committee would naturally desire to escape from the restriction to preliminary work, though ready to seek the co-operation of authorities who might be specially competent to deal with special materials or problems. The Managing and the Mineral Committees might therefore be in frequent friction with the Laboratory Committee, the duty of which would be to see that the other committees and the Institute staff committed nothing beyond an elementary commercial examination. The clause in the schedule enumerating the purposes of the Institute "To conduct preliminary investigations of raw materials and, when it may be deemed advisable, to arrange for more detailed investigation by appropriate scientific or technical institutions," therefore, might well be amended by omission of the word "preliminary" and the alteration of "more detailed" into "further" investigation.

The main discussion hitherto has been over the galleries, the great educational value of which has been frequently pointed out in NATURE. The new Bill empowers the governing body to maintain galleries for the exhibition of Empire products. If the Bill be passed as now worded, some future official might maintain that collections of commercial samples in the Dominion offices in different parts of London would satisfy this clause, and this Bill might be used to give effect to the very policy which it is understood that the Government at present in office has abandoned.

The schedule stating the purposes of the Imperial Institute does not even refer to the Institute galleries. The only clause dealing with collections states that the Institute is "to organise, so far as practicable, exhibitions of Empire products." This clause is quite inadequate as a statement of the duties of the Institute in connexion with its public exhibition galleries. It implies that all the Institute should arrange is exhibitions of commercial samples, which, as the Colonial Office Committee recommended, might be peripatetic.

The clause should be amended to state definitely that the Institute should retain its galleries at South Kensington and maintain in them exhibitions of the products of the Empire, so displayed as to demonstrate their nature and uses, and to illustrate adequately the geographical conditions and material resources of the British Empire.

A few amendments are therefore desirable to prevent ambiguity. Without these changes, there is the risk that the Act will, in effect, be used to return to the recommendations of the majority report of the Colonial Office Committee of Enquiry, and thus to prevent the Imperial Institute from fulfilling the important functions proposed for it by its far-seeing and generous founders.

The New Astronomy.

The Depths of the Universe. By George Ellery Hale. Pp. xv+98. (New York and London: Charles Scribner's Sons, 1924.) 7*s.* 6*d.* net.

ASTRONOMY is a subject which, in spite of the delicate refinement of its observations and the severe technicality of its mathematical processes, yields results which can be fairly apprehended by the general educated public,—results moreover which, though apparently far removed from humanity, yet invariably arouse a human interest. There was a time when it appeared to be a completed, so to speak, perfected science, in which little of a revolutionary character was to be expected. But modern discoveries in physics have changed all that; and discoveries are yearly being made which are likely to enlarge our ideas about the constitution of the heavens in a striking and revolutionary manner.

Part of this progress is due to the enthusiastic workers, and the great resources provided for them, on the other side of the Atlantic; where lavish provision has been made for experimental resources, where sufficient mathematical skill is available for devising methods and interpreting results, and where the clearness of the air on mountain-tops has been utilised after the enterprising manner characteristic of the American nation.

Among the workers in novel directions the name of George Ellery Hale is held in honour throughout the civilised world; and the whole world hopes for his restoration to health, so that he may continue to infect his co-workers with enthusiasm, and that he may have the joy of continuing the utilisation of the magnificent Observatory and laboratories on the top of Mount Wilson in California. Meanwhile he has been giving us the benefit of his powers of exposition in articles and discourses, some of which are being collected in small and illustrated books, one called "The New Heavens," and another, which has just been published, entitled "The Depths of the Universe." The main branches of the subject dealt with in this little volume are three in number. The first relates to the stars and star clusters, with some account of the remarkable and novel principles by which spectroscopic determination of excessive and otherwise hopelessly immeasurable distances can be made. The second relates to the nebulæ, and especially to the dark nebulæ discovered by the late Edward Emerson Barnard, of the Yerkes Observatory, whose lamented death has so recently occurred, and to whom the author pays an affectionate and admiring tribute. While the third chapter in the book gives further details about the author's own great discovery about the magnetic condition of the sun and its spots, a subject begun to be expounded in one of the chapters of "The New Heavens," and now carried to a further stage.

The treatment throughout is of a popular character, and all recent advances are linked on to the history of the past. Thus in the first chapter, which is specially on "The Depths of the Universe," Prof. Hale begins with Galileo and the first telescope, and carries the history rapidly forward, through Herschel, to the determination of stellar and globular-cluster distances by Dr. Harlow Shapley, of Harvard.

The main theme of the first chapter is the size and shape of our stellar cosmos, familiar to all as "the Milky Way," which must be of unexpectedly vast extent if the immensely distant globular clusters form any part of it. Outstanding questions about the spiral nebulæ are not dealt with; but many details are given about other objects, and especially the dark nebulæ emphasised by Barnard. Some of them are regarded as immense clouds of dust driven away by the pressure of light, but held together, even in diffuse form, by their own gravitation. It is suggested that many of the nebulæ are only luminous because they reflect, or fluoresce in, the light of luminous stars in their neighbourhood. This seems specially to apply to the great nebula in Orion. But the globular star clusters are of a different order, perhaps more analogous to the constellation of Orion itself, the great cluster or crowded and enormous constellation in Hercules being apparently at a distance of 36,000 light-years.

Incidentally I would here express a hope that the light-year, as a unit of stellar distance, may be generally employed instead of the less satisfactory parsec, as a cosmic measure. Distances can very properly be expressed in terms of speed and time: that is indeed the fundamental way of measuring them, and far superior to anything dependent on the copying of an arbitrary unit such as a yard or a metre. Parallax, dependent on the length between earth and sun, is absurdly incompetent to express enormous distances: the period of earth's revolution combined with the speed of light is better. It seems impracticable to get away altogether from the earth, in devising a cosmic unit, but the periods of the earth's rotation and revolution are universal terrestrial units of time; while as to the velocity of light, it appears to be about the only absolute thing we know.

To return from this brief digression. In order to emphasise the enormous number of stars now accessible to photography, Prof. Hale gives an interesting series of photographs, with different exposures, of a small region in Auriga near a third magnitude star. The first exposure is long enough to show stars down to the ninth magnitude, but none are visible, only the big one. The second exposure would show twelfth magnitude stars, and there are now five or six on the plate. A further exposure, long enough to bring out those of the fifteenth magnitude, shows something like fifty in all. Exposing long enough for seventeenth magnitude stars, more than two hundred appear; and when stars of the eighteenth magnitude are allowed time enough to impress the plate, the field is crowded with a number like four hundred.

The chapter on sun-spots begins with ancient observations, and continues, through the discovery of Faraday of the rotatory effect of magnetism on light, to the supplementary great discovery of Zeeman; and so on to its quite recent application by Prof. Hale to ascertain the nature of the hydrogen vortices in the upper layers of the sun, which appear to be more or less closely associated with the deeper-seated sun-spots below. Every one now knows that the lower regions of a sun-spot were proved to be powerfully magnetised by Hale's discovery of the Zeeman effect in the light emitted by them. This discovery has now been extended into most interesting detail, by the splendid power of the 150-ft. tower telescope erected on the top of Mount Wilson, with a spectroscope 75 ft. long sunk in a well below it. This telescope forms an image of the sun 16½ in. in diameter. A small sun-spot can be focussed on the slit of the 75-ft. spectroscope, so as to fall on a Rowland grating at the bottom of the well; and, though the slit is only three thousandths of an inch wide, the light passing through it is returned as a long spectrum extending 40 ft. from red to violet—a spectrum of the second order, on photographs of which observations can be made, with complete polarimetric proof that the interior of a spot produces precisely similar effects to those of an ordinary powerful longitudinal magnetic field.

The result has been to confirm the importance of the eleven-year solar period, and to show that it is only half the real period, when not merely the appearance of spots but their magnetisation is taken into account. Sun-spots are known to begin far from the solar equator during a minimum, and gradually to form nearer the equator. It would be simple if we could say that all those in the northern hemisphere of the sun are magnetised one way, and all those in the southern hemisphere magnetised the other way, and that then in the next sun-spot period these directions were reversed. That is not true, though something like it is true. It is not true because sun-spots do not occur singly. They occur for the most part in pairs, the two components of each pair not being necessarily equally well marked. They might be likened provisionally to the two opposite whirls we see when a teaspoon is drawn across a cup of tea; those two whirls are united by a semicircular vortex below. It may be so in the sun, though that is not yet clear. Allowing the analogy, however, the teaspoon must be drawn one way in the northern hemisphere and the opposite way in the southern during one eleven-year period; but in the next eleven-year period these directions must be reversed, giving twenty-two years for the time of the whole cycle of changes.

Moreover, by their magnetic properties, Hale found it possible to discover invisible or submerged sun-spots. They are all deep-seated disturbances, far below the photosphere; and it is only when a hydrogen whirl in the upper regions coincides with the electronic whirl below, that they burst out as it were and become visible. A great slowly alternating magnetic disturbance is going on in the body of the sun, of a quite unknown character, and with a twenty-two year period. These great electrical whirls must have a profound meaning, not yet dissected out. We are so dependent on the sun for everything, that they may have an unexpected influence on terrestrial phenomena and earth life. Meanwhile, we only know of them—at least until quite recently—by the manifestation we call sun-spots, when whirls happen to extend into the upper regions of the solar atmosphere and so break through.

Discovery is still going on; and it is to be hoped that Prof. Hale and his co-workers may long continue to elucidate this portentous phenomenon, which has proved itself so much more law-abiding than anything in our terrestrial weather and storms appear to be. There are some analogies: there may even be some connexion, but at present we can only say that whatever may be the truth about cyclones in the earth's atmosphere, they certainly exist on a huge scale in the solar atmosphere, or solar substance—for the whole sun may be obedient to the laws of gases at that high temperature—and that probably much more remains to be discovered about both.

OLIVER LODGE.

Modern Chemistry.

Chemistry in the Twentieth Century: an Account of the Achievement and the Present State of Knowledge in Chemical Science. Prepared under the guidance of a Committee representing the Scientific Societies, with Dr. E. F. Armstrong as Chairman and Editor. Pp. 281. (London: Ernest Benn, Ltd., 1924.) 15*s*. net.

IT was a very happy thought which prompted the preparation of this impressive work under the guidance of a committee representing the scientific societies, with Dr. E. F. Armstrong as chairman and editor. No one even remotely interested in the achievements of chemical science who visits the Chemical Hall at the British Empire Exhibition can fail to be profoundly impressed by the display of chemical products which he sees there, but he will not perhaps so easily realise the important part which British scientific workers have played in building up the knowledge which rendered that display possible. To make the achievements of British chemists clear to all the world is the purpose of the book under review; and the purpose is realised most excellently in this series of monographs written by distinguished men of science and preceded by an introduction from the pen of the editor. After reading through the 280 pages or so of which the volume consists, one has a feeling of pride in the work which British chemists and men of science have accomplished.

In a series of two dozen articles there is told, in a language which all who have a moderate acquaintance with chemistry can understand, the story of the growth of chemical science during the past quarter of a century, as promoted more especially by the labours of British chemists. In his general introduction, Dr. E. F. Armstrong gives an excellently composed survey of the domain as a whole, and we get here the kernel of the succeeding specialised articles. The opening sections of the work deal with the physical basis of matter: the atom, the molecule, the ion (by Prof. I. Masson); the structure of the atom (Dr. E. N. da C. Andrade); crystallography (Mr. T. V. Barker and Sir Henry Miers); and X-ray analysis of crystals (Sir William Bragg). These articles give a very complete survey of the whole domain of atomics, sub-atomics, and atomic arrangement in crystals, and will convey an adequate knowledge of these subjects to those whose main interests lie in other directions.

The story of the rare gases of the atmosphere is told delightfully by Dr. Travers, who does not fail to point out the practical applications of argon and helium and neon, a matter in which the layman is always specially interested.

The almost autobiographical sketch, "Milestones in Organic Chemistry," by Prof. H. E. Armstrong, one would gladly have seen expanded to greater length. It is a piece of history which all younger students of chemistry should read and ponder. The reviewer feels that it should have been placed before, not after, the article on the chemistry of the carbon compounds by Prof. J. F. Thorpe, in which the author discusses with amazing skill almost the whole realm of organic chemistry. Stereochemistry might perhaps have received rather more space.

The "Chemistry of Colloids" (Dr. W. Clayton), "Catalysis" (Dr. T. P. Hilditch), and "Fats and Oils" (Mr. J. Allan), are brief but clearly written, and will be read with pleasure. The story of one of the most notable British contributions to organic chemistry, the work of the St. Andrews school on carbohydrates, is told, as one would wish it told, by the director of the investigations, Principal Irvine. The work of Scottish chemists also finds a prominent place in the "syntheses in the terpene series," and one regrets that no room was found for an article on stereochemistry, to the development of which past and present workers in University College, Dundee, have very largely contributed.

"Cellulose" (Mr. C. F. Cross), "Colour in Nature" (Mr. R. Furness), "Coal-tar Colours" (Mr. E. A. Bearder), all deal with sections of chemistry which have been largely developed by British chemists, and the enormous growth of the cellulose industries, production of viscose silk, etc., is one of the achievements of applied chemistry of which British chemists may be proud.

How great has been the progress in biochemistry and in branches related thereto, is well seen from the interesting series of articles by Drs. F. L. Pyman and T. A. Henry ("The Alkaloids"), by Dr. R. H. A. Plimmer ("The Nitrogenous Constituents of the Living Cell"), by Dr. A. Harden ("Biochemistry and Fermentation"), and by Sir John Russell and Mr. H. J. Page ("The Chemistry of the Soil and of Crop Production").

The development of the production and utilisation of alloys and of pottery and refractories is described by Prof. C. H. Desch and by Mr. Joseph Burton. Dr. H. F. Coward contributes an interesting article on "Flame, Fuel, and Explosion," in the study of which Great Britain holds a foremost place; and Sir Robert Robertson writes, as few others could write, on "Explosives." The achievements of British chemists since 1914 in this important section of chemistry are perhaps insufficiently known and insufficiently appreciated. "The Chemistry of Photography," by Sir William Pope and Mr. W. Clark, fittingly concludes the volume. The production of plates sensitive to light of all colours and capable of giving a correct rendering of different colour tones is a great advance due to chemists, and in the production of the necessary dyes the Cambridge chemistry school occupies a prominent position.

For this great record of achievement all British chemists, at least, will be very grateful. For some reasons, perhaps, one might have preferred a more homogeneous composition from a single pen; but in the time available such a production would have been impossible. On the other hand, compensation is found in the fact that impressiveness is added to the tale, and a sense of the magnitude of the contribution of British workers to chemical science is given by the rapid change of subject and of literary style. This book should itself occupy a prominent position in the Chemical Hall at Wembley. ALEX. FINDLAY.

The Unity of Life.

Life: a Book for Elementary Students. By Sir Arthur E. Shipley. Pp. xvi+204. (Cambridge: At the University Press, 1923.) 6*s*. net.

SIR ARTHUR SHIPLEY'S little book is of an unusual type. "A year ago," he says in his preface, "the University Press asked me to write a book that would make students of elementary Biology think." Perhaps this is putting the matter a little strongly: it is scarcely just to suggest that students of elementary biology have not previously used their brains.

In his book Sir Arthur has tried to get away from the type system, and "to emphasise the unity of Life and the interrelation of living organisms." But he has still another purpose. "Finally, I venture to hope that this book will be not without interest to the public that is not preparing for examinations, and thank heaven that public is still in the great majority!"

What we lack in Great Britain is not school text-books of biology. On the contrary, there are too many, and they are usually too large, too well-organised and too informative. The great desideratum is a school *reader*—a book that might really interest a reasonable proportion of boys. "Life," if not the ideal book for the purpose, is at least of the desired type.

As the author's friends would expect, it is not only lucidly but engagingly written. You may tell a schoolboy a dozen times the percentage of water in the human body, and ten to one he will forget it. But when he reads "Even the Archbishop of Canterbury comprises 59 per cent. of water," he may remember. Or again, we are all taught that plants differ from animals in obtaining their nutriment from inorganic compounds. But the fact becomes vivid and fraught with consequences when we find it put as Sir Arthur puts it: "Their food comes to them as the roast geese in Heine's description of Heaven perpetually flew up to the angels offering them tureens of delicious soup;" but "the pleasure of the chase is denied them. Their food must be intolerably monotonous and extremely insipid. . . . Yet one hears no complaint."

The description of what a patch of grouse-moor would look like if magnified a hundred times is alone almost worth the price of the book. Admirable too is the dictum, "Fleas do not jump anything like the height or length that you think they do when you are trying to catch them." As a finale, we cannot refrain from quoting from the characteristic section on appetite. "Hunger undoubtedly induces people to eat food which a well satisfied man would not care to tackle. On the other hand, elaborate sauces and good cooking will often tempt a jaded appetite to put forth new efforts." Then we are told of the gastronomic preferences of Sydney Smith, Disraeli, Charles Lamb, and Dr. Johnson, and are hoping for more, when our author's conscience pricks him and he ends, "But I must stop dealing with these literary appetites, and get on with the next chapter." But meanwhile in another chapter he has made an important pronouncement on the same subject: "Man is the only animal that cooks its food, but the distance between the rough cookery of the Australian native or an Abyssinian and that of a French chef is almost immeasurable. The higher branches of cookery are one of the chief arts in which men invariably rise superior to women. . . ."

The book is not, however, without its faults. There is too much illustrative detail; the beginner will often find it difficult to see the wood for the trees. Especially in the more recent fields of research, the author has not always shown himself very critical. There are various errors and omissions which should be rectified. *E.g.*, on p. 71, the only positive statement made about the economic status of wild birds is that "they do a great amount of destruction in our gardens and orchards, and our cornfields." This may be so, but if there is one established fact in economic ornithology it is that the net benefit due to birds is enormous. The statement (p. 5) that the ductless glands are "the cause of many obscure diseases" is surely a lapse of our author's usually lucid pen. Many free-living protozoa (including the familiar Paramecium) are easily visible to the naked eye, in spite of Sir Arthur's statement to the contrary (p. 18). If he had wished to be very up-to-date he might have put in a word of warning against overdoing the fat-soluble vitamin in adult life.

However, Sir Arthur's book deserves a place in the library of every school department of biology; the professional biologist will read it with pleasure, and the layman with both pleasure and profit. But the author might make the second edition even better than the first.

Our Bookshelf.

The Principles of Insect Control. By R. A. Wardle and P. Buckle. (Publications of the University of Manchester: Biological Series, No. 3.) Pp. xvi + 295. (Manchester: University Press; London: Longmans, Green and Co., 1923.) 20*s.* net.

THE literature dealing with the various methods of controlling injurious insects has now assumed such vast proportions that it is almost beyond the capacity of the economic entomologist to keep abreast of it. The necessity has arisen for periodic stocktaking of this accumulated information in order that the situation may be reviewed as a whole. Messrs. Wardle and Buckle have rendered a very distinct service in providing an excellent résumé of the present-day position with regard to insect control. In undertaking this task they have had the difficulty of sifting a literature often contained in unfamiliar languages, and scattered through a heterogeneous series of scientific, technical, and practical publications—many of which are relatively inaccessible. The collation and arrangement of the extracted information also presents certain difficulties, particularly on account of the wide and disjointed range of subjects dealt with.

These troubles have been surmounted by the authors very successfully, and they have managed to produce a very readable and coherent book. Their method has been to divide the volume into four parts, comprising altogether sixteen chapters. Part I. is devoted to biological means of control, including host-resistance, effects of climatic factors, disease, predaceous and parasitic insects, and insectivorous birds. All these different subjects are, for the most part, adequately treated. Part II. is concerned with insecticides, and is the longest and best section of the book. Part III. deals with mechanical control, including cultural methods, restriction of spread, storage of crops, and baits and traps. The section devoted to cultural methods might perhaps have been longer in view of their importance, and more examples of such methods enumerated. Part IV. is devoted to a short discussion of legislative control, and the book concludes with an appendix on various types of insecticide machinery, together with a very good classified bibliography. In a few words, it may be said that the volume should appeal to economic entomologists, since it covers the whole field of a subject which has not been previously surveyed in so comprehensive a manner.

(1) *Foundations, Abutments, and Footings.* Pp. xiv + 414. 20*s.* (2) *Structural Members and Connections.* Pp. xviii + 611. 30*s.* (3) *Stresses in Framed Structures.* Pp. xiv + 620. 25*s.* Compiled by a Staff of Specialists. Editors-in-chief, Prof. George A. Hool and Prof. W. S. Kinne. (Structural Engineers' Handbook Library.) (London: McGraw-Hill Publishing Co., Ltd., 1923.)

THE three volumes before us belong to a series of six, which is intended to provide a complete work of reference covering the design and construction of modern civil engineering structures. A large number of prominent American engineers have co-operated in the production, and the commendable plan has been followed of making each volume, so far as possible, complete in itself. (1) The volume on foundations is copiously illustrated with examples taken from practice, and deals with all the matters which require consideration, from the preliminary investigation of the soil to the completed foundation, and includes such special points as underpinning, waterproofing, etc. Practically all types of engineering foundations are included. (2) The volume on structural members and connexions opens with brief statements of the general theory, occupying the first 171 pages; the remainder of the volume is taken up with the design of steel, cast-iron, wooden, and reinforced concrete members. The student who has mastered the elementary work on materials will find much of interest in the earlier part of this volume. The part dealing with design is exceptionally good, and contains much matter which is usually either omitted or receives scant treatment in British text-books. (3) The volume on framed structures also opens with a section on the general theory, occupying 158 pages. This part is by no means copied from the second volume, and includes methods of treating moving loads. The remainder of the volume deals with roof and bridge trusses, portal bracing, deflexion, secondary stresses, statically indeterminate frames, high buildings, towers, etc. The slope-deflexion method is generally employed for the solution of statically indeterminate frames in this treatise. Taking all three volumes, the authors have succeeded in producing an extremely valuable work of reference which cannot fail to be of service to civil engineers.

Theory and Practice of Mine Ventilation: a Text-book for Students and a Book of Reference for Managers and Under-managers. By Thomas Bryson. Pp. viii + 255. (London: E. Arnold and Co., 1924.) 8*s.* 6*d.* net.

MR. BRYSON is an experienced teacher of mining and is well known as a writer in mining technology. He has been at considerable pains to present his material in that order and manner which renders it most readily assimilable by the majority of his readers. The subject is undergoing re-solution; its treatment just now is difficult, and there is evidence that the author has not found it easy to balance between obsolescent dogma on one side and the quicksands of controversy on the other. The task is too Blondin-like to escape an occasional slip. We observe, for example, a repetition of the usual fallacy in reference to the origin of the "fuel cap," as the non-luminous mantle of a flame is inappropriately called. Nor do we agree with the neglect of the "dynamic water-gauge" at the expense of the "static gauge," especially as the former is required in determining the efficiency of fans. Again, the simpler and more precise form of Pitot tube made by the Cambridge and Paul Scientific Instrument Company is to be preferred to the type illustrated, and the simpler British alternative is more satisfactory than the hygrodeik.

It is to be doubted whether the inclusion of "ventilated" colliery plans without complete analysis can be of benefit. The author has, perhaps, attempted the impossible in treating of the "ventilation of plans" in a single short chapter.

Mr. Bryson is a strong and convincing advocate of the direct method of expressing ventilating resistance—a method which he places to the credit of Cambessédès—and for his presentation of that side of the subject we have nothing but praise.

The reputation which Messrs. Arnold have gained as the producers of well-printed and capably edited scientific text-books is not likely to be diminished by this volume, the virtues of which considerably transcend the defects.

Bibliographie de la relativité : suivie d'un appendice sur les déterminants à plus de deux dimensions, le calcul des variations, les séries trigonométriques et l'azéotropisme. Par Maurice Lecat, avec la collaboration de Mme M. Lecat-Pierlot. Pp. xii+291+47. (Bruxelles : M. Lamertin, 1924.) 90 francs.

It is a striking instance of the acceleration of ideas in the modern world that a theory which five years ago was known only to a narrow circle of mathematicians engaged on an abstract and abstruse problem, and until then unverified, should have produced already a flood of literature. The mere catalogue of the books and articles written on the principle of relativity occupies 290 pages, and an appendix of more or less associated mathematical works, another 47. A whole century elapsed before the hypothesis of Copernicus became the universally accepted Copernican theory, and at least one generation passed before Newton's gravitation formula received general recognition. Of course in neither case was the proof so dramatic and the conviction so immediate and the interest so intense as in the eclipse expedition of 1919. The nearest analogy to that was Pascal's experiment with the barometer on the Puy de Dôme in 1648, which established the theory that the atmosphere has weight.

The author's incentive to compile this catalogue and the diligent application it required are set forth in a rather curious preface, in which the writer, a pacifist and cosmopolist, bemoans the militarism of his country and its government. The relevance is not quite clear. He tells us, however, the significant fact that numerous authors, almost all university professors, begged him with a touching insistence, that he would omit some of their writings, if not all, because they were completely false. To this request, however, he informs us he was inexorable. No doubt selection would be difficult and hazardous, but it seems hard that a writer should be held to the fatal ὃ γέγραφα, γέγραφα.

The Birds of Portugal. By William C. Tait. Pp. xii+260+10 plates. (London: H. F. and G. Witherby, 1924.) 18*s.* net.

When one thinks of the many ornithologists and bird-lovers in Great Britain, and of the numerous books on British birds, it is surprising to learn that Mr. W. C. Tait knows of only one native field ornithologist in Portugal, where he has himself for long been resident, and that the literature on Portuguese birds is exceedingly meagre. His own book on the subject fills a gap in a useful way. It is almost entirely devoted to a systematic account of the status in Portugal of each species, no attempt at descriptions of birds being made. An introductory chapter describes the physical characteristics of the country. A second general chapter deals with migration, giving a somewhat disjointed but nevertheless interesting account of its Portuguese aspects. Many species which are native to Northern Europe are only winter or passage visitors to Portugal, and that country is perhaps interesting to us, ornithologically, chiefly by reason of its place in the migratory path of our own summer birds. In an appendix, Mr. Tait gives a list of all the marked birds which he knows to have been recovered in Portugal, although we notice that this is not quite so complete as it could have been made from published sources; nearly thirty species are represented in the list, in which birds marked in the British Isles and in Holland bulk most largely (little marking is done in France), although there are also birds from Germany, Denmark, Sweden, Czecho-Slovakia, and Switzerland.

Developments in Power Station Design. By E. Austin. (The Engineer Series.) Pp. xv+271. (London: Constable and Co., Ltd., 1923.) 31*s.* 6*d.* net.

This book will be found useful and interesting by every one connected with the design of electrical power-houses or associated with the installation and operation of steam and electrical plant. The author looks forward to the time when every factory will be driven electrically and power production will be confined to very large power stations. Before this happens, however, it is essential that every manufacturer who generates power for his private use should cut down his consumption of fuel to a minimum. This is highly desirable, not only to reduce his working expenses but also to prevent waste of the nation's coal resources.

There are excellent chapters on pulverised coal-plant, low temperature carbonisation, and waste heat. The boiler-house plant is discussed very thoroughly, but we should have liked a more thorough discussion of the electrical side of power generation. It is a pity that up to the present time very little progress has been made with the huge scheme outlined by the Coal Conservation Sub-Committee in 1918. This is partly due to the lack of interest in the subject by the nation.

Cobalt Ores. By Edward Halse. (Imperial Institute: Monographs on Mineral Resources, with special reference to the British Empire.) Pp. ix+54. (London: John Murray, 1924.) 3*s.* 6*d.* net.

This small work forms one of the series of Imperial Institute Monographs and follows the familiar arrangements of its predecessors, commencing with a description of the occurrences of cobalt ores and the uses to which the metal is applied, this being followed by a chapter on the sources of supply of cobalt ores within the British Empire and in foreign countries. As usual, a useful bibliography completes the volume. The work has been quite satisfactorily done, though it must be admitted that the task in this case was a tolerably easy one, as a good deal of the matter was ready to hand. The Canadian Department of Mines has published a good deal of information about cobalt, particularly the researches on the metal and its alloys by Dr. H. T. Kalmus. Naturally the statistical and other material collected by the Imperial Mineral Resources Bureau has been made use of. The little work can be recommended to any one who desires a concise review of the occurrences and distribution of the ores of cobalt.

Letters to the Editor.

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

The Use of "Shear" in Geometry.

WHEN an area or solid is subjected to "shear," although the boundaries are changed in form, the area or volume remains constant.

This characteristic of shear may be applied in the demonstration of a large class of geometrical propositions, and I have found it useful in many physical inquiries.

If any plane area is supposed to be divided into straight linear elements, parallel to a given axis, and if each element is caused to move in its own direction by an amount proportional to its distance from the axis, then if the axis passes through the centre of inertia of the area, the result is a pure shear. In any other case both shear and displacement are produced, or if the axis is infinitely distant, the change becomes a simple displacement without distortion.

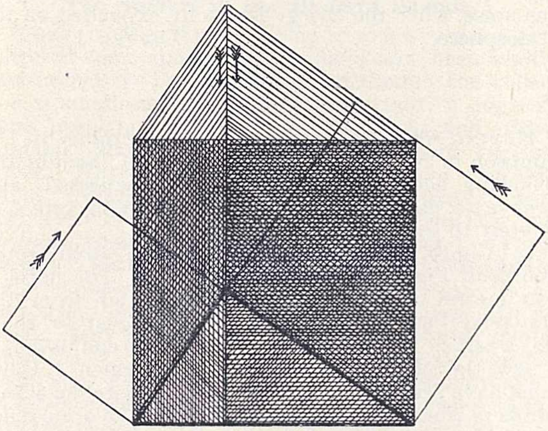

Fig. 1.

The constructions and proofs furnished by the method of shear seldom require the use of words or writing, but may be compared to the putting together of picture-puzzles in which the pieces, while retaining a constant area, may be changed in form and position according to certain rules.

The following examples will indicate the kind of propositions to which the shear method is applicable:

(1) If one side of a triangle is given, and a line parallel to that side is drawn through the vertex, then by a single shear, that is, by shifting the vertex along the line, every possible triangle can be formed which has the same base and area as the original triangle.

(2) If two sides of a triangle are given, the area of the triangle is a maximum when the angle contained by the given sides is a right angle.

(3) From this it follows that the maximum area of any polygon the sides of which are given occurs when the angles of the polygon lie on a circle;

(4) and, hence, the maximum area which can be enclosed by a line of given length is a circle.

(5) By two shears, any triangle can be converted into a rectangle of equal area.

(6) By two shears, any rectangle can be converted into an equal square.

(7) Such of Euclid's propositions as relate to equality of areas can be dealt with by shear. As an example the proof of Prop. 47, Bk. I. is shown in Fig. 1. (Here the successive pairs of shears are indicated by single and double hatching.)

(8) A circle of radius r can be converted into an ellipse with semi-axes a and b ($r^2=ab$) by a shear the magnitude of which is $(a-b)/r$ (see Fig. 2).

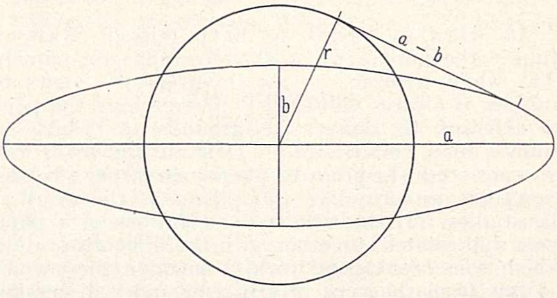

Fig. 2.

Often there are several ways of arriving at the same result, and in complex cases (especially in three dimensions) it requires some practice to select those shears which produce the required change of form with the fewest operations. It is always possible, however, by the shear method to transform any plane or solid figure into any other assigned form having the same area or volume.

A. MALLOCK.

9 Baring Crescent, Exeter,
June 6.

Mendelism and Evolution.

ALTHOUGH I do not wish to defend Dr. Annandale's theoretical views, or to maintain that his evidence for his conclusions was sufficient, I feel tempted to make some comments on Mr. J. S. Huxley's letter in the issue of NATURE for June 7. First, I should like to point out that Mr. Dover was using an unfortunate expression in writing that "some inherited characters at least are persistent." It is generally agreed that all inherited characters are more or less persistent. It would seem that Mr. Dover meant that some effects of environment are inherited.

Mr. Huxley states that no biologist disputes that "the differences seen between species, genera, etc. . . . stand in some intimate relation with their environment." The proposition is disputed by myself for one, and by Mr. Bateson for another, and Mr. Huxley will admit that Mr. Bateson at least is a biologist. It is necessary for "progress in evolutionary biology" to distinguish between those characters which are obviously in relation to the environment, and those which, although diagnostic of species, genera, etc., exhibit no such relation. There is no evidence concerning the majority of specific characters that they are in intimate relation with the environment.

Mr. Huxley considers that experiment is the one thing necessary for the elucidation of evolutionary problems, but I have long ago come to the conclusion that experiment by itself is of no more value than observation by itself. Two other things are essential —(1) a real and thorough understanding of the phenomena to be explained and the problems they present, (2) sound reasoning applied both to observation and experiment.

Instances are almost daily afforded of unsound reasoning from experiments, leading to erroneous conclusions applied to problems which are imperfectly understood. For example, Prof. T. H. Morgan discovered that castration of hen-feathered cocks was followed by the development of normal cock-feathering, and drew the conclusion that secondary sexual characters were, or might be, the by-products of internal secretions the real "utility" of which was quite different. J. T. CUNNINGHAM.

University of London Club,
21 Gower Street, W.C.1.

MR. HUXLEY seems to have missed (NATURE, June 7) the main point I wished to emphasise, namely, that while criticism of one investigator's views by another is always valuable, it is stretching the point to attempt to define the grounds on which an opinion may be advanced. It is natural for a man who has studied a group of phenomena from a certain viewpoint to formulate an opinion as the result of his studies. If the admitted limitations of a paper were appreciated, together with the difficulties under which some zoologists work, I imagine they would be free from the type of criticism under discussion. That Dr. Annandale's opinions may have been strengthened or modified by experimental data I do not deny, and if Mr. Huxley's letter directs attention to the neglect of experimental work in India it will have served a useful purpose; but, as I said, it is expecting too much to require a man already engaged in studies so diverse as Dr. Annandale's to supply the need himself.

Mr. Huxley's assumption of my lack of knowledge of his studies on the courtship of birds is perhaps natural. I may mention, however, that I have always followed his writings with interest, and I ask his indulgence if I missed the ecological importance of the paper he refers to, and previously regarded it as a valuable contribution to bird "behaviour," or rather psychology.

With reference to Mr. Huxley's concluding epigram I would point out that, apart from the limited scope of Dr. Annandale's paper, attempting as it did only correlation, it seems to be inconsistent with recent opinions on the notion of cause. Mr. Bertrand Russell ("Mysticism and Logic and other Essays," pp. 180-208: London, 1919) regards the word "cause" as "so inextricably bound up with misleading associations as to make its complete extrusion from the philosophical vocabulary desirable," and if I interpret him aright he proves that the idea of causation (absent in advanced sciences) as a fundamental axiom of science is erroneous, and that the supposed "causation" is really correlation. Accepting this argument, the geneticist is also correlating, though in a manner quite different from the methods of the pure ecologist. CEDRIC DOVER.

London, June 12.

Frequency Curves of Genera and Species.

IN NATURE for June 7, Mr. Tate Regan refers to "the series x, $x/2$, $x/3$, $x/4$, etc. . . . x/x, representing the number of genera with 1, 2, 3, 4, etc. species in a group where the sizes of genera are purely a matter of chance." I am unable to attach any *definite* meaning to the phrase "are purely a matter of chance," since the sizes might be "a matter of chance" in many different ways, and I do not see what process Mr. Tate Regan has supposed to be followed. Will he be so good as to state exactly in what way he supposes the systematist to operate, and to show how the series in question arises from his operations?

G. UDNY YULE.

St. John's College, Cambridge,
June 10.

THE simple graph published in NATURE of June 7, p. 822, by Mr. Tate Regan demonstrates the result of log plotting $xy = n$, but is otherwise irrelevant. For if the matter were so simple as that, then an infinity of species per genus would be as probable as an infinite number of monotype genera, and there would be no room on the earth for us. The introductory chapter of Mr. Udny Yule's remarkable paper in the Philosophical Transactions is carefully written for the non-mathematical biologist, and should be read by all such. W. LAURENCE BALLS.

The Orchard House, Bollington Cross,
Near Macclesfield,
June 18.

Study of Explosions.

WHETHER anything physical and instructive about the atmosphere can be learnt from a study of purposely produced explosions, I am not sure. Ordinary explosives must waste much of their energy on the earth; and if atmospheric waves are wanted, it would seem better to explode a balloon filled with a detonating gas, say a mixture of hydrogen and oxygen, at a considerable height. Gas exploded without any rigid envelope, as in a soap-bubble, makes a tremendous noise, since the energy is wholly expended on the atmosphere. OLIVER LODGE.

Ball Lightning.

HAVING read the article on Ball Lightning by Dr. Simpson in NATURE of May 10, p. 677, I thought the following account of what I once witnessed, and believe to have been ball lightning, might prove of interest to some of your readers.

In August 1900 I was staying at the Voxli Hotel, Hankelid Fjeld, Telemarken, Norway. The hotel is 776 metres above sea-level and not far from the Hankelid Pass (1123 metres). On August 21 there was a terrific thunderstorm, towards the end of which I saw the particular lightning flash which I think must have been ball lightning. I will quote the actual words in which I attempted to describe the occurrence at the time.

"We were sitting in the dining-room at supper (precisely 8 o'clock Norwegian time); on an ordinary day it would still have been good daylight, but owing to the storm it was only just light enough to see the outline of the hills on the opposite side of the lake. This was the direction (south-west) from which the storm was coming, and I had been watching the particularly vivid lightning for some time, when suddenly I saw a streak of 'yellow,' apparently about one inch broad, dart from the sky just above the top of the hill opposite and, gradually falling, make straight for where I was sitting. I was too spellbound to move, and the length of time of the whole occurrence was too short to call the attention of those who were sitting with me. I remember having the sensation that it must hit my forehead, when just as it got in front of the hotel window it changed to a ball of dazzling yellow fire (about the size of a cricket-ball) and then burst with a frightful crash, emitting volumes of violet-coloured flame, which spread in all directions. This must have happened in one or two seconds, but for several minutes afterwards I was completely dazed.

"Next day I examined the ground and found the track of the flash commenced just 20 metres (no yard measure to be had here) from the hotel window. The whole of the surrounding space is covered with small sods and branches of trees, and two or three small trees are uprooted. The most noticeable thing is a furrow in the ground, in plan shaped like a horse shoe, but curved at both ends. Its entire length is 44 metres: its breadth varies from 7 to 24 centimetres and its depth 4 to 12 centimetres. In the path of the furrow is a large granite boulder from which two respectable-sized lumps have been cut off; one I could just lift, the other (thrown 5 metres from the boulder) I could just move but could not lift. The furrow then skirts round the edge of the boulder for a long distance, in places being completely underground. It becomes visible again farther on, passing under the roots of a small shrub, and shortly after meets the face of another rock 3 metres high. The discharge must have passed up this face, for it has left a track on the top of the rock, where moss has been torn off; but just beyond the bare rock falls into the lake and nothing more is visible."

I have some "snap-shot" photographs of parts of the track of the furrow; they are not large enough to show much detail, but I shall be glad to forward them for inspection to any one interested.

ARTHUR W. CROSSLEY.

Shirley Institute,
Didsbury, Manchester.

The Spiders of the Madeira Islands.

WHEN in the Madeira Islands a few years ago I collected some spiders, which have now been kindly determined by Dr. N. Banks. Although the collection is small and relatively unimportant, it suggests some problems of general interest. At and about Funchal, Madeira, I obtained *Cyrtophora citricola* Forsk., *Epeira crucifera* Lucas, *Mangora acalypha* Walck., *Teutana grossa* Koch, *Lepthyphantes tenuis* Blk., *Xysticus insulanus* Thor., *Clubiona decora* Blk., and *Chiracanthium albidulum* Blk. In the island of Porto Santo I collected *Lycosa maderiana* Walck. (abundant under stones), *Pholcus phalangioides* Fuessl. (in an outhouse), *Argiope trifasciata* Forsk. (this African species also abounds in Madeira), *Ariadne portosancti* Kulcz., *Dysdera crocata* Koch, *Dictyna* (*Ergatis*) *puella* Sim., *Epeira crucifera* Lucas, *Ero aphana* Walck., *Xysticus insulanus* Thor., *Thanatus vulgaris* Sim., *Teutana grossa* Koch, and *Zilla x-notata* Clerck.

The spiders of Madeira have been discussed by several authors, comparatively recent papers being those of Warburton (1892), Van Hasselt (1891), Bösenberg (1895), Schmitz (1895) and Kulcznski (1899). I have not seen Kulcznski's account of the Schmitz collection, though I saw the spiders themselves in the Seminario at Funchal. Warburton lists the 64 species then known from the Madeiras, 35 being supposedly endemic. As the islands are of the oceanic type, a careful study of the spider fauna should give interesting results. The means by which spiders might reach the islands are probably four: (1) Young spiders on gossamer threads floating through the air, (2) introduction by man, (3) on the plumage of birds, (4) on floating objects. The first two may be presumed to be far the most important. Such forms as the Argiope and Pholcus may be safely put down as introduced. *Epeira crucifera* seems to be a recent introduction; it is not mentioned (at least under that name) by Warburton. It would be interesting to determine whether the species likely to be carried on gossamer threads are prevalent in the islands, and whether some species frequently so carried are absent.

The differences between the spider fauna of Madeira and that of Porto Santo have not been clearly made out, and it is not known whether there are any special forms on the islets off Porto Santo. According to J. Y. Johnson (1863) there are three species of the large snail-eating wolf-spiders, *Lycosa maderiana* confined to Porto Santo, *L. blackwallii* Johns. to Madeira, and *L. ingens* Blk. to the Desertas. The snails on which they prey, representing endemic genera, are presumably much older inhabitants of the islands. Possibly there are endemic genera of spiders surviving in remote places. The collecting done so far has been mainly in the vicinity of the towns, or in the towns, and it may be that it does not fairly represent the fauna of the Madeiras.

T. D. A. COCKERELL.

University of Colorado, Boulder,
May 29.

The Scotoscope.

CAN any of your readers explain the principle of the scotoscope which Pepys defines in his diary (Aug. 13, 1664) as an instrument enabling objects to be viewed "in a dark room"? It seems scarcely credible that in the seventeenth century any such instrument could have existed, and bearing in mind the lack of science which Pepys evinced, one is tempted to wonder whether he had misunderstood the instrument-maker's "camera obscura," which would account for his speaking of a "dark room" instead of saying "in darkness" or "in the dark."

Only one other reference (without definition) to the scotoscope is given in the Oxford Dictionary, and the word is generally defined in the dictionaries, through reliance on Pepys, as being what it suggests—an instrument for revealing objects in the dark. If it was merely a synonym for the camera obscura, such a definition is misleading.

CHARLES E. BENHAM.

Colchester, June 18.

Chimæras Dire.

DR. FINKLER's experiments on the transplantation of the heads of insects have attracted both scientific and popular attention to a degree which was marked on the one hand by an exhibit last year at a Royal Society soirée and, on the other, by mention in the pages of *Punch*. It is desirable, therefore, to direct attention to an emphatic repudiation of his claims which has just been published in the *Zeitschrift für wissenschaftliche Zoologie* (vol. cxxiii. pp. 157-208) by Hans Blunck and Walter Speyer.

It will be recalled that Finkler stated that the heads of adult insects could be successfully grafted on to bodies of the other sex, and even on to bodies of distinct species belonging to widely different genera. He inferred, rather than observed, the union of tissues following the operation and hastened on to describe its remarkable results, physiological and psychological. The head of an herbivorous water-beetle persuaded a carnivorous body to be content with, and seemingly to digest, a vegetable diet; a male head led a female body into unwonted perversities; and a Dytiscus strove to moderate the colouring of its wing-cases to suit the sober tastes of its new Hydrophilus brain. Experiment was added to experiment, and water-boatmen abnormally coloured by inverted illumination transferred the abnormal coloration with their heads to other individuals not so illuminated.

It was to be expected that a field of work offering such remarkable possibilities would speedily be occupied by other investigators. The living material is easy to obtain, the technique is simple ("an Roheit schwerlich zu übertreffen," say Blunck and Speyer), and the results are got in a brief space of time; and yet no one, with the solitary exception of Dr. Kammerer, appears to have claimed success in repeating even the less startling of Dr. Finkler's experiments.

Now Dr. Blunck and Dr. Speyer (already known by a long series of anatomical and biological researches on the very water-beetles that were among the chief of Finkler's *corpora vilia*) come forward with a detailed and documented confession of their failure, after persistent attempts, to confirm the simplest of Finkler's results. They followed carefully his instructions as to procedure, and only after this failed did they try to refine upon his technique. The severed heads certainly adhered to the bodies on which they had been placed, cemented, in fact, by the coagulated blood which dried to a chitin-like hardness, but in no case did the insects survive longer than others in which, after decapitation, the wounds were stanched with a little melted wax; in no case did the chimæras behave differently from the headless trunks; in no case did stimulation of the head produce reflex movement in the body or its limbs. Microscope sections showed no attempt at regeneration or union of the tissues, but instead, a progressive necrosis, leading more or less quickly to the death, first of the head and later of the trunk. These results followed, even in cases of replantation where the severed head was replaced at once on the body from which it had been detached.

Dr. Finkler may of course be able to point out to us where the German experimenters have gone wrong, but there seems to be a familiar ring in their complaint that he has ignored requests to produce his chimæras, alive or dead, for investigation by others. He cannot ignore the challenge of their final words: "Die Wissenschaft hat angesichts der allen Erfahrungen widersprechenden Angaben des Wiener Autors keine Veranlassung, sich weiter mit ihm und seine Schriften zu beschäftigen."

W. T. CALMAN.

British Museum (Natural History),
South Kensington, S.W.7.

The Origin of Ores.

REFERRING to the very kind review by Prof. H. Louis of my book "The Geology of the Metalliferous Deposits" in NATURE of June 7, p. 812, I wish to direct attention to one point. Prof. Louis quotes the following sentence: "It would perhaps be too much to say in the present state of our knowledge that all primary ore-deposits are of igneous origin, but this is a view which may very likely be established as a result of future work." He then goes on to instance the hæmatite deposits of Cumberland as ores which are certainly not of igneous origin. With this, of course, I entirely agree, and I wish to say that my statement was certainly never meant to include them, as may be seen by referring to p. 330 of my book. The emphasis in the sentence quoted is on the word *primary*, whereas I regard the hæmatites of Cumberland and northern Spain as secondary ores. Should a second edition of the book be called for, steps will be taken to make this point quite clear.

R. H. RASTALL.

Christ's College, Cambridge.

Exhibit of Pure Science at the British Empire Exhibition.

IN NATURE of June 21, p. 896, there is a reference to the instruments exhibited under my name in the Royal Society's section in the Government Pavilion at the British Empire Exhibition dealing with the measurement of atmospheric pollution. I should like to make it clear that the credit for the original idea underlying the contrast photometer exhibited is due to Mr. L. F. Richardson. It is a development of the method described by him in the Proceedings of the Royal Society, A, vol. 96, 1919. The principle was further elaborated by the Photometric Sub-Committee of the Advisory Committee on Atmospheric Pollution, my share being only that of getting out a workable design and making the experimental instrument. I was fortunate in getting at the first attempt an instrument with remarkable sensitiveness and accuracy, which required practically no alteration and enabled a measure of light obstruction by fog to be obtained.

During the smoke fog in the afternoon of November 26 last in South Kensington, a fairly dense fog containing about 2¼ milligrammes of soot per cubic metre and about 24,000 smoke particles per cubic centimetre, the obstruction of light in 50 feet was 46 per cent. In the morning of the same day at 11.45 the amount of suspended matter was 3·8 milligrammes per cubic metre and the number of particles 82,000, the obstruction of light in 50 feet being 75 per cent.

J. S. OWENS.

Advisory Committee on Atmospheric Pollution,
47 Victoria Street, Westminster,
London, S.W.1, June 25.

Birds as a Geological Agent.

ALL along the tops of the cliffs of the Undercliff from Ventnor to Blackgang empty shells of the common limpet are found in large numbers, and it has usually been assumed that their shape has caused them to be blown by the wind from the beach over the cliffs. There are so many of them that I have found it difficult to believe this theory, and on mentioning it to a local naturalist, he has assured me that he has seen rooks and jackdaws pick them up from off the rocks while living, and convey them in their beaks to the trees where they roost and nest and to other places, and after feeding on them, cast away the empty shells. This may account for the mixture of marine shells with land shells in some of the tertiary strata which is sometimes inexplicable.

EDWARD A. MARTIN.

285 Holmesdale Road,
South Norwood, S.E.

A Substitute for the McLeod Gauge.

THE letter on the McLeod gauge appearing in NATURE of November 3 has only just come to my notice.

There may be gauges which, having been compared with a McLeod gauge, will give equivalent readings, but there is no substitute for the McLeod gauge in its perfect measurement of low pressures, expressed in height of mercury column.

If the McLeod gauge is used with proper knowledge, it *will* indicate aqueous vapour as well as permanent gases. When the gauge is so proportioned that the difference of the height of the mercury in the capillary columns is less than 4 mm. and the temperature is above 0° C., any aqueous moisture present will act as a permanent gas and will give a true reading of the pressure absolute.

HENRY A. FLEUSS.

47 Albert Road, Caversham, Reading,
June 16.

Ceremonial Banquets.

I HAVE recently received an invitation to forward a cheque for two guineas, as a fee for attending the banquet in connexion with the Kelvin Centenary. It is difficult to understand why the memory of a man of simple habits should call for such a sumptuous repast, or why scientific workers of frugal habits should be excluded from such a celebration. In view of the growing tendency to limit functions such as these to men of means rather than to men of science, it is surely time to make a protest against the methods of organisation which lead to so undesirable a result.

F.R.S.

The Plant Commonwealth and its Mode of Government.[1]

By Sir FREDERICK KEEBLE, C.B.E., F.R.S.

THE plant commonwealth lies within the contours of an individual plant — rose, lily, grass, oak tree or any other. The physical features of the commonwealth have been surveyed and are well known. Notwithstanding their differences in outward aspect, all the members of the commonwealth—root, stem, leaves, and flowers—own a common plan of organisation. As the human being is the unit of a commonwealth of nations, so is the cell or protoplast the unit of the plant commonwealth. Just as certain men have the appearance of simplicity, so has the plant cell—a minute mass of nucleated cytoplasm, bounded by a solid wall of cell-wall substance, of such small dimensions that one thousand cells might lie comfortably side by side along the diameter of a penny piece. Yet, as is the case with man, the simplicity of the cell is illusory. The cell lives, feeds, respires, grows, and does many different kinds of work. Nor does it live unto itself alone. In all its manifold activities the cell influences and is influenced by other of the well-nigh innumerable cell units of the commonwealth. Indeed, the messages which by word of mouth, by post and telephone, telegraph and wireless, pass between members of our own commonwealth and leave us but little peace, are rare by comparison with those sent and received by the living cells of plants. Throughout life they are always "listening in." In the simplest plants of all—the unicellular plants—the cell is the commonwealth. So is it in the highest (multicellular) plant at the moment of the rebirth of the individual within the ovary of the flower of the mother-plant. All plants begin life each as a single, minute mass of semi-fluid nucleated protoplasm. Every activity evinced by this living particle shows alike the diversity of its unrecognisable parts and the integrity, that is, the individuality of the whole, and throughout life diversity of activity and oneness or individuality alike persist.

From simple raw materials the cell-protoplasm restores and augments itself, and gradually stage by stage the plant carves out its body from this increasing mass of living substance. The primal cell grows and divides to form two daughter cells, each, like the mother cell, consisting of nucleated protoplasm invested by a wall or coat of cell-wall substance. Yet though a solid wall divides them, the daughter cells are not isolated from, but remain in communication with one another. For, in the first place, the separating wall is very thin and soluble substances may pass across it readily, and, in the second place, fine strands of cytoplasm radiating from the central mass penetrate into pits in the cell wall and, joining or all but joining with corresponding strands from a neighbouring protoplast, maintain vital touch between the cells. So in like manner the daughter cells divide, and the cells to which they give rise maintain vital contact by their protoplasmic connecting fibres, until after many divisions the embryo is recognisable within the swelling seed. If by some magical liquor the cell walls and all the non-living contents could be dissolved away and the transparent semi-fluid protoplasm made hard and visible, the contours of the plant would still be recognisable.

[1] Discourse delivered at the Royal Institution on Friday, March 21.

Not all of the cells which compose the body of the embryo plant remain unchanged. Some, it is true, appear to do nothing else but grow and divide. They are the producer or embryonic cells destined throughout the life of the plant to carry on the work of cell formation. Groups of them are to be found at all ages of the plant in the growing point of the root and in the buds on the stem. In long-lived plants, after a thousand years and many thousands of divisions, these embryonic cells still retain their powers of cell-formation. Theirs is the gift of perennial youth; they never grow up. Once established, a growing point exercises a dominating influence over the broods of cells which it throws off by the division of its component embryonic cells. In some way, as yet unknown, it influences or perhaps determines the morphological fate of its offspring. For, as has been shown recently, a minute fragment of a root tip $\frac{1}{25}$ in. in thickness, if cut off and fed with mineral salts and suitable proteins, grows, divides, and in the cells which it produces, the same differentiation appears as in the normal root.

Other cells of the plant body soon cease to divide, but undergo no very great change of form. They become the general working cells of the body. Others assume curious and characteristic forms and, grouped together, constitute gangs of cells—skilled cellular artisans—to each of which some special task is assigned. Yet other cells or groups of cells undergo greater change of size and shape. For example: those destined to give rise to the woody vessels along which sap passes from root to stem grow wide and very long, join above and below in single file with cells like themselves, build thick and woody longitudinal walls, often beautifully sculptured, and, losing their contents and dissolving away their cross walls, form long uninterrupted tubes—mere aqueducts. It requires but little imagination to realise how imperative must be the constraint brought to bear on those wood-forming cells to induce them thus to immolate themselves for the benefit of the plant commonwealth. Their fate suggests that as the commonwealth develops the cellular units suffer more and more curtailment of liberty. Each is constrained to endure a limitation of freedom, and each imposes a limitation on that of other units of the plant body. In this compromise between liberty and social obligation a new and higher unit is fashioned—the individual plant, that is, the plant commonwealth. If this way of regarding the individual be correct, it must be of interest to explore the nature of the messages which, passing between members of the plant body, bind them together and determine the subordination of the cells and their integration into an individual. On these trifles, "light as air but strong as iron," the existence of the commonwealth is based. It is to the origin, nature, and effects of these messages that I propose now to refer.

I know of no better way of approach to this task than by describing—at the risk of the smile it may evoke—the strange things that happen when a potato is peeled. An immediate effect of the operation is the setting up of a state of fever. During this wound fever the temperature of the tissues near the cut rises rapidly as a result of increased cell respiration. The wounded cells die; those of the layer next to them, no longer hemmed in on all sides, find some relief from the bondage which held their activities in subjection. They grow out to form bladder-like or tubular projections. In the welter and confusion due to loss of touch with other cells, these cells break rank and become a law unto themselves. Their growth is, however, limited and aimless, and presently withering and turning brown, their dead remains form a thin dry skin over the wound. Behind the broken ranks the orderliness of behaviour of the cell layers is maintained; but it is a new order which these cells obey. They form a new front. Dividing rapidly and in a regular manner, these cells come to present the appearance of rows of microscopic bricks. When the originally single layer of dividing cells has given rise to several layers, the cells of the outermost form thick corky walls, lose their living contents, and come to consist of mere empty shells fitting as hollow bricks might fit closely one with another. Thus by the formation of wound tissue is the wound healed. Until recently, nothing was known of the provenance of the new orders which stir the cork-forming cells to activity and, releasing them from obedience to previous orders, cause these cells to renew their youth and reassume the power of division. But it is now known as a result of investigations made by Prof. Haberlandt that the renewed activity is called forth by messages from the stricken and dying cells.

The origin and nature of these messages may be determined by very simple experiments. For example: if the bulbous stem of a kohl rabi (turnip-stemmed cabbage) be cut across, all the changes just described may be observed to take place. But if the cut surface be rapidly and thoroughly washed with a stream of water, little or no cork formation occurs; the wound does not heal. When, however, the washed surface is covered with a layer of brayed-up cells of kohl rabi tissue, cork formation proceeds even more vigorously than it does in the unwashed wound. Whence it is to be concluded that messages are sent by the wounded cells and that the messages are of a chemical nature. As they die, these cells liberate some substance which, diffusing into the living cells, quickens them to activity and provokes their division. This stimulator of specific change may be spoken of as a wound hormone. Its presence may be demonstrated experimentally in many different kinds of wounded tissue, and in none better than in the succulent leaves of sempervivum and sedum. Leaves of these plants may be readily torn asunder without mechanical destruction of their cells; for the cell walls between the cells give and split so that the protoplasm of the cells remains intact. Now it may be shown that whereas by cutting a leaf and thereby destroying numerous cells the cell division provoking hormone is produced, by tearing it the hormone is not produced. The wound hormone, this message of healing, is sent out by the dying cells. Thus may plants rise by stepping-stones of their dead cells to higher things.

Further insight into the circumstances in which wound hormones are produced may be obtained by observing the effects which follow upon mechanical injury of delicate plant-tissues, as, for example, the multicellular hairs so often found on leaves and stems. These structures are formed each by the outgrowth and division of a single surface cell. This cell divides to form a row of cells placed end to end; after a few divisions growth ceases, and the constituent cells of the hair divide no more. If, however, the hairs on the leaf or stem of a coleus or zonal pelargonium be maltreated by cutting or pinching or by less drastic means, as, for example, rubbing gently between the fingers or brushing with a hair brush, cell division may in certain circumstances be resumed. If a hair be cut across with a sharp instrument the cell cut into dies at once, its contents dry up, and no division occurs in the remaining intact cells. But if the instrument, in removing the top of the hair, also bruises the cell beneath the one cut into, the bruised cell enclosed in its wall, though it dies ultimately, has time to prepare its message, and its last will and testament consists in wound hormone which, passing to the next-of-kin, endows that cell with renewed powers of cell division. The wound hormone, diffusing into a cell, exercises an attraction on the nucleus which moves up in the direction of the injury, and in consequence nuclear divisions and subsequent division occur in the part of the cell near the wall across which the hormone diffuses. In some plants, as, for example, the zonal pelargonium, the basal cell of the hair appears to resist injury more than the other cells, and hence it may happen that when the stem bearing the hairs is brushed not too harshly, all the cells of a hair are killed except the basal cell. If this sole surviving cell, though damaged as may be seen by a puckering of its wall, has not been mortally injured, it produces wound hormone and thereby stimulates itself to cell division.

It may, and I think it will be that these discoveries are destined to throw light on many obscure phenomena in plants. Thus it has long been known that by wounding a plant a turmoil may be set up which spreads from the seat of injury to the uttermost parts of the plant. When a branch of a tree is lopped there are repercussions in the roots buried deep underground. The turmoil is visible under the microscope. In normal circumstances the protoplasm of a plant cell presents no sign of movement; but in certain circumstances an incessant restlessness very marvellous to witness overcomes it. All its granular mass except the layer next the cell wall begins and continues long to circulate around the cell or else to stream up and down along certain lines. When tissues are injured this streaming or circulation of protoplasm begins in cells near the wound, infects the cells next to them, and so on until, like bees disturbed in a hive, the myriad protoplasts of the plant are all in active movement.

In the light of the experiments with wound hormones, it would seem probable that the propagation of the disturbance which leads to streaming is due to some chemical message passing by diffusion from cell to cell. Again, it would seem possible to ascribe the remarkable behaviour of the fertilised egg cell to the influence of a wound hormone. As is well known, the egg cell of a plant or animal remains quiescent until it is penetrated by the male reproductive cell. Soon after this event the fertilised cell begins actively to divide, and continues growth and division until the embryo has been formed. Ingenious experimenters have shown that egg cells of the lower animals and of some plants may be caused to undergo division and to produce embryos even in the absence of fertilisation. Thus the unfertilised egg of a frog pricked by a needle has been caused to undergo division and development, and to give rise to fatherless tadpoles. Hence there would seem to be little doubt that, in normal fertilisation, the abrupt entrance into the egg cell of the male reproductive cell leads to the production of a wound hormone which acts specifically in provoking cell division.

It might be objected that such an hypothesis presupposes an almost incredible delicacy of protoplasmic organisation, but the objection has no weight with the plant physiologist who knows from long experience that disturbances of protoplasm, often so slight as to escape our own powers of perception, may suffice to produce marked and far-reaching effects in plants. The exposure of one side of the tip of the seedling leaf of oat or other grass to direct sunlight for periods of so brief a time as $\frac{1}{2000}$th of a second suffices to interrupt the uniformity of its upright growth and make it do obeisance to the sun. The tendril of the passion flower has a receptiveness so acute that the hanging upon it of a thread weighing no more than $\frac{1}{1000}$th of a milligram suffices to deflect the tendril from its course of growth. It curves in the direction of an incubus, the weight of which would have to be increased tenfold before we, if it were placed upon the skin, could be made aware of it by our sense of touch. The human eye is apt to distinguish small differences of light intensity. When we are young, our eyes can perceive the difference between a ninety-nine and a hundred candle-power lamp. As we grow old, acuteness of perception fails, and we are lucky if we can tell the difference between lights of one hundred and ninety-six candle-powers. A leaf can "tell the difference" between one hundred and 98·7 candle-power, so that its sensitiveness, as expressed by responsive movement, is equal to that of a fairly young eye. The trained eye is a wonderful instrument for perceiving whether or no a line be truly vertical, but I doubt whether its power is greater than that of the root of any plant. More than once a delicate experiment in plant behaviour has come to grief because the experimenter failed to notice that his table was not absolutely horizontal, and in consequence his plants not vertical. The plants themselves took heed of the displacement and set to work to rectify it to the undoing of the experiment.

(*To be continued.*)

Large Crystals of Iron.

THE paper by Prof. Edwards and Mr. Pfeil presented at the May meeting of the Iron and Steel Institute on "The Production of Large Crystals by Annealing Strained Iron" has now brought iron into the rapidly growing list of metals which can be obtained in the form of very large crystals. The research follows on a preliminary paper presented to the Institute by the same authors a year ago, in which they dealt with the commercial importance of coarse crystallisation in a number of defective stampings which had come into their possession. Methods of producing large metallic crystals may be classified under the following heads: (1) By slow cooling of the melt; (2) by drawing a rod slowly out of the melt; (3) by straining to a critical amount a test-piece composed of small metallic crystals, followed by heat treatment; (4) by the simultaneous application of strain and heat treatment to a metal wire. The method adopted by the authors is No. 3, which was introduced in 1921 by Carpenter and Elam in the case of the metal aluminium, and the large crystals produced are very similar in form.

It could have been predicted that iron would be more difficult to prepare by this method in the form of "single crystal" test-pieces than aluminium, for two reasons: (1) That no suitable form of commercial iron exists; and (2) that no heat treatment can be carried out above 900° C. on account of the A_3 change point at which the α to γ change occurs. Another difficulty presented itself in the course of the research to which reference will be made. The authors employed as their starting material mild steel plate 0·125 in. thick, containing 0·10 to 0·13 per cent. of carbon and the usual amounts of commercial impurities. The sheets were covered with a thin layer of scale which had to be removed by pickling in dilute sulphuric acid, leaving a dull metallic surface free from serious defects. The test-pieces used were from 8 to 12 in. in length by 1 to 2 in. in width. Chappell's earlier work having shown that the presence of carbon in iron restricts the size of the crystals which could be developed, and the authors' investigations of the defective stampings having shown that coarse crystallisation was more pronounced where decarburisation has occurred, it was decided to remove all carbon from the test-pieces before attempting to produce large crystals. It was necessary to determine carefully the conditions of decarburisation, since the problem resolved itself into obtaining an iron of suitable crystal size free from carbon. As the result of a large number of experiments, it was found that a grain size of approximately 120 grains per square millimetre is required. This was obtained by decarburising at a temperature of 950° C. for 48 hours (*i.e.* in the γ range), followed by slow annealing (12 hours from 950° to 100° C.). The complete removal of carbon was found to be necessary. From this material large crystal test-pieces could be prepared by an elongation of 3·25 per cent. produced by tensile stress, followed by annealing just below the A_3 change point (about 880° C.) for three days. The maximum size obtained was 4 in. × $1\frac{1}{4}$ in. × $\frac{1}{8}$ in.

A complication from which aluminium is free is the presence of a surface film of very fine crystals which masks the very large crystals produced, and in order to reveal them it is necessary to remove this layer. The authors' experiments show that in general this film was just one crystal thick, and they concluded that those crystals in the original material which had a "free boundary" did not undergo the same kind of change during deformation by tensile strain as the interior crystals. They found, however, that if the elongation was produced by rolling, the surface film of fine crystals was not produced after annealing.

Tensile tests were carried out on test-pieces cut from strips containing large crystals, so that the parallel portion in each case was occupied by a single crystal. Values of from 9 to 10 tons per square inch ultimate stress and 30-50 per cent. elongation on 2 inches were obtained, and may be compared with about 19 tons per square inch and 53 per cent. elongation obtained for the same material in the fine-grained condition. A single crystal cut from the coarsely crystalline strip can be rolled out to 100 times its original length and reduced from 0·125 to 0·001 in. without annealing and without showing any signs of cracking at the edges. The properties in this respect were very similar to those of the aluminium crystals made and tested by Carpenter and Elam. It was found, however, that in certain circumstances these large iron crystals were exceedingly brittle, a property not hitherto observed with aluminium. If a crystal were placed in a vice in a certain way and given a sharp blow with a hammer, fracture frequently occurred along what appeared to be a cleavage plane. A large number of crystals were broken in this way. Only in a few cases did bending occur, such as would happen in finely crystalline iron. In the large majority of crystals tested it was found possible to obtain fractures in two planes exactly at right angles. The authors consider it probable that the large crystals grown in strained iron possess a similar orientation.

Messrs. Edwards and Pfeil have established two important facts which bear on the production of large iron crystals: (1) The critical strain required to produce very large crystal-growth on subsequent annealing varies with the initial grain size of the material used, the larger the grain size the greater being the strain required. With very large crystals, sufficient strain to cause growth cannot be applied, since recrystallisation occurs at the crystal boundaries. (2) Surface crystals of the original finely crystalline aggregate behave differently from those in the interior and require a greater tensile strain before they will disappear.

The authors explain these facts in the following way. In the case of a single crystal it is considered that deformation occurs by a process of slip causing little change in the crystal lattice. Some change must occur, for single crystals of tungsten, aluminium, and iron are hardened by cold work, but in the case of single iron crystals, whatever change up to 25 per cent. elongation occurs is removed on annealing without producing recrystallisation. If, however, two crystals in contact are deformed, there will be interference with slip, owing to the change in the direction of the slip planes in passing from one crystal to the other. In these circumstances some other kind of movement must occur during deformation. X-ray analysis does not indicate any difference between the lattice constants of cold worked and annealed metals, but shows a relation in the former between the direction of the crystallographic axes and that of straining.

The second type of deformation is interpreted therefore as a rotation of the crystallographic axes accompanied by elastic strain. The depth to which this change penetrates from the boundaries depends upon the degree of deformation. With small crystals but little deformation will cause the depth to correspond with the radius of the crystals. The larger the crystals the greater the deformation necessary to cause the change to reach the centres. When this second type of deformation has penetrated to the centres (and the strain at the crystal boundaries has not exceeded a certain value) the authors consider that the degree of axial alignment due to rotation has proceeded to such an extent that, on annealing, it is easier for the atoms to form a single crystal than to revert to their original orientations. With very large crystals, however, before the second type of deformation has penetrated to the centres, the strain set up at and near the crystal boundaries has become so great that, on annealing, the atoms in these highly strained regions preferably form new crystals, *i.e.* recrystallise.

With regard to the small surface crystals, the authors consider that a greater degree of deformation produced by tensile stress is required before the change is sufficiently complete to permit of growth or absorption during annealing. When, however, the critical degree of strain is caused by rolling and the freedom of the surface crystals is thus at least partly removed, their growth or absorption can occur.

H. C. H. C.

Immigrant Cultures in Egypt.

By Sir FLINDERS PETRIE, F.R.S.

A GENERATION ago our view of Egypt was limited to three brilliant periods, without beginnings or connexions. The discovery of the predynastic ages in 1895 showed two successive civilisations, waxing and waning, which were disentangled by the classification of sequence-dating, and appear to have come in first from the west and then from the east. The further discovery of the royal tombs of the earliest dynasties at Abydos provided a monumental basis for what had, so far, only been recorded history. There the position has rested for twenty years, but recently much more has come to light, consolidating the long view of the past.

On a jasper cylinder seal of Asiatic work, the figure of a king named Khandy was identified with the same name recorded in the VIIIth dynasty of Egypt. As that king is shown receiving homage from a Syrian, and secondarily from an Egyptian, it appears that he was ruling in Syria and holding Egypt. Other foreign names in that dynasty indicate that the VIIth and VIIIth dynasties, who succeeded the first pyramid age, were Syrian rulers. This accords with the frequent use then of button badges, always of foreign work, and bearing designs known in Babylonia and Cilicia. Excavation of the cemetery of the IXth and Xth dynasties capital, Herakleopolis, showed an entire absence of the Syrian buttons, and a throw-back on to Egyptian lines, apparently due to a Libyan immigration.

Last winter the study of the rock tombs of the Uah-ka princes of Qau—south of Assyut—of the IXth and Xth dynasties, has opened a fresh view. It had already been noted that certain black granite sphinxes from Upper Egypt, which resembled the kings of the XIIth dynasty, were markedly of the Galla type. At

Qau, the temple-tombs cut in the rock are of exactly the plan of the Nubian temples, a form unknown elsewhere; and, further, the family name—Senusert—of the XIIth dynasty appears. These facts link together and agree with the Egyptian "prophecy" of the XIIth dynasty, that a king Ameny (=Amenemhat) should arise from the south, the son of a Nubian woman. It appears, then, that when the Syrians broke in on the north, the Gallas pushed down from the south, controlled the artists in black granite, and founded a rule of the south which centred at Qau; this was in alliance with the Herakleopolite dynasties, and eventually founded the XIIth dynasty at Thebes.

Last year there came to light some work of a prehistoric culture, differing in all respects from the recognised prehistoric Egyptian. This year the clearance of a stratified deposit showed that this unknown culture was as old, or older, than the early prehistoric age already recognised. As the known prehistoric culture is quite continuous on all sites, and bears nothing like the new material, the presumption is that we are handling remains of a still earlier period. This new culture is identical in the types of flint chipping with the flints so widely spread from the Fayum up to the Palestine desert. We have now certainly the general products of this people, who have as yet only been known by their flint work. Further, this work is closely like that of the lowest stages of Susa, and the Solutrean of Europe. All of these seem to be due to various waves of one Asiatic culture, and thus accord with the recent views in the "Cambridge Ancient History." The peculiarities of this earliest known culture in Egypt are: in flint, the swallow-tail arrowhead, delicate *vesica* tools pointed at both ends; in pottery, the thinnest and hardest ware known, polished black, with the surface streaked by comb-dressing all over; in beads, glazed steatite, garnet, and carnelian; in painting, the use of long rectangular palettes, concave at the ends, with green malachite, and red hæmatite face-paint. All of these may be seen in the exhibition of the British School in Egypt at University College, Gower Street, open on July 5-26. There will also be shown more remains of the earliest human period known in Egypt, from the gravels of the eastern desert; after further study, it is hoped to give some account of these.

Obituary.

Charles Oberthür.

By the death, at the age of seventy-eight, at Rennes of the veteran naturalist, Charles Oberthür, workers in the study of insect life have suffered the loss of one whom personal tastes, the circumstances of life, and a persevering and enthusiastic character combined to make a conspicuous and leading figure among the fraternity of entomologists. As the printer and producer of his own works, Oberthür was able to give full scope to his conception of the requirements of entomological description and illustration. Similar ideals have presented themselves to others, but to few indeed has the opportunity been given to carry them out on so extensive and magnificent a scale. The splendid series of "Études d'Entomologie" and of "Lépidoptérologie Comparée" which emanated from his press at Rennes bear witness to his indefatigable labours in the advancement of his favourite pursuit, and to the liberal, one might even say the lavish, expenditure which he devoted to the worthy presentation of the results of his entomological studies. The beauty and accuracy of the hand-painted illustrations in these volumes have never been surpassed.

Though the order of Lepidoptera engaged most of his attention, Oberthür did much to further the subject of economic entomology, which he rightly recognised as being of high importance to an agricultural community such as that of the greater part of France. The material accumulated by him is of the greatest service to students of bionomics; but to Oberthür himself the various topics offered by evolutionary problems, such as those of protective resemblance, mimicry, phylogeny and distribution, made little or no appeal; nor did he concern himself with experimental investigation of the phenomena of heredity. But in his own line, and in the working out of his own methods, he was exceptionally efficient. Many have had occasion to be grateful for his kindly and helpful generosity.

Prof. Filip Počta.

Within the past few months death has taken heavy toll among the professors of the Charles' (Bohemian) University of Prague. On January 7 died Prof. Počta, professor of palæontology and geology. He was born in Prague in 1859 and studied first in our University, then in Bonn, in the Musée d'Histoire naturelle in Paris, in the Lavalle Museum in France, and from there in Stockholm with Prof. Lindström. His first big work was a modern investigation of the sponges from the Bohemian calcareous formation, of which he studied not only the external form but also the interior skeleton, and this study he extended to sponges from Hungary, Dresden, France, and from the collection of the Bonn University. After this he studied the rudists and worked in the Sorbonne, the École de Mines in Paris, as well as in the British Museum. After the death of Prof. Novák he investigated the material which was left by Barrande, who intended to describe it in the eighth volume of his classical work, "Système silurien du centre de la Bohême." For this purpose Počta made a great collection of illustrations of corals and Cœlenterata, a collection which was, as regards execution, without a rival. He also deciphered for the first time the inner structure of the end chamber of Orthoceras. The first part of the eighth volume was published in 1894 and the second in 1902. Being originally a palæontologist, he became later on a geologist. He published much in both sciences in Bohemian, German, French, and Magyár. Počta was a member of the Royal Society of Bohemia, of the Bohemian Academy of Sciences, of the Geological Societies of Paris, Berlin, and of other learned societies. BOHUSLAV BRAUNER.

We regret to announce the following deaths:

Dr. George Little, state geologist of Mississippi, 1868–72, and of Georgia, 1874–81, on May 15, aged eighty-six.

Prof. Charles Hunter Stewart, professor of public health, University of Edinburgh, on June 30, aged sixty-nine.

Current Topics and Events.

THE history of the discovery of insulin occupies an almost unique place in the scientific literature of recent times, and in the supplement which accompanies this issue we print an account of the present position of investigations regarding this substance. So many investigators had previously been within an ace of making its discovery that, as Prof. MacLean says, "it still remains a mystery why insulin was not isolated many years ago." The discovery is a good illustration of two salient facts bearing on scientific research work: first, that a very slight modification of a technique which had led previous explorers to failure might lead one to success; secondly, that research work of an applied nature, such as the search for a cure for diabetes, is very closely dependent upon related investigations which belong more properly to the domain of academic science—in this instance the improvement of methods for the accurate determination of small quantities of glucose in the blood. Insulin as now placed on the market is a therapeutically trustworthy preparation, and there must be many persons who owe life and health to the careful administration of this substance. But we must not be too sanguine that a diabetic taking insulin is to be regarded as a normal person. Prof. MacLean's article also contains a warning which it is to be hoped will be taken seriously to heart: careful investigation has shown that no beneficial results ensue from taking any pancreas preparation by the mouth, and this also applies to insulin itself, which is speedily destroyed by the juices present in the alimentary canal. From the academic point of view, insulin presents many problems of absorbing interest. At present the chief of these is the problem of what happens to the blood sugar and to glycogen after the administration of insulin: both apparently disappear, yet no intermediary or end products have yet been traced. Lastly, it cannot be too strongly emphasised that the discovery, from start to finish, could not have been made without those experiments on living dogs which some would seek to have abolished.

WHY it should have been left to Sir Douglas McGarel Hogg, Sir William Bull, and Sir Malcolm Macnachten to bring in "a Bill to confer certain powers on the Trustees of the British Museum," we have been unable to ascertain; nor can we discover whether the idea arose in the minds of those gentlemen spontaneously, or whether the seed was sown by some such body as the Museums Association. The Bill is, in brief, to empower the Trustees, under certain conditions, to lend for public exhibition in any gallery or museum controlled by a public authority in Great Britain, specimens falling under the graphic arts, jewelry, and "objects of art in gold, silver, bronze or crystal,"—a sufficiently curious selection. It proposes, therefore, an extension of the openings already made in the foundation Act of 26 George II., by which all objects entering the Museum were to "remain . . . to all Posterity." The Trustees have already obtained power to exchange, sell, or dispose of (7 & 47 George III.), as also to give away (41 & 42 Vict.), duplicate objects "not required for the purposes of the Museum"; but they have not as yet the power to lend. We do not know that they want it. If they are given it, we may rely on them to exercise it with due discretion. The British Museum is a storehouse to which there come by thousands inquirers from the uttermost ends of the earth. Such a student must not arrive in London to find that, of the objects he wishes to compare, one has been sent to Aberdeen and another to Penzance. There can never be any advantage in encouraging the British Museum to emulate the admirable Circulating Department of the Victoria and Albert Museum.

IN the *Times* of June 26 there was a somewhat sensational paragraph entitled "New anti-tuberculosis vaccine." It was stated that Prof. Calmette of the Pasteur Institute had, with various collaborators, discovered a new tuberculosis preventive. The further contents of the paragraph show that in its essence the discovery is not altogether new and has in part, at any rate, been referred to on more than one occasion, and most recently in the Annales de l'Institut Pasteur (xxxviii., 1924, p. 371). Calmette's vaccine is a living culture of tubercle bacilli which has been grown on a potato medium containing bile and glycerin for thirteen years. During this period it has become avirulent and is incapable of producing tuberculosis. It is claimed, however, that it is capable of establishing an immunity against virulent tubercle bacilli, and particularly so when injected into calves shortly after birth. The protection afforded by the avirulent bacilli lasts for more than a year. It is believed that the same results may be obtained in infants, and some work in this direction is briefly referred to in the *Times* paragraph.

IN NATURE of May 10, p. 685, we published a note on the alleged discovery of the long-sought virus of foot-and-mouth disease by Profs. Frosch and Dahmen of Berlin. From the reputation of these workers and their statement of experiments we were inclined to regard the discovery as correct, and this now appears to be so. In an article in the *Lancet* of June 28 considerable details are given of a lecture delivered by Dahmen and Frosch at Utrecht, and it is therein stated that a committee of six experts, including such well-known investigators as Titze, Giese, Kleine, and Gins, have been able to confirm the statements of Frosch and Dahmen, and that with subcultures of the virus in the sixth and twenty-sixth generation they had succeeded in reproducing the disease. On the assumption that the virus of foot-and-mouth disease has been discovered, it has been assumed by some that a royal road has been opened up for the prevention of the disease, but it is perhaps scarcely necessary to point out that this is not a corollary, for the establishment of immunity may not take place in spite of the presence of the virus.

THE annual conversazione of the Institution of Electrical Engineers held at the Natural History Museum, South Kensington, on Thursday, June 26, was one of the most notable of a long series of annual functions in pleasant surroundings, due to the fact that it was held on the hundredth anniversary of the birth of Lord Kelvin, and formed a part of the group of centenary celebrations being held this summer in scientific and engineering circles, and to include, as we have already announced, the Kelvin Centenary Oration by Sir J. J. Thomson on July 10 and the Kelvin Centenary Banquet on the following day. A large company was received by the president, Dr. Alexander Russell, and Mrs. Russell and members of the Council of the Institution, and an excellent programme of vocal and instrumental music, in which Miss Phyllis Carey Foster took part, was provided in the Reptile Gallery, while the string band of the Royal Engineers performed in the Central Hall. Many distinguished engineers were present, and there must have been many there who remembered Lord Kelvin's regular attendance at these conversaziones in his later years.

It is of interest at the present time to recall that Lord Kelvin, Sir George Stokes, and Prof. Huxley were elected fellows of the Royal Society in the same year and on the same day, namely, June 5, 1851. Each of this brilliant triumvirate lived to receive the honour of the presidency, in 1883, 1885, and 1890 respectively. The certificate of candidature of Lord Kelvin (William Thomson) was signed by Michael Faraday, John Couch Adams, and Adam Sedgwick, the distinguished Woodwardian professor of geology in the University of Cambridge. In retrospect, the support of Sedgwick is especially interesting since we know, through Sir Archibald Geikie, that from the year 1844 onwards for some eighteen years Lord Kelvin watched with increasing impatience the spread of the doctrines of the Uniformitarian School in geology, and at length, in 1862, "broke silence on the subject, declaring the doctrines of that school to be opposed to physical laws." It was one of the accepted tenets of the Uniformitarian School that the range of past time available for the explanation of the phenomena of geology was unlimited; but by arguments drawn from the origin and age of the sun's heat, the internal heat and rate of cooling of the earth, and the tidal retardation of the earth's rotation, Lord Kelvin fixed limits to the possible age of our planet. These have, of course, more recently been disputed. Lord Kelvin was always most punctilious in correspondence. Following the onerous engagements incidental to the celebration of his professional jubilee at Glasgow in 1896, he occupied himself on the way to London in writing autograph acknowledgments of the congratulation of friends. Not a few of his distinctive shorter papers were composed during railway journeys between Glasgow and London. In fact, wherever there was motion he found an atmosphere of calm, the hum of machinery acting as a mental stimulus. Mention may be made here that Lord Kelvin's portrait, by Orchardson, hangs in the Royal Society's meeting-room, the gift of a circle of fellows.

A TORNADO of hurricane strength swept over a fifty-mile stretch of the southern shore of Lake Erie in the afternoon of Saturday, June 28. According to the correspondent of the *Times*, three hundred persons are believed to have perished at Lorain, and the number of persons injured in the devastated track is estimated to be 2500. Many buildings are completely wrecked at Lorain, and in parts of the town it is reported that not a house was left standing. The principal destruction and damage occurred between Sandusky and Cleveland, and fear is entertained for some small passenger steamers plying on the Lake. The report states that the full extent of the damage will not be known for days. Earlier in the day, much havoc is said to have been caused by storms in the Upper Mississippi Valley. At Peoria, Illinois, hundreds of houses were unroofed and damage is reported from other places. The U.S. Weather Bureau will without doubt give details of the tornado. In the past, many such storms have been dealt with, notably by Finley and Ferrel.

IN view of some criticisms that have been made in Canada concerning Dr. V. Stefansson's recent geographical discoveries in the Arctic, attention may be directed to an article in the *Geographical Journal* for June. The Royal Geographical Society, on receiving from Mr. J. White, technical adviser to the Ministry of Justice, a detailed statement of the criticisms, submitted these to a searching examination by an impartial authority. All relevant original documents were consulted, including blue books of the various Franklin search expeditions, Sverdrup's charts of the adjoining regions, and Dr. Stefansson's own charts. A lengthy reply to Mr. White's letter, illustrated with charts, is published. Each point is examined in great detail, and the conclusions reached may be taken as final. They completely exonerate Dr. Stefansson of the charges that his discoveries of new land were anticipated by previous explorers, with the sole exception that Lougheed Island may have been sighted by Richards in 1853, but there was no suggestion of a land mass of the size of the island charted by Dr. Stefansson. The extensive islands now called Brock and Borden Islands were never suspected to exist. The Royal Geographical Society has done a service to polar exploration in disposing of these criticisms and establishing the validity of Dr. Stefansson's claims.

IN our issue of June 16, 1923, p. 818, reference was made to the formation of a committee to collect funds in order to commemorate the late Prof. A. D. Waller and Mrs. Waller. We understand that the fund has now reached a total of 1820*l*. and that a meeting of subscribers, probably a final one, will be held on July 5 at 5 P.M. at the London (R.F.H.) School of Medicine for Women. It will be remembered that the fund is to be used for the promotion of scientific research and is to be administered by the council of the London (R.F.H.) School of Medicine, with which Prof. Waller and Mrs. Waller were associated for many years. It is hoped that the fund will reach 2000*l*. by the time of the meeting on July 5, and that it will then be possible to discuss the final form of the memorial.

THE staff of the Bombay Department of Agriculture interested in research into botanical and genetical problems has grown very considerably of recent years, and on April 14-16 the plant breeders of the Department held a conference in the Botanical Laboratories of the College of Agriculture, Poona, under the presidency of Dr. W. Burns, Economic Botanist to the Government of Bombay. An introductory address by Dr. H. H. Mann emphasised the need of attacking problems of economic interest in a truly scientific manner, and the subsequent proceedings of the conference, when methods of testing the performance of varieties of crop plants of economic importance were rigorously examined in the light of modern knowledge of statistical, botanical, and agricultural technique, suggest that Dr. Mann was preaching to the converted. Some forty specialists gathered at the conference, which was convened at short notice; they were drawn from the fifteen workers in the Government Plant-breeding Department, the five men working under the Sassoon David Trust, the Indian Cotton Committee investigators, and the staffs of the Economic Botanist and the Horticulturist. The conference also utilised the occasion to examine the experimental and demonstration plots conducted by the Poona College of Agriculture, of which Dr. Burns is Principal. At the close the conference recommended to the Director of Agriculture that such a conference should be held annually, and that next year it should meet in Surat.

THE influence of Joseph Leidy on science forms the subject of three interesting addresses delivered in December last at the Academy of Natural Science of Philadelphia and published in the *Scientific Monthly*, April 1924. The veteran Dr. Edward S. Morse said that in the midst of the rush for the description of new species, Leidy pursued his researches on the habits and anatomical details of creatures ranging from the protozoa to mammals, and his profound knowledge of the osteology of mammals enabled him to lay with a master hand the foundation for the palæontology of the reptiles and mammals of North America. Nearly a third of his published memoirs, extending over a period of forty years (1848–88), are on this subject. Prof. W. B. Scott reminded his audience that Leidy throughout his life was primarily interested in human anatomy and that he remained, almost to his death, professor of human anatomy in the Medical School of the University of Pennsylvania. Prof. Scott paid generous tribute to the value of Leidy's work in palæontology and geology. He stated that Leidy was the first to show that there were native horses and rhinoceroses in America, and he also found the first American camel. Prof. H. S. Jennings pointed out that Leidy seems to have attempted and carried out to a remarkable degree of success the project of forming for himself, and communicating partly to others, a detailed picture of the living world in relation to the environment. He was the better enabled to do this because of his artistic aptitude; indeed his work is largely a portrayal of Nature as seen by a thorough scientific artist, of which his great memoir on the fresh-water rhizopods is an outstanding example.

WE learn from *Science* that Prof. J. C. McLennan, of the University of Toronto, has been elected president of the Royal Society of Canada.

THE Agricultural and Horticultural Research Station of the University of Bristol will be open to visitors on July 15, when the experimental work in progress will be demonstrated by the staff.

MR. E. E. AUSTEN has been appointed deputy keeper in the Department of Entomology of the British Museum (Natural History), South Kensington.

THE Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts was incorporated on March 30, 1824. The centenary, therefore, falls due this year, and will be celebrated on September 17-19.

APPLICATIONS are invited for two assistantships at the Solar Observatory of the Commonwealth of Australia. They should be sent to reach the High Commissioner for Australia, Australia House, Strand, W.C.2, by, at latest, July 31. Further particulars are obtainable upon request.

MR. E. R. D. MACLAGAN has been appointed by the President of the Board of Education to succeed Sir Cecil Harcourt Smith, who will retire from the position of Director and Secretary of the Victoria and Albert Museum in September next. Mr. Maclagan has been deputy keeper of the Department of Architecture and Sculpture in the Museum since 1921.

THE Imperial Botanical Conference opens at the Imperial College of Science and Technology, South Kensington, on July 7, under the presidency of Sir David Prain. A large number of overseas and British botanists have signified their intention of attending the Conference, for which an attractive programme has been arranged.

THE Safety in Mines Research Board is in need of the services of a number of abstractors—men or women—able to make rapid and accurate translations (abstract or full) from German and French scientific publications. Applications for the posts, giving full particulars of qualifications, etc., should be addressed to the Under Secretary for Mines, Mines Department, Dean Stanley Street, S.W.1, not later than July 19.

A GOVERNMENT chemist is required for service in Fiji, largely in connexion with the agricultural department. Candidates should, if possible, be University graduates; they must be associates and fellows of the Institute of Chemistry, and have had experience of the work of a public analyst. Requests for forms of application and for further particulars should be addressed in writing to the Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1.

A DECIMAL-METRIC Conference has been arranged by the Decimal Association and will be held on July 9 in the house of the Institution of Electrical Engineers. The subjects to be discussed are decimal coinage, with special reference to the ten-penny shilling, and piecemeal proposals for introducing metric weights and measures. Among the speakers will be Sir Robert Horne, Sir Robert Hadfield, Sir Napier Shaw, Mr. Harold Cox, Mr. Gordon Selfridge and Mr. Felix Blakemore. A number of chambers of commerce and other public bodies in the Dominions Overseas are sending delegates, and representatives from the United States will also be present. In connexion with the Conference a visit to the National Physical Laboratory, Teddington, has been arranged for July 10.

AT a meeting of the Botanical Society of Edinburgh, to be held at the Royal Botanic Garden, Edinburgh, on July 17 and 18, demonstrations and communications on various aspects of vegetative plant propagation are to be given. At the morning sessions of the meeting, numerous illustrations of the methods and results of propagation from stem, leaf, and root, will be presented, while the afternoon sessions will be devoted to the reading of papers and to a general discussion of the exhibits. The following papers will be read: (1) The propagation of clematis, by Miss Edith Philip Smith; (2) on cuttings of camphor, by Miss Oona Reid; (3) horizontal branch propagation, and (4) root cuttings, by Mr. L. B. Stewart; (5) propagation by bulb scales, by Dr. R. J. D. Graham.

THE Egyptian Government Almanac for 1924 (Cairo: Government Publications Office, 1924; price 10 P.T.) maintains the high standard of usefulness of former editions. It contains a good deal of statistical matter, but aims rather at being explanatory and descriptive. Matters of scientific interest include some papers on the geographical features of Egypt and a useful article on the Nile, its tributaries and water supply. There are notes on the survey of Egypt, the antiquities department and the physical department, including a summary of meteorological data. The section on agriculture and industries is particularly full.

MESSRS. H. SOTHERAN AND CO., 140 Strand, W.C.2, and 43 Piccadilly, W.1, have just issued No. 789 of their "Price Current of Literature," being No. 3, Pt. 4, of their "Catalogue of Science and Technology," and comprising the titles and bibliographic details of some hundreds of books relating to physics, many of which are rare and of great interest and importance. A valuable list of works by, and respecting, Sir Isaac Newton is included. The catalogue should appeal to all students of physics.

ERRATUM.—In announcing the award of a Research Prize of 1000 dollars to Dr. Mary Evelyn Laing in NATURE of June 28, p. 935, it should have been stated that the award referred to is the Ellen Richards Research Prize for 1924.

Our Astronomical Column.

EYEPIECES USED BY SIR WILLIAM HERSCHEL.—It is well known that Sir William Herschel stated that at times he used eyepieces giving magnifying powers in the neighbourhood of 6000. The eyepieces themselves seem to have been lost sight of after his death, and considerable scepticism as to the reality of these powers was expressed by subsequent writers. But recently, Dr. W. H. Steavenson, who was making by request a thorough examination of the Herschel instruments at Slough, found the eyepieces in question, and measured their powers with a dynamometer. He found values agreeing within 10 per cent. of those stated by Herschel, the highest power being well over 6000. This was naturally a single lens, $\frac{1}{50}$ inch in diameter. From a highly enlarged photograph the lens was seen to be not a natural spherical drop, but carefully figured. The curves were hyperbolæ rather than circles, and the two sides were not quite symmetrical, but Dr. Steavenson found that he could get fair definition on a portion of Saturn: the diameter of the well-defined region was only 26″, so that it must have been excessively difficult to keep objects in the field without equatorial mounting. It is satisfactory that Sir William Herschel's accuracy of statement is once more vindicated.

MINOR PLANETS.—The observation of these bodies, which was greatly interrupted by the War, is now once more in full swing. Several interesting objects have been detected in recent months. *Astr. Nach.* No. 5293 contains a study of the special perturbations by Jupiter and Mars of 132 Aethra, by Mr. C. J. Merfield, of Melbourne Observatory. He gives osculating elements for the oppositions of 1924, 1925, 1926, together with an accurate ephemeris for the next few weeks. This body was found by Watson in 1873, and was then lost for fifty years, being recovered in December 1922.

Astr. Nach. No. 5292 contains some observations of Eros made at Berlin-Babelsberg last autumn, its magnitude being 9·6. The planet afterwards went southward, and its observation was continued at Johannesburg. Dr. Witt, its discoverer, is engaged on a careful study of its perturbations, in order to predict the conditions of its near approach to the earth in January 1931. These recent observations will be very useful, as the planet was fairly near the earth.

The last assignment of numbers to recently discovered planets extended to No. 995. As many have been discovered since, the next numbering, in a few months' time, will undoubtedly extend beyond 1000. It should be noted that the number of those known to exist, but not all observed sufficiently for definite numeration, passed 1000 several years ago.

REPORT OF THE CAPE OBSERVATORY.—Dr. H. Spencer Jones, recently appointed H.M. Astronomer at the Cape, has just issued his first annual report. Besides the usual meridian observations, heliometer comparisons of the major planets with neighbouring stars are being made regularly. These have a considerably smaller probable error than meridian places, so will ultimately be very useful for improving the tables of these bodies.

Stellar spectrographs have been taken with the Victoria telescope for the measurement of radial velocities. Many plates have also been taken for proper motions both with this telescope and the astrographic: they are examined by Dr. Innes with the blink micrometer. Messrs. Long and Skjellerup, two voluntary observers, used the small equatorials for the study of 60 variable stars, obtaining more than 140 observations.

Dr. Halm is continuing his studies on stellar masses and luminosities. He suspects that the masses are grouped round the values 6·5, 3·3, 1·6, 0·8, in terms of the sun; they appear to form a geometrical progression. Further details are promised shortly.

Wireless time-signals for the use of ships are sent from the Observatory to Slangkop, where they are automatically distributed.

Research Items.

POPULATION AND ENVIRONMENT.—Dr. S. M. Shirokogoroff has published, through Messrs. Edward Evans and Sons of Shanghai, under the title "Ethnical Unit and Milieu," a valuable study of population problems, in which he lays down a number of propositions supported by examples drawn mainly from his studies of the peoples of north-eastern Asia. In a community, if an increase of population exceeds the possibility of nourishment, the excess of population must perish or the natality must be regulated by some means, medical, artificial, social, etc. Increase of population is regulated by the extent of territory and by the growth of culture; the more intensive the exploitation of territory, the larger the population it may nourish, as, for example, in an agricultural as contrasted with a hunting community. Maintenance of the level of numerical value must be understood relatively to the variation of culture and territory, a conclusion which has a direct bearing upon the question of degeneracy and decline of any given people. Variation of some aspects of the cultural complex is followed by variation in the whole complex and entails a period of cultural disequilibrium. Physical degeneracy may be either a process of extinction or a substitution of one anthropological type for another; in both cases there is an ethnical disequilibrium. Limitations being imposed upon the possibility of variation in the factors of culture, territory and density of population, which are interdependent, the general conclusion follows that there will be a degeneration or decline and an end of the present species of man. It is probable that the greater part of the way to absolute density of population is already covered, and that mankind is at present near its culmination.

THE MOTHER GODDESS IN EGYPT.—In No. 11 of the Journal of the Manchester Egyptian and Oriental Society, Mr. John Lewis analyses certain forms of Egyptian belief with the view of showing that they point to conceptions associated with the cult of a Great Mother Goddess such as Prof. Elliot Smith has postulated to lie at the root of primitive and early religion. Mr. Lewis compares the graffiti of the rocks at Gebel Hetematt, Wady Hammanat, and Selsileh, and the paintings of the prehistoric tomb near Hierakonpolis, with the cave drawings of France and Spain, and from their similarity deduces that they are based upon identical magical ideas connected with food and protection. The statues of the god Min, at one time a female deity, link up the ideas of water, the life-giving element, the shell, which is the life-giving female deity, procreation, the mother-deity and the father-deity. The girdle of Hathor-heads on the slate palette of Narmer is a development of the shell-girdle, the strength of Hathor-Isis, which connects the shell-deity with Hathor.

ORIENTAL PREHISTORY.—M. J. de Morgan contributes to *l'Anthropologie*, t. xxxiv. 1-2, the first of a series of articles on the prehistory of Western Asia and Egypt. In neolithic times, possibly from late quaternary times, it is suggested as a working hypothesis that the areas under consideration were inhabited by four races—in the north a white Caucasic race, of which traces may perhaps still be found in the remote mountain districts of the Caucasus; in the south, stretching from Elam to the Mediterranean, a negrito race related possibly on one side to peoples living in the Indian Peninsula, on the other to the inhabitants of the European caves; in Egypt and North Africa, Berbers; and Semites in Arabia. This multiplicity of races at this stage throws no light upon the question of origins. That part of Western Asia, of which the country of the Euphrates and Tigris—the cradle of civilisation—is the centre, is cut off from the rest of the world. It contains three types of geographical areas, a mountain region, plateaus, and plains. An examination of the geological conditions from early quaternary times indicates that Chaldæa, lying between mountains and plateaus with their cold and humid climates and the hot dry desert area, alone afforded conditions suited to man in early times, and this owing to the fact that it was watered by two rivers. The plateaus did not become habitable by man until he possessed domesticated animals capable of subsisting on pasture land.

ANIMAL LIFE IN DESERTS.—In the Proceedings of the Royal Society, B, vol. 96, 1924, pp. 123-131, Mr. P. A. Buxton records the results of some investigations made in Palestine on the relations of temperature and moisture to animal life in deserts. This observer finds that the soil surface commonly reaches 60° C. at midday, and certain insects are active upon it even at that temperature. Their body temperature is lower than might be expected, probably owing to loss of water during respiration. An interesting point is that the black form of a dimorphic grasshopper has a body-temperature 4-5° higher than the buff form, when exposed to the sun. If the loss of water hypothesis be correct the insect's need for water is greater than is commonly believed. Deserts have a great diurnal range of temperature and of relative humidity. The night air is often almost or quite saturated with moisture, while by day the humidity may drop to 20 per cent. It appears that the desiccated fragments of the annual vegetation are hygroscopic: that they take up a considerable proportion of water from the moist night air and hold it for several hours after the sun has risen. The author believes that this property of the dried pieces of grass and herbage is one of the foundations which support all animal life in deserts during summer. These fragments, with the moisture absorbed over night, are eaten by certain insects which in turn become a source not only of food but also of water, for the birds, lizards, predaceous insects, and other carnivorous animals.

SYMBIOSIS BETWEEN TERMITES AND THEIR INTESTINAL PROTOZOA.—L. R. Cleveland has given further details of his work on the symbiotic relationships between the intestinal protozoa of termites and their host (*Biol. Bull.*, vol. 46, pp. 177-225, 1924). The protozoa principally concerned are flagellates—Trichonympha and related forms. By incubating termites at 36° C. for 24 hours (a method due to Grassi) the flagellates are killed, but the termites are uninjured. If such "defaunated" termites are given their normal diet of wood, they eat quantities of it, but they become less active and die within three or four weeks. If "defaunated" termites are placed with ordinary ones, the former—by feeding on the fæces of the latter—become reinfected with protozoa, and after about ten days regain the ability to utilise wood and can live indefinitely. When termites were starved, the wood-ingesting protozoa in their intestine died within eight days, and the termites when returned to a wood diet lived only a few weeks. These and other examples emphasise the close correlation between the wood-feeding habit and the presence of protozoa. That the latter use the wood as food and not the intestinal fluids of their host is proved by direct observation—numerous wood particles are present in the posterior portion of Trichonympha—and by the fact that these protozoa die ten to twenty days before their host when wood is withheld. In normal-feeding termites a large percentage of the wood which they have eaten may be found in the protozoa, and in termites starved for a few hours it is almost impossible to find any wood particles in the intestine; they have all been ingested by the protozoa and the particles gradually disappear. A large amount of glycogen is present in these protozoa produced by digestion of the wood. The termites furnish food and lodging to the protozoa, and the latter provide products formed by digestion of the wood—a clear case of symbiosis. The young termites feed on excreta loaded with flagellates, so that they are practically certain to become infected, and then they begin to eat wood.

MASS RELATIONS OF CYTOPLASM AND NUCLEUS.—Prof. R. W. Hegner brings together (*Scientia*, June 1924) evidence from his observations on Arcella and Opalina and from those of other investigators on protozoa, in regard to the mass relations existing between cytoplasm and chromatin, and concludes that the following generalisations are reasonably established: At each stage in the life cycle of these organisms there is a fairly definite amount of cytoplasm associated with each nucleus. The size of the nucleus is an indication of the amount of chromatin contained within it; the amount of chromatin is the real factor involved in the ratio of nucleus to cytoplasm. Nuclear division is initiated by an increase in the amount of cytoplasm as compared with that of the nucleus.

VITALITY OF POLLEN GRAINS.—Mr. S. Nohara (*Japanese Journ. of Botany*, vol. 2, No. 1) has made an experimental study of the pollen in several species and hybrids of Salix. Germination of the pollen was most successful in 2-5 per cent. sugar solution, beginning very quickly, and the pollen tubes attaining a length of 4-8μ in half an hour. Tests of the longevity of pollen showed that it was much affected by temperature, humidity, and light, and that its germinating power could be maintained for seventy days in a dry, cool, dark place. Temperatures so low as 21° below zero for 8 hours do not lessen the germinating and fertilising power, while a temperature so high as 37° kills the pollen. Chloroform vapour terminates the germinating power of pollen in 4-5 hours, and ether vapour in 20 hours. In certain hybrids between *Salix viminalis* and *S. multinervis* the pollen and seeds were nearly normal, but the catkins showed various intersexual conditions.

BOTANICAL NOTES FROM CEYLON.—The Annals of the Royal Botanic Gardens, Peradeniya, vol. viii., May 1924, is mainly contributed by Mr. I. Petch, Government Botanist and Mycologist, Ceylon. A long paper upon the insect catching proclivities of the flowers of species of Aristolochia cultivated in Ceylon includes a record of their insect visitors so far as identification of the tropical insects had proved possible. Mr. Petch concludes that the flies are attracted to the flowers by their odour, which is offensive in *A. gigas*, but in some species, such as *A. ridicula* and *A. elegans*, is not detected by man's senses. The flies then seem to enter the tube of the flower by accident, and are prevented from crawling out by the inwardly and downwardly directed hairs, until later these hairs wither. One interesting conclusion from the record of insect visitors is that the hooded type of flower, which is regarded as primitive, is the most effective in attracting and trapping insects; the striking bizarre forms, such as *A. ringens*, attract few flies, so that "the advantage of a further evolution in the direction taken by these extraordinary forms is not obvious." Mr. Petch also describes the species of Xylariaceæ recorded for Ceylon up to the present date (pp. 119-166), and has a note upon extraordinary forms of fructification extending the range of variation recorded for Diplodiella. Mr. C. Ragunathan confirms the occurrence of teleutospores in *Hemileia vastatrix* B. and Br., the coffee leaf disease; they were previously recorded by the late Prof. Marshall Ward, but have not been seen by subsequent investigators.

ORIGIN OF TINSTONE.—Bulletin No. 5 of the Geological Survey of Nigeria, by Mr. C. Raeburn, deals with the tinfields of Nassarawa and Ilorin Provinces (London: Crown Agents for the Colonies, 1924. 10*s*. net.) It describes two separate areas in considerable detail and discusses the origin of the tinstone, which it says "is due to pneumatolytic action on the granite and gneisses near their contact. This gives rise to greisen, usually containing topaz and tin, and carrying networks of quartz veins with tinstone, and at times to a complete replacement of the rock in the direction of topazisation or micasisation. As regards that part of the tinstone which is related to the pegmatites, it must be emphasised that it, both in point of time and manner of origin, is quite different from the other. On the one hand we have tinstone as an original constituent which had already commenced to crystallise before the intrusion of the rock; on the other we have tinstone as a later mineral formed by pneumatolysis after the intrusion and solidification of the granite."

ZIRCONIUM AND HAFNIUM ORES.—The results of some analyses of zirconium ores by G. Hevesy and V. T. Jantzen are published in the *Chemical News* for May 30. Malacon from Madagascar and from Hitterö is particularly rich in hafnium, the former containing so much as 7 per cent. and the latter 5 per cent. of hafnium oxide. Three out of four specimens of thorteveitite showed a higher hafnium than zirconium content. The superior radioactivity of ores with a high hafnium-zirconium ratio over that of the more abundant zirconium ores is due to the presence of uranium and thorium oxides.

METEOROLOGICAL DATA OVER THE OCEANS.—From various sources the Royal Netherlands Meteorological Institute has produced some useful tables of monthly meteorological data over the oceans for the year 1921 (Bulletins 6^1 and 6^2). The computations are for ten-degree squares and give the mean force and direction of the wind, the atmospheric pressure, air and water temperature, and cloudiness. In the Atlantic Ocean the data are given between 5° to 25° N. and 25° to 45° W. and between 0° to 20° S. and 10° E. to 10° W.; in the Indian Ocean between 10° and 20° N. from 70° to 90° E. and between 10° and 30° S. from 90° to 110° E.; while in the Pacific Ocean the limits are 10° to 30° N. and 140° to 160° W., and 10° to 20° S. and 90° to 110° W. The observations thus leave out of account large areas of the oceans especially in high latitudes, and are not complete in many parts of the Pacific Ocean within the limits given. But they can of course be obtained only on frequented trade routes. The number of observations in each month varies in different squares from one to more than a hundred. The corresponding data for 1917–1920 consisting only of Dutch observations are promised shortly.

FREE-AIR TEMPERATURES AND WIND DIRECTIONS.—The *Monthly Weather Review* for January, published by the U.S. Weather Bureau, has an article by Mr. W. R. Gregg showing the relations between the above.

The purpose of the discussion is to utilise, for the advancement of the subject, the available free-air observations made in the United States from 1915 to the present time. All observations made with kites are considered, but the discussion is chiefly confined to data from Drexel, Nebr., and Ellendale, N. Dak. Observations of wind and temperature are grouped for 16 points of the compass for the surface, and for one, two, three, and four thousand metres above sea-level for each station, also for spring, summer, autumn, winter, and the year. The observations with N.N.W. to N.N.E. and S.S.E. to S.S.W., with distinctly north and south components, are separately combined for each elevation. At all levels to at least 4 kilometres much higher temperatures prevail with south component than with north component surface winds. Differences are smallest in summer, averaging about 5° C. The differences are greatest at 1 and 2 kilometres, but at 4 kilometres they average 7° to 8° C. It is pointed out that the free-air position of a low barometrical centre is usually to the north-west of the sea-level position, and that of a high to the south-west, so that winds are south-westerly above the sea-level positions of lows and north-westerly above the sea-level positions of highs, and consequently the air above lows is warmer than that above highs. Taking the lowest and highest pressures at different heights as the basis of comparison, it is found that the lowest pressures are accompanied by the lowest temperatures, the pressure itself at any level being largely a function of the mean temperature of the air column beneath. Numerous examples and charts are given, showing the influence of the source of air supply on the changes of temperature experienced during the passage of areas of low and high barometer. The discussion is of great value to experimental meteorology.

ADSORPTION.—Since Gibbs deduced an equation for the change of concentration of a dissolved substance at the surface of separation of its solution from another material, in terms of the rate of change of surface energy with concentration, attempts have been made to test its validity by experiment. The most successful experiments up to the present were those of Donnan and Barker in 1911. J. H. Mathews and A. J. Stamm, in the May number of the Journal of the American Chemical Society, describe experiments at a liquid-liquid interface, using a drop-weight method. Solutions of dimethylaniline in heptane and in benzene were used. The qualitative results confirmed Gibbs' formula, and by calculation from the quantitative results Langmuir's theory of adsorption was found to be verified, namely, the adsorption is one molecule thick up to concentrations where a complete surface layer is formed. The molecular thicknesses and cross-sections agree with those of other investigators.

APPARENT SELECTIVE REFLECTION OF X-RAYS BY CRYSTALS.—Dr. W. Kossel, in the *Zeitschrift für Physik* for May, deals with the observations of Clark and Duane, which these authors have interpreted as indicating selective reflection. Kossel points out that, according to the ideas of the mechanism of radiation held up to the present, a coherence between the radiation of separate atoms, such as is required to explain selective reflection, is not to be expected, since the times during which they are excited are supposed to be irregularly distributed. He finds it possible to explain a good deal of the experimental material of Clark and Duane, in part quantitatively, by considering the variations of the absorption coefficient of the crystal. X-rays of wave lengths for which the coefficient of absorption is small penetrate to a greater depth into the crystal than those for which it is large, and stronger interference effects are produced by the crystal lattice with the first than with the second. It seems doubtful whether any new phenomenon, which can be described as selective reflection, is involved.

MAGNETON NUMBERS AND ATOMIC STRUCTURE.—It is interesting to note that a certain amount of scientific work is still being carried out in Russia. Dr. J. Dorfmann contributes a paper, dated from Leningrad, to the May issue of the *Zeitschrift für Physik*, in which he puts forward a series of hypotheses as to the relation between the electron orbits of the elements, and their magnetic properties. Bohr has shown that atoms with a closed electronic configuration, where the orbit groups contain 2, 4, 6, 8 similar n_k orbits, are diamagnetic; and that paramagnetism appears when they contain 1, 3, 5, 7 orbits. If there is only one electron in an orbit group, the magnetic moment due to it is given in Bohr units, by the k number of the orbit; the author assumes that, with a group having 3, 5, 7 or $2p+1$ orbits, $2p$ of them form a symmetrical diamagnetic complex, while one of them takes part in the paramagnetism, and contributes a moment of k units to the atom. The moments due to different asymmetrical orbit groups are supposed to add, when the principal quantum number n is the same for all the groups concerned; while for different values of n they are regarded as combining vectorially. Orbit configurations have been worked out for different ions of the elements between scandium and zinc; and values of the magnetic moments have been calculated, on the above assumptions, which agree quite well with the observed values. A similar table is given for the elements from lanthanum to hafnium, for which, however, the observational data are not quite complete.

STEAM-NOZZLES.—The third report of the Steam-Nozzles Research Committee has now been presented to the Institution of Mechanical Engineers, and comprises (*a*) tests on convergent impulse nozzles, 20° nominal angle, with thick partition plates; (*b*) a series of tests to determine the effect of chamfer on the exit edges of comparatively thick plates; (*c*) work on the ⅝-inch Parsons standard 430 B blades, which emphasises the effect of entry on nozzle efficiency; (*d*) the first test results of a set of straight elementary nozzles designed by Prof. A. L. Mellanby. The general shape of the curves obtained for the velocity coefficients of steam-nozzles (given in the second report) has been corroborated, and in one or two cases the curve has been carried sufficiently far into the low velocity region to indicate that it "turns over" as predicted by Mr. Martin. The effect of chamfering thick plates of convergent nozzles is clearly shown in the present report; it would appear that a thick plate nozzle with a chamfered exit can be made as efficient, over a considerable working range, as a nozzle with very thin plates. A straight elementary nozzle is in general 5 per cent. more efficient than the practical types of nozzles which have been tested. A review of both second and third reports goes to show that the condition of entry or of exit is important; the steam should approach the nozzle as smoothly and as slowly as possible, and no flat surfaces should be left on the exit side of any nozzle. There are other interesting conclusions on the effect of superheat, for which reference should be made to the report. The work of the committee is proceeding without interruption, and has been greatly assisted by contributions from the British Electrical and Allied Industries Research Association.

International Conference on Soil Science.

THE fourth International Conference on Soil Science was held in the building of the International Institute of Agriculture at Rome on May 12-19, when between 120 and 150 delegates from various countries were present. The Ministry of Agriculture appointed the following delegates from Great Britain: Dr. N. M. Comber, Dr. B. A. Keen, Mr. H. J. Page, and Mr. G. W. Robinson.

The general organisation of the conference was in the hands of Prof. Hissink, of Groningen, Holland, and the actual arrangements for the meeting were carried out by local committees in Rome.

In all, some 250 papers were presented to the conference, distributed over the following sections:

1. (*a*) Physical Properties, and Mechanical Analysis of Soil.
   (*b*) Application of Soil Science to Field Conditions.
2. Chemical Properties of Soil.
3. Biochemical and Bacteriological Studies.
4. Soil Classification.
5. Soil Surveys and Maps.
6. Physiological Studies in Relation to Soil.

These sections met both independently for the consideration of their own papers, and jointly for discussions of common interest.

In addition, the following lectures were given during the conference:

La nitrification et ses conséquences agricoles, Prof. G. André (Paris); Recent Advances in Soil Physics, Dr. B. A. Keen (Rothamsted); Dispersoidchemie und Bodenkunde, Prof. G. Wiegner (Zurich); Die modernen Ziele zur Erforschung der Bakterientätigkeit im Boden, Prof. J. Stoklasa (Prague); The Fertiliser Industry of the United States in Relation to Soil Science, Prof. J. G. Lipman (New Jersey); Analisi del terreno e suo valore, Prof. A. Menozzi (Milan).

Some considerable time before the conference, arrangements had been made for certain outstanding questions to be studied co-operatively by workers in different countries. The reports of these investigations formed an important section of the conference. Among them may be mentioned an investigation of the various methods employed for dispersing soil samples prior to a mechanical analysis. Samples of two given soils were distributed to each worker so that the results of the various methods were strictly comparable. The mechanical analyses showed considerable variations, not only among the different methods, but also for the same method in the hands of different workers. The studies are to be continued and extended in view of the vital importance of complete dispersion of the soil suspension for the newer methods of mechanical analysis, such as those of Odén and Robinson, which depend on one single sedimentation.

Further joint discussions took place on the question of base exchange in soils and on the production and cause of soil acidity. It cannot be said that any general agreement emerged from these discussions, nor in the present state of our knowledge would this be expected. The contributions of Ramann and Wiegner on base exchange were noteworthy. The former supported the view that base exchange alone is produced by neutral salts; hydroxides and salts with alkaline reaction give base exchange and adsorption; acids and acid salts decompose the silicates, and an exchange between the cations of the silicates and the hydrogen of the acids causes the formation of acid soils. Wiegner developed the view that base exchange in clay or soil is a special case of the so-called "polar" exchange-adsorption, and is intimately linked up with the degree of dispersion of the clay. On this view a clay particle may consist of an aggregate of smaller particles. The total surface of the compound particle is available for base exchange phenomena, while the electrical properties of the aggregate are a function of its outer surface only.

All the six sections combined for the discussion on soil acidity. The chief value of this discussion, which extended over too wide a range for an adequate summary to be given here, was the opportunity afforded for those studying the subject from the physico-chemical aspect to appreciate the problem from the physiological point of view, and vice versa. A number of the speakers dealt with the efforts made to develop a field technique on which practical recommendations as to liming could be based. Prof. Hissink described his quantitative adaptation of the well-known Comber test for sour soils that was now in extensive use in Holland as a means of measuring lime requirement. Dr. Comber directed attention to the danger in assuming that any qualitative test that showed a reasonable degree of quantitative relationship for any given soil type was suitable for general application.

Special mention must be made of the work of Section 5. In the face of considerable difficulties, financial and otherwise, a very complete account of the present position of soil survey work was collected from experts in many different countries. With the assistance of the Geological Institute of Rumania, Bucharest, Profs. Murgoci and Opresco were able to have these memoirs printed for distribution to the conference. The volume forms a most valuable record of the present state of the subject, and will be of great value for comparative studies.

In connexion with the conference, a small exhibition of apparatus, maps, etc., was held. Several members took this opportunity of demonstrating the apparatus they had already described at the conference. The younger German workers are showing considerable activity in devising field instruments. The problem of measuring the moisture content of soils *in situ* by means of the electrical resistance has been attempted before, but the apparatus was not satisfactory. The new method of Dr. Götz, of Berlin, is based on the same principle, but is a distinct improvement and appears to be of great promise. Dr. Trenel, of Berlin, demonstrated an apparatus for measuring the P_H of soils *in situ*.

Perhaps the chief value of a conference such as this lies not so much in the meetings and reports as in the numerous opportunities afforded for informal discussions with workers from other countries. The conference was well served in this respect, as the local committee arranged several receptions and excursions during the meeting. The Italian Government took an active interest in the proceedings; the King was present at the opening of the conference, and the Minister of National Economy attended the closing meeting.

The final act of the conference was to establish an International Society of Soil Science, having as objects the promotion of soil science by means of conferences, the formation of special committees for co-operative work, the publication of a review, and the institution of a central office in the International Institute of Agriculture at Rome, where all reports and documents can be filed, and from which members can obtain information needed in their work.

The first president is Prof. J. G. Lipman, of the New Jersey Experimental Station, and on his invitation, the conference appointed America as the place for the fifth meeting. The following were elected honorary members: Prof. Cayeux (France), Prof. Glinka (Russia), Prof. Murgoci (Rumania), Prof. Ramann (Germany), Sir John Russell (England), and Prof. Winogradsky (France). The acting-chairman and general secretary is Prof. Hissink, Groningen, Holland. The International Mitteilungen für Bodenkunde has been taken over as the official journal of the society, and will be in future published by the International Institute of Agriculture at Rome.

The society has undoubtedly an important future, and it is hoped that it will have many British members. Further information can be obtained from either Prof. Hissink or Dr. B. A. Keen, Rothamsted Experimental Station, Harpenden. B. A. KEEN.

International Mathematical Congress.

DURING next August, Toronto is to be the scene of two great scientific gatherings. The British Association will hold its ninety-second annual meeting on August 6-13, and an International Mathematical Congress will be held on August 11-16. International gatherings of mathematicians have previously been held in Zurich (1897), Paris (1900), Heidelberg (1904), Rome (1908), Cambridge (1912), and in Strasbourg (1920). The North American continent is for the first time the meeting place of such an assembly. The natural boundary of distance, with the incident expense of transportation, is being in a large measure overcome by the generosity of the Governments of the Dominion of Canada and the Province of Ontario, each of which is making a contribution of 25,000 dollars to defray the expenses of the Congress. The greater part of these funds will be used to assist the passage of eminent European men of science, mathematicians, and representatives of those sciences and professions which apply mathematics. It is estimated that the attendance from Europe will exceed one hundred and fifty. The British representation on the applied side promises to be large. At least twenty will come from France, nearly as many from the Scandinavian countries, and more than a dozen from Italy. Not less than fifteen European countries will be represented. The attendance from Canada and the United States is expected to run into the hundreds.

Difficulties in arranging suitable dates for the Congress delayed the sending out of notifications. The Organising Committee has tried to notify all those likely to be interested resident in countries adherent to the International Mathematical Union, or eligible for adherence thereto. In all, some six thousand notifications have been sent out, and a large number of universities and learned societies have been invited to be represented by delegates. Among those bodies which will be represented are the National Committees of the International Mathematical Union. These Committees are, as a rule, appointed by the National Academies of the respective countries, and through them the Academies might be regarded as obtaining representation. Many of the Academies, however, will, in addition, be directly represented. This, for example, will be the case with the Reale Accademia dei Lincei and the Académie des Sciences de l'Institut de France. Many specialised scientific societies too have named delegates. Among such are the Société Mathématique de France, the Circolo Matematico di Palermo, the American Mathematical Society, the Physical Society of London, the Société Française de Physique, the Royal Astronomical Society, the Royal Meteorological Society, and sister societies in a number of different countries. Statistical and actuarial societies will also be represented. The Institution of Naval Architects, the Institution of Electrical Engineers, the Institution of Mechanical Engineers, and other engineering organisations have appointed representatives. The same is true of the British Association and the corresponding organisations in France and the United States. The National Physical Laboratory and the Bureau of Standards have also named delegates, while many universities will be represented, including, among others, Cambridge, Paris, and Rome.

The Congress is being held under the auspices of the University of Toronto and the Royal Canadian Institute, and will be conducted in accordance with the regulations of the International Research Council. Prof. J. C. Fields, president of the Royal Canadian Institute, is chairman of the Organising Committee, and the other members of the Committee are Sir Robert Falconer, president of the University of Toronto, Prof. A. T. DeLury, Prof. J. C. McLennan, Prof. C. A. Chant, Mr. T. H. Hogg, Dr. J. S. Plaskett, Prof. M. A. Mackenzie, Prof. E. F. Burton, Mr. J. Patterson, Mr. W. P. Dobson, Wing-Commander E. W. Stedman, and Prof. J. L. Synge (secretary). Dr. F. A. Mouré, bursar of the University of Toronto, is acting as treasurer. An Editorial Committee has been organised, with Prof. Fields as chairman. There are also associate committees to deal with hospitality, excursions, printing, publicity, meeting rooms, signs and messengers, finance and transportation.

An excursion has been arranged for a selected party to the Western Provinces on special trains, leaving Toronto on the night of Sunday, August 17, and returning in about three weeks' time. There will also be an excursion through Northern Ontario, and excursions to Niagara Falls on August 9 and August 16, the route being by steamer across Lake Ontario, the journey each way taking about two hours.

The Congress will meet in the following sections:

Section I. Algebra, theory of numbers, analysis.
Section II. Geometry.
Section III. (*a*) Mechanics, mathematical physics.
(*b*) Astronomy, geophysics.
Section IV. (*a*) Electrical, mechanical, civil and mining engineering.
(*b*) Aeronautics, naval architecture, ballistics, radiotelegraphy.
Section V. Statistics, actuarial science, economics.
Section VI. History, philosophy, didactics.

It will be observed that this scheme of sections differs from those adopted at former congresses in the additional attention devoted to the applications of mathematics. It has been devised in order to secure in the sphere of applied mathematics full opportunity for consideration not only of those questions the interest of which is purely scientific, but also practical problems of engineering the solutions of which contribute directly to the cause of material progress.

The Organising Committee would be obliged if those who expect to attend the Congress would notify the secretary to that effect, stating their order of preference in accommodation from a choice of hotel, boarding-house, or university residence. Abstracts of papers intended for presentation should be in the hands of the secretary well in advance of the meeting.

Further information may be obtained from Prof. J. L. Synge, secretary of the Organising Committee, International Mathematical Congress, Royal Canadian Institute, 198 College Street, Toronto, Canada.

The Physical and Physico-chemical Problems relating to Textile Fibres.

IN the joint discussion held by the Faraday Society and the Textile Institute at the British Empire Exhibition, Wembley, on June 11, under the presidency of Sir Robert Robertson and Mr. Lester, a number of important developments of research on textile fibres was disclosed. The papers covered a wide field and dealt with the physical properties of cotton, wool, flax, and silk fibres. It is intended in this article to describe some of the points raised during the discussion rather than to refer in detail to the subject-matter of the papers, which is to be published later.

The introductory address was given by Dr. W. L. Balls, who proposed to divide physical research in textiles into two sections: (1) that relating to the physical unit in each raw material; and (2) that relating to the larger field concerned with the building up of the yarn and fabric. The appropriateness of this division is at once apparent; it separates, at least vaguely, the bio-physical problems from the mechanical ones, implying by the latter those problems concerned in the transformation of a mass of raw material into a useful yarn or fabric. In his conclusion Dr. Balls said: "The defects of yarn and fabrics which admittedly exist, together with other defects whose existence is not even recognised, were formerly due to faults in the machinery employed. Many of these have been eliminated in the course of time; and the physicist is now concerned rather with studying the causation of defects which are inherent in the properties of the raw material."

This warrants a note of criticism. The present writer pointed out that though the importance of physical tests on raw materials cannot perhaps be overstated, at any rate from the grower's point of view, yet at the same time it should be clearly understood that there are, on the industrial side, limitations to the profitableness of such work. I refer particularly to trade samples of raw material. It would no doubt be an easy though laborious matter to obtain valuable information concerning certain characteristics of the cotton fibres and their correlations, for example, provided one confines the effort to one or more special varieties. But it must be borne in mind that the practical spinner has no direct interest in special varieties; he buys and mixes his raw material according to market prices. Such raw material makes physical research on the "textile unit" a most uncertain and despondent field when the results are interpreted according to the expectations of the spinner or manufacturer. To take an example, it is now known that the lustre of a doubled yarn depends on a certain relationship between the constants for spinning the singles and for doubling them. If this condition is not satisfied, it is easy to make a highly lustrous raw cotton into a less lustrous yarn than might have been produced by using a less lustrous cotton and working it properly. This is quite apart from the measurable characteristics of raw cottons, such as staple length, fineness, or convolutions, etc., and shows that the relative *position* of the fibres, determined by the spinning processes, is at least as important as the properties of isolated fibres. Again, the percentage irregularities of yarns spun from high- and low-grade cottons are about the same, so that this important property does not depend appreciably on the raw material. Such examples might be multiplied a hundred-fold. While not denying that many of the defects existent in yarns and fabrics are rightly concerned with variability in the raw material, it is necessary to emphasise the fact that many defects are traceable to the machines, scarcely one of which, in the writer's opinion, cannot be improved by physical research. Dr. Balls' remark that "the utility of the scientist in industry is largely conditioned by the degree of stability of the industry" is only too true; it enforces the necessity for work on the complex mixtures of raw material almost universally used in practice, and leads us to the conclusion that work of this character is the more immediate. Furthermore, it is the duty of the Textile Industrial Research Associations to supply such practical information while still keeping a preserve for work on "textile units," which, it is hoped, will eventually be of vital importance to the producer of the raw material.

Dr. S. A. Shorter dealt with the nature of the recovery from strain of the wool fibre, in particular, attributing the creep to the combined effects of elastic and impeded elastic portions of the fibre structure rather than to its plasticity, to which property other authors have ascribed the effects. He stated that the elasticity of wool approaches the ideal, the hysteresis being almost entirely a true effect, and suggested that the fibre acts as a two-phase system, including (*a*) a perfectly elastic framework, (*b*) a viscous fluid; the two affording a complete explanation of the phenomena observed in the finishing of woollen and worsted fabrics. Mechanical models were described to illustrate the type of structure advocated, and the system of impeded elastic elements was used to explain how the shedding fault arises in a loom which has been standing over (say) the week-end.

Some experiments on loaded gelatin sticks were described by Mr. Pool, who concluded that the elastic effects observed in such purely colloidal systems were analogous to those simulated by Shorter's model. It was pointed out by Dr. Mardles that similar effects were common in many materials, *e.g.* steels, time and stress introducing new phases initiated by molecular changes. Mr. Peirce thought the effects were due to impeded but reversible orientations within the mass and these effects were ultimately inherent in the molecules themselves. In his paper on the fibre balance, Dr. Barratt described load-extension diagrams showing the relative degree of non-recovery from strain in wool, cotton, silk (viscose) and flax, the order, as indicated, being decreasing. Dr. Shorter was of the opinion that in the case of the wool fibre, practically all the residual strain would disappear by wetting, while he agreed that with cotton fibres a small amount of non-recovery persists.

Two important communications were made by Dr. T. Barratt on the lustre of cotton fibres and the transparency of fabrics. The lustre comparisons were made by a special arrangement of a Joly photometer, the fibre pads being so mounted that varying angles of incidence and diffusion could be obtained, and also so that they could be rotated in their own plane. Unmercerised and mercerised cotton and glass fibres were tested and the conclusions drawn that (1) the light reflected from a mercerised fibre in certain positions is concentrated within a small angle; (2) the light from an unmercerised (twisted) fibre is scattered over a wide angle; and (3) the lustre is enhanced when a number of mercerised fibres are laid parallel to each other (the case of a sateen with "floating" threads). The increased lustre shown by a mercerised fibre is due to light regularly reflected in a plane containing the length of the fibre. In keeping with this result, the work of the writer and Mr. Adderley was mentioned, which showed that in doubled yarns the optimum lustre was obtained when the fibres in the doubled yarn are parallel to its axis, so that, looking along the yarn, the light is mainly reflected along the length of the fibres.

Using the Joly photometer, measurements of (1) the total transparency of fabrics (defined as percentage of incident light transmitted), (2) thread transparency (the percentage of light falling on the threads alone, which is transmitted), were made. The determination (2) was made possible by dyeing the threads black and so obtaining a measure of the light transmitted by the spaces alone. From the combined readings it is then possible to calculate the total light incident on threads *alone* and that transmitted by threads *alone*, which is a measure of thread transparency.

Mr. C. R. Nodder showed slides of the structural characteristics of compressed flax fibres, up to fifty daily growth rings being visible, and also the spiral fibrillæ in each layer. Herzog and Jancke have obtained X-ray point diagrams with flax and ramie fibres which they attribute to a rhombic (or monoclinic) symmetry of constituent crystallites. With powdered fibres they obtained diffraction rings confirming this result. Flax and ramie fibres subjected to similar compression presented optical effects which indicate the true crystalline nature of their structure.

A large number of physical data relating to the silk fibre (the ultimate filament of fibroin, two of which, gummed together by sericin, form the cocoon thread) were detailed by Dr. W. S. Denham. The most interesting of these concern the crystalline structure found by Herzog and Jancke. Some measurements on the lustre of silk fibres with the plane of incidence perpendicular and parallel to the fibre length were discussed in terms of the arbitrary expressions for lustre recommended by Zart, Schultz, and Adderley, and Dr. Denham reasonably advocated some universal standard. The lustre is greater with the plane of incidence containing the fibre length (cf. Barratt, *supra*). The thermal conductivities of textiles have been measured by Miss Rood ; the values, for the same density, increasing in the order, silk, wool, artificial silk, linen, and cotton.

An interesting account of experiments on the tautness of aero-fabrics was given by Dr. Ramsbottom, who pointed out that though dope may be regarded as the primary factor in fixing tautness, still the nature of the fabric is of importance in maintaining this property at high humidities and after long exposure. Fabrics woven from fine yarns preserve tautness better than those containing coarser yarns, and linen, cotton, and silk all give satisfactory tautness at low humidities. With cotton and linen, at high humidities the tautness falls but recovers with absorption of water by the fabric, whereas with silk the tautness falls off continuously, so that silk fabrics are inferior to others. Mercerised cotton is preferable to unmercerised cotton or linen. Measurements on strength and deterioration on weathering were given. Dr. de Waele asked if it were possible to obtain a mesh of (say) silk and cotton which would have constant tautness, in reply to which Mr. Crompton said it was quite feasible to double artificial silk and cotton to test this point.

The action of light on textiles was discussed by Dr. Barr, who laid stress on the difficulties of measuring the photochemical action due to sunlight, which is the real aim of such research. With sunlight the spectrographic method has given negative results, while only incomplete data have been obtained by using glass screens. The method of first dyeing the fibres and exposing them to white light has given some practical results, but these are difficult to interpret, being complicated by the ill-defined nature of the light stimulating the reaction and the possibility of unknown interaction between fibre, dye, and the reaction products.

With the mercury arc in quartz, rapid deterioration of textile fibres may be developed, but such effects cannot be safely translated into terms of sunlight. Cellulose is very sensitive to wave-lengths less than 3000 Å.U., which exist in the mercury arc but not in sunlight. Aston's work on cotton and linen threads (for aero-fabrics) indicates that with light from the mercury arc, the most destructive rays have wave-lengths less than 3990 Å.U., a conclusion which has been verified by Ramsbottom by using coloured glass screens. Two hundred hours' exposure to sunlight produced no effect. Assuming that ionised oxygen is responsible for the deterioration, Lindemann has deduced from the quantum theory that the most destructive radiation has a wave-length of 3230 Å.U.

Very little is known about the tendering action of light on other textile fibres. Silk appears to be considerably more affected than linen, while wool is almost immune.

Mr. F. D. Farrow referred to some recent advances in the experimental study of warp sizing, and dealt with the work of Owen and New on the oscillating resisting properties of yarns, and that of Farrow and Lowe on the viscosity of starch pastes. The work on viscosity involves a modified Poiseuille's equation, a " coefficient of flow " being measured which is proportional to a power of the pressure, the index varying between 1 and 2.

A review of the recent work on the moisture relations of textile materials was contributed by Mr. A. R. Urquhart and Dr. A. M. Williams. The hysteresis effects observed in the authors' work have been interpreted in terms of Zsigmondy's theory of the existence of capillary spaces within a gel, which, in the case of cotton, have a diameter of the order 13×10^{-8} cm. A study of the rates of absorption and desorption indicates that these processes are discontinuous.

A paper on the effect of water in the wet-spinning of flax was given by Dr. W. H. Gibson, who held the view that the process was conditioned by a gradual variation in the fibre constitution from pectin through intermediate products to cellulose. There is apparently a considerable breakage of the fibres (about 12 in. long) with a drafting reach of $3\frac{1}{4}$ in., as might be expected, and frequency curves showing the displacement of the breaking load modes of the yarn and rove confirm this.

In addition to the papers submitted for discussion, a number of interesting slides of linen fabrics from Tutankhamen's tomb were exhibited by Dr. A. Scott. These depicted (*a*) a linen veil, unbleached, 150-160 threads per inch × 80 threads per inch, in reflected and transmitted light; (*b*) a pall of much coarser linen fabric; and (*c*) a very friable linen fabric having two threads one way and one the other.

Sir Robert Robertson pointed out the great importance of obtaining further knowledge of the action of light on fabrics, and Mr. Lester remarked that we knew next to nothing about the life of a fabric, recalling the process of laundering and the effect of acid. In a few months a fabric might lose 60 per cent. of its strength.

A. E. OXLEY.

University and Educational Intelligence.

BIRMINGHAM.—The degree of Ph.D. has been awarded to the following candidates, the subjects of the theses being indicated in each case : Mr. N. F. Budgen (Researches with cadmium) ; Mr. Denis Bunting (An investigation of the brittle ranges of brass) ; Mr. Kamil Iskander (The development of precision measuring instruments for the determination of the heating value of gases) ; Mr. T. D. Jones

(The strata temperatures of the South Wales coal field, and causes of variation in the same; Hygrometric observations in South Wales collieries).

DUBLIN.—Among the honorary degrees which have been conferred at Trinity College are the following: *D.Sc.*: Prof. R. A. Millikan, of the California Institute of Technology, Pasadena, and Prof. E. B. Poulton, Hope professor of zoology in the University of Oxford; *D.Litt.*: Prof. Ernest A. Gardner, Yates professor of archæology, University College, London.

LEEDS.—Mr. A. Seymour-Jones has presented to the Leather Industries Department his library, consisting of about 200 books on leather and kindred subjects, and a set of framed photomicrographs for display in the Department.

It has been decided to institute a lectureship in medical radiology and electro-therapeutics, and to appoint thereto Dr. Scargill and Dr. Cooper as joint lecturers. Mr. William Davies has been appointed demonstrator in engineering.

LONDON.—Prof. E. A. Gardner, Yates professor of archæology in the University, tenable at University College, has been elected Vice-Chancellor for 1924–25 in succession to Mr. H. J. Waring.

Dr. B. B. Baker has been appointed as from October 1 to the University chair of mathematics, tenable at the Royal Holloway College. Since 1920 Dr. Baker has been lecturer in mathematics at the University of Edinburgh; in 1921 he was elected a fellow of the Royal Society of Edinburgh and hon. secretary of the Edinburgh Mathematical Society. His published work includes various articles in mathematical and scientific journals.

Dr. C. L. Burt has been appointed as from August 1 to the University (part-time) chair of education, tenable at the London Day Training College. From 1908 to 1912 Dr. Burt was lecturer in experimental psychology in the University of Liverpool, and from 1912 to 1913 assistant lecturer in the Psychological Laboratory, Cambridge. Since 1913 he has been psychologist in the Education Department of the London County Council. He has published a number of works on intelligence tests and allied subjects.

The title of professor of surgery in the University has been conferred on Dr. C. C. Choyce in respect of his appointment as Director of the Surgical Unit at University College Hospital Medical School.

The title of reader in geology in the University has been conferred on Mr. H. Gladstone Smith in respect of the post held by him at East London College. Mr. Smith has been lecturer in geology at East London College since 1918.

The title of professor of physics in the University has been conferred on Prof. O. W. Richardson in respect of his part-time appointment as Director of Research in the Department of Physics at King's College. Prof. Richardson will cease to hold the Wheatstone chair of physics, which he has occupied since 1914, on taking up the Yarrow Research Professorship of the Royal Society on August 1.

Sir Hermann Gollancz has given his library to University College to commemorate his twenty-one years' tenure of the Goldsmid professorship of Hebrew. Mrs. Preedy has presented to the University library a valuable collection of books on Greek and Roman archæology and art, formerly belonging to her son, the late J. B. Knowlton Preedy, who served for some years prior to the War as a secretary in the University Extension Department.

The following doctorates have been conferred:—D.Sc. (*Chemistry*): Miss M. L. V. Gayler (Bedford College), for thesis entitled "The Constitution and Age-hardening of the Quaternary Alloys of Aluminium, Copper, Magnesium, and Magnesium Silicide"; D.Sc. (*Physiology*): Mr. J. A. Hewitt (King's College), for a thesis entitled "Metabolism of Carbohydrates (Part III.)"; D.Sc. (*Physiology*): Mr. F. M. R. Walshe (University College and University College Hospital Medical School), for a thesis entitled "(i.) The Physiological Significance of the Reflex Phenomena in Spastic Paralysis of the Lower Limbs, (ii.) On certain Tonic or Postural Reflexes in Man, with special reference to the so-called 'Associated Movements,' (iii.) On Variations in the form of Reflex Movements, notably the Babinski plantar response, under different degrees of Spasticity and under the influence of Magnus and de Kleijn's Tonic Neck Reflex"; D.Sc. (*Geology*): Mr. Ernest Neaverson, for a thesis entitled "Ammonites from the Upper Kimmeridge Clay."

A degree of M.Sc. in the principles, history, and method of science has been instituted for both internal and external students.

MANCHESTER.—Applications are invited for the headship of the department of pure and applied physics in the College of Technology. The position carries with it the title and status of lecturer in the University. The latest date for the receipt of applications, which should be sent to the Registrar of the College, is July 16.

OXFORD.—Among the recipients of honorary degrees at the Encænia held on June 25 were Sir Humphry Rolleston, Bart., president of the Royal College of Physicians, and Prof. S. Alexander, professor of philosophy in the University of Manchester, who received the degrees of D.Sc. and D.Litt. respectively.

PROF. SYDNEY CHAPMAN, at present professor of mathematics and natural philosophy in the University of Manchester, has accepted the invitation of the Governing Body of the Imperial College of Science and Technology to undertake the chief professorship of mathematics at the Imperial College beginning in September next, in succession to Prof. A. N. Whitehead, who has been appointed to the chair of philosophy at Harvard University, U.S.A.

AT the universities' conference held at Simla in May it was decided that an Indian inter-university board should be constituted with one representative of each university, to facilitate the co-ordination of university work, to assist in obtaining recognition in other countries of Indian degrees, diplomas, and examinations, to act as an appointments bureau for Indian universities, to facilitate the exchange of professors, and generally to fulfil such duties as may be assigned to it from time to time by the Indian universities. The cost of maintenance of the board is to be met by equal contributions from the universities, but the Government of India and the provincial governments are to be asked to make a grant towards its expense. It has for some years been recognised that some such co-ordinating body was needed, and in April 1920 a committee was formed for drafting an outline of its functions and constitution. The project was further advanced at the Congress of Universities of the Empire in 1921, but the universities were not unanimously in favour of the proposals then formulated. The board now to be set up will be the Indian counterpart of the Conference of Canadian Universities, the Standing Advisory Committee of the Australian Universities, the Vice-Chancellors' Committee of South Africa, and the Standing Committee of Vice-Chancellors and Principals of the Universities of Great Britain and Ireland.

Early Science at the Royal Society.

June 29, 1681. In discussion the president [Wren] observed, that it was necessary, that all wholesome food should have oils: that most roots wanting oil are not of themselves a good nourishment: and that in Ireland, where the people feed much on potatoes, they help themselves by drinking milk soured, to make the potatoes digest the better.

June 30, 1686. Ordered, that the treasurer, to encourage the measuring of a degree of the earth, do give to Mr. Halley fifty pounds or fifty copies of the "History of Fishes," when he shall have measured a degree to the satisfaction of Sir Christopher Wren, the president, and Sir John Hoskyns.

July 1, 1663. Mons. Moncony's description of the way used in Egypt of hatching in ovens, was read, and ordered to be registered. He was of opinion, that the temperament of the air in Egypt contributed greatly to the method of hatching chickens, since the grand duke having sent for some of the christians of Cairo, who are the only persons, that carry on that business, they had built an oven at Florence, but failed of hatching chickens.

1680. Sir Christopher Wren affirmed, that extreme freezing will sweeten salt water: that the curd which is then upon the surface of the water, will be found sweet: that this is found in Hudson's Bay: and that a little hole left in a window in winter, and a little fire in the chimney, will freeze anything to a great degree.

July 2, 1662. It was ordered that the committee appointed to view the Towgood's engine, meet the Saturday following afternoon in the Temple church.—A new astronomical hypothesis of a stranger was referred to the consideration of Dr. Wren [and others].

1668. The experiments appointed for this meeting not being prepared by reason of the operator's indisposition, it was ordered that on the like occasion another person should be hired and made use of *pro tempore* to do the manual part, that the Society might not be destitute of experiments.

July 3, 1661. Mr. Croune to procure, against the next meeting, some fresh vipers; and the operator to provide fresh hazel-sticks.—Mr. Evelyn presented his relation of graving and etching; and, after public thanks returned to him, was requested to transcribe it.

1672. Dr. Grew was put in mind to see, what might be discovered of the peristaltic motion in plants, asserted by Signor Malpighi.—Mr. Hooke was called upon for making a report concerning Signor Cassini's paper concerning the satellites of Jupiter, and desired to give in writing what he had said upon it that it might be without mistake imparted to Signor Cassini, who had desired that favour.

1679. It was ordered that Mons. Papin be employed for the writing of all such letters, as shall be ordered, to the correspondents of the Society: and that for so doing the said Mons. Papin shall receive the sum of eighteen pence per letter, unless the letter shall exceed two sides of a quarter of a sheet of paper; for every of which he shall receive two shillings.

July 4, 1678. A letter was read to the meeting written by Jacobus Pighius, dated at Padua, wherein he expressed the high respect which he had for the Society, and his great desire of being known to them. He mentioned his esteem for the English in general, and the favour done him by the English students at Padua, in choosing him their pro-syndic.

1683. It being thought proper, that some man should be appointed to keep the door of the meeting-room during the time that the Society was assembled, the porter, who removed the seats, was ordered to wait, and to have 12*d.* a time, when he waited.

Societies and Academies.

LONDON.

Royal Society, June 19.—J. C. McLennan and G. M. **Shrum**: On the luminescence of nitrogen, argon and other condensed gases at very low temperatures. Experiments are described on the luminescence of nitrogen and argon at the temperature of liquid hydrogen under electronic irradiation. The spectra of the light emitted by both elements contains wavelengths close to but not coincident with that corresponding to the auroral green line. Both solid nitrogen and solid argon phosphoresced brilliantly under electronic excitation. From these experiments there is no confirmation of Vegard's theory that the auroral green line originates in vaporous solidified nitrogen.—H. Grayson **Smith**: On the fine structure of the band spectra of sodium, potassium and sodium-potassium vapours. Four bands of the blue-green group of the band absorption spectrum of sodium and three bands of the red group of the band spectrum of potassium have been examined. Two values of the moment of inertia of the normal sodium molecule have been found from different bands, 2·515 and $2·286 \times 10^{-39}$ gm.cm.². Assuming that the molecule is diatomic, the corresponding values for the distance between the nuclei are 1·151 and $1·098 \times 10^{-8}$ cm. The moment of inertia of the potassium molecule is $18·39 \times 10^{-39}$ gm.cm.², so that the distance between the nuclei of a diatomic molecule is $3·069 \times 10^{-8}$ cm., which is in fair agreement with X-ray measurements. Two bands of a new group found by Barratt in the absorption spectrum of a mixture of sodium and potassium vapours give a moment of inertia of $6·615 \times 10^{-39}$ gm.cm.². This agrees with the supposition that these bands are due to NaK molecules, the distance between the nuclei being $2·137 \times 10^{-8}$ c.m.—Lord **Rayleigh**: (1) The non-luminous oxidation of phosphorus in an oxygen atmosphere. The views on phosphorescent combustion of phosphorus developed in former papers require that phosphorus vapour, when apparently inactive in an atmosphere of oxygen, should in reality be combining with it at isolated centres, though the action fails to spread. Either this action or the ordinary phosphorescent combustion can be caused to occur *at one given pressure and external temperature*. The rate of oxygen absorption is widely different in the two cases. With a given area of phosphorus surface, the rate of action is enormously increased by allowing a large oxygen space around it. The action occurs in the volume of the gas space, and therefore between oxygen and phosphorus vapour. (2) The light of the night sky: its intensity variations when analysed by colour filters. The comparison light is a uranium salt rendered self-luminous by radioactivity. Three alternative colour filters are provided; one of these approximately isolates the green aurora line. A red and a blue filter isolate the regions of the spectrum on either side of this line, excluding the line itself. The light of the sky as seen through these is equalised with the standard by means of neutral tinted glasses. Owing to faintness of the light, colour differences are not perceptible. Systematic observations of the auroral light for fifteen months, and of the other components for seven months, show variations which are far too large to be explained by changes in atmospheric transparency. The highest values of the auroral light were found during October 1923, which was the middle of a period of three months showing considerable sunspot activity. For the rest of the time there were few spots. The auroral light varies very little over the whole range of latitude from England to the Cape of Good

Hope. The polar aurora is contrasted with this non-polar aurora. The latter may be a phenomenon of phosphorescence, the luminosity being excited by the sun during daytime and carried round by the earth's rotation as in the phosphoroscope. The light of the night sky is much richer in red, measured relative to blue, than is daylight. In this respect it approximates to the light of a ½-watt incandescent lamp.—W. G. **Palmer** and F. H. **Constable**: The catalytic action of copper. Pt. IV. By measuring the velocity of dehydrogenation of alcohol passing over copper film catalysts when the temperature of the catalyst is rising and again when it is falling, a measure of the temperature coefficient of the change is obtained. Above a temperature of 280° C. the adsorbed alcohol film becomes unimolecular, and the aldehyde bombarding the bare copper surface polymerises and causes decay of the activity by covering the surface. No evidence of decay due to sintering was obtained during the experiments, which lasted up to five hours. The catalytic activity varied with the temperature of reduction of the copper oxide in a periodic manner; in general the greater the activity of the catalyst the less the temperature coefficient. Reduction at 420° C. seems to change both the grain structure and the nature of the surface. The "heat of activation" of an alcohol molecule is held to vary with the arrangement of the atoms in the surface on which it is adsorbed.—Rev. A. L. **Cortie**: The 27-day period (interval) in terrestrial magnetic disturbance. At a period approaching minimum solar activity (May 1921–July 1923), the persistence of notable magnetic disturbances in series at a 27-day interval, when the sun was entirely free from spots, and even sometimes of bright faculæ and flocculi, led to two long sequences of such disturbances, May 12, 1921–April 13, 1923, containing 26 synodic recurrences, and October 27, 1921–July 10, 1923, embracing 23 recurrences. In each sequence, from the magnetic data alone, a mean solar latitude has been computed, and a mean solar longitude, which fit accurately two regions of intermittent solar activity, one in the sun's northern hemisphere, and the other in the southern hemisphere. Moreover, these two regions, separated by about 180°, practically contained all the sunspots that had appeared in the period discussed. But there is no parity between the intensity of sunspot or floccular activity, and of magnetic disturbance. In the period discussed, magnetic disturbances occurred without, but not independently of, solar activity in a restricted area.—E. K. **Rideal** and C. G. L. **Wolf**: The destruction of rennin by agitation: a case of catalysis at an air-liquid interface. Rennin solutions undergo a chemical destruction when agitated, due to a chemical reaction occurring at the air liquid interface. The second reactant is a capillary active substance which is present in ordinary rennin solutions, but can be removed by dialysis. The dialysable reactive constituent is probably a fatty acid.—W. G. **Palmer**: The use of the coherer to investigate adsorption films. Loose contacts or "coherers" formed of tungsten-tungsten, carbon-tungsten, and platinum-platinum surfaces have been studied with particular regard to the action of the gas surrounding them. The voltage required across the contact to effect full metallic conduction is, for a given gas, a constant practically independent of the pressure of the gas and varying between wide limits for different gases. The cohering action may be due to the evaporation of an adsorbed film of gas under electrical stress. From the critical voltage the latent heat of evaporation of the film is calculated.—R. J. Lang: On the ultraviolet spark spectra of some of the elements. The wavelengths are given for the following elements: carbon, calcium, titanium, vanadium, chromium, manganese, cobalt, arsenic, molybdenum, cadmium, tin, antimony, tellurium, cerium, platinum, gold, thallium, lead, bismuth, uranium, in the ultraviolet region. They range from $\lambda = 2000$ A to $\lambda = 224$ A.—W. T. **Astbury** and Kathleen **Yardley**: Tabulated data for the examination of the 230 space-groups by homogeneous X-rays. Diagrams are given, one for each of the 230 space-groups, showing the distribution of symmetry elements and the relative positions and orientations of the molecules in the unit cell; and accompanying these diagrams are tables giving the fundamental Bravais lattice, the number of asymmetric molecules per cell, the abnormal spacings to be expected, and the possible molecular symmetry for each space-group.—J. W. **Campbell**: On the drift of spinning projectiles. The following assumptions are made: (1) The shell is stable. (2) Its initial rotation is all about the axis of symmetry. (3) The resistance of the air can be represented by two forces, one along the axis of symmetry of the shell, and the other at right angles to the axis and in the plane of the tangent to the trajectory and the axis, the latter force acting at some point (variable) in front of the centre of gravity of the shell. When the initial oscillations have been damped out by air resistance, (2) is practically realised. Experiments show that the principal parts of the air resistance are represented by the force system (3). The solution obtained contains: (1) A formula for lateral drift. (2) Formulæ for the vertical and lateral components of the yaw. (3) A formula for cross-range wind deflexion. The solution is valid provided the yaw and the inclination of the axis of the shell to the plane of fire do not become too great, and it exhibits the well-known properties of the phenomena of drift.—A. L. **Narayan** and D. **Gunnaiya**: Absorption of lithium vapour. Absorption of the lithium vapour in the visible region has been studied. The vapour possesses channelled absorption spectrum both on the short and the long wavelength side of the first member of the principal series.

PARIS.

Academy of Sciences, June 10.—M. Guillaume Bigourdan in the chair.—A. **Haller**: The action of tetrachlorophthalic and tetrabromophthalic acids on turpentines. A new method of preparation of the camphols and therefore of the lævo- and dextro-camphors. The interaction of the tetrahalogenophthalic acids and pinenes gives bornyl, isobornyl and fenchyl tetrahalogenophthates, which by saponification give mixtures of these alcohols and their acid esters. The alcohols thus formed give fenones or camphors according to the terpene employed.—Charles **Rabut**: The scientific rules to be followed in structures of armoured concrete.—M. de **Sparre**: Pelton turbines working under a variable head.—J. Kampé de **Fériet**: A particular class of hypergeometrical functions of one variable.—Georges J. **Rémoundos**: The pairs of meromorp or algebroid functions corresponding to the points of an algebraic curve.—Octave **Mayer**.—A geometrical interpretation of the second fundamental quadratic form of a surface; in relation with the theory of parallelism of Levi-Cività.—P. **Dumanois**: The use of light alloys for the pistons of internal combustion motors.—A. **Barbaud**: Tracing lines of height and its application to aerial navigation over the sea.—T. **Peczalski** and A. **Launert**: The electrical resistance and density of copper cemented by salts.—P. **Bovis**: The absorption spectrum of bromine. The maximum absorption corresponds sensibly to the same wavelength for liquid bromine as for its vapour; but, calculated to the same weight of bromine, the maximum values are different, the optical density of the liquid being more than double that of the vapour.—M. **Duffieux**: The origin of the first and second positive group of the band spectrum of nitrogen.—H. **Chipart**: The electromagnetic theory of optical activity and the postulate of MacCullagh.—H. **Pélabon**: The direct formation of the oxychlorides, oxybromides, and oxyiodides of mercury. Mercuric chloride, bromide, and iodide can unite directly with yellow or red mercuric oxide, dry or in the presence of water. In the last case the equilibrium is affected by alkali dissolved from the glass containing-vessel.—Stefan **Triandafil**: The influence of temperature on the galvanic polarisation of nickel.—René **Dubrissay**: The capillary phenomena which appear at the surface of separation of water and benzene in the presence of the fatty acids and of alkalies.—Francis **Perrin**: The law of decrease of the fluorescent power as a function of the concentration.—E. **Darmois**: The compounds of malic acid and copper. Measurements of the P_H and rotations of solutions of copper hydroxide in malic acid indicated the presence of two malates only, the acid salt and Liebig's basic salt.—M. **Bourguel**: The transformation of the substituted acetylene hydrocarbons into true hydrocarbons by sodium amide. Hydrocarbons of the type $RC\equiv C.CH_3$ are readily transformed by heating with sodium amide at 110° C. into hydrocarbons of the type $(CH_3)R.C\equiv CH$. The homologues $RC\equiv C.C_2H_5$ undergo a similar change, but much more slowly.—A. J. A. **Guillaumin**: The action of hydroxylamine on ethyl tartrate.—Alphonse **Mailhe**: The decomposition of chlorophyll extracts. Distilled with magnesium or zinc chloride, these extracts give a gas rich in carbon dioxide, a mixture of liquid hydrocarbons containing a high proportion of olefines, and a solid, probably dinonylketone $(C_9H_{19})_2CO$.—P. **Lasareff**: The mass of metallic iron contained in the ferruginous deposits at Koursk (Central Russia).—Albert **Nodon**: Observations on the propagation of the explosive waves resulting from the experiments at La Courtine. Details of the methods employed to measure the velocities of the air waves and earth waves caused by the explosions at La Courtine, distance 243 kilometres.—P. **Gillot**: Remarks on the determinism of sex in *Mercurialis annua*. This plant is unsuitable for investigations on sexual determinism.—A. **Maige**: The different stages of amylogenic condensation.—D. **Chouchack**: Influence of the nutritive elements on the development of soil bacteria.—F. **Granel**: The pseudobranchia of the selacians.—MM. **Barthélemy** and **Bonnet**: The influence of the temperature on the utilisation of energy in the course of the development of the egg of *Rana fusca*.—MM. J. E. **Abelous, Moog,** and **Soula**: Splenectomy and the demineralisation of the organism.—P. **Le Noir** and A. Mathieu de **Fossey**. Study of the ionic urinary acidity in normal man. The influence of food.—MM. **Pézard, Sand,** and **Caridroit**: Hormono-sexual modifications in adult Gallinaceae and the theory of specific form.

Official Publications Received.

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau Central de Magnétisme terrestre. Publiées par les soins de Prof. Ch. Maurain. Tome 2. Pp. viii+150. (Paris: Les Presses universitaires de France.)

Department of Agriculture and Natural Resources: Weather Bureau. Annual Report of the Weather Bureau for the Year 1920. Part 4: Hourly Results of Observations made at the Magnetic Observatory of Antipolo near Manila, P.I., during the Calendar Year 1920. Pp. 47. (Manila: Bureau of Printing.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 486: Some new Thermoelectrical and Actinoelectrical Properties of Molybdenite. By W. W. Coblentz. Pp. 375-418. (Washington: Government Printing Office.) 10 cents.

Annual Conference of the Universities of Great Britain and Ireland, 1924. Report of Proceedings. Pp. 63. (London: Universities Bureau of the British Empire.) 1s.

Diary of Societies.

SATURDAY, July 5.

INSTITUTION OF MECHANICAL ENGINEERS (Joint Meeting with the Institution of Civil Engineers), at 11.30.—Draft Standard Test Code for Hydraulic Power Plants, drawn up by a Joint Committee of the Institutions of Civil and Mechanical Engineers.

RONTGEN SOCIETY AND THE ELECTRO-THERAPEUTICS SECTION OF THE ROYAL SOCIETY OF MEDICINE (Joint Meeting at the Radcliffe Infirmary, Oxford), at 3.30.—Sir Thomas Horder: The Influence of Radiology upon the Criteria of Disease (Mackenzie Davidson Memorial Lecture).—Prof. S. Russ: Experimental Studies upon the Lethal Dose of X-rays and Radium for Animal Tumours.

MONDAY, July 7.

INSTITUTION OF SANITARY ENGINEERS (at Royal United Service Institution), at 10 A.M. and 2.—International Conference.

PHOTOGRAPHIC CONVENTION (at Royal Photographic Society of Great Britain), in afternoon.—Presidential Address—Annual General Meeting.

FARADAY SOCIETY (at Chemical Society), at 7.45.—Annual General Meeting.—At 8.—G. R. D. Hogg: Note on the Conduction of Heat down the Necks of Metal Vacuum Vessels containing Liquid Oxygen.—C. L. Haddon: The Mechanism of Setting of Calcium Sulphate Cements.—J. J. Doolan and Prof. J. R. Partington: The Vapour Pressure of Tellurium.—E. E. Turner and W. H. Patterson: Cryoscopy in Sodium Sulphate Decahydrate.—D. B. McLeod: The Viscosity of Binary Mixtures.—J. B. Firth and F. S. Watson: The Catalytic Decomposition of Hydrogen Peroxide Solution by Animal Charcoal—The Production of Highly Active Charcoals.—Prof. A. J. Allmand and A. N. Campbell: The Electrodeposition of Manganese.—J. Grant: Concentration-Cells in Methyl Alcohol. Part II. Solutions containing Tetraethyl Ammonium Iodide.—F. H. Jeffery: The Electrolysis of Solutions of Potassium Oxalite with a Tin Anode and an Electrometric Determination of the Constitution of the Complex Anions formed.—F. J. Fraser: An Improved Form of Crook's Elutriator.

THE ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. H. Wildon Carr: The Scientific Approach to Philosophy.

TUESDAY, July 8.

INSTITUTION OF SANITARY ENGINEERS (at Royal United Service Institution), at 10 A.M. and 2.—International Conference.

INSTITUTION OF CIVIL ENGINEERS, at 8.30.—Prof. Elihu Thomson: Electrical Progress and its Unsolved Problems (James Forrest Lecture).

WEDNESDAY, July 9.

INSTITUTION OF SANITARY ENGINEERS (at Royal United Service Institution), at 10 A.M. and 2.—International Conference.

DECIMAL ASSOCIATION (Decimal-Metric Conference) (at Institution of Electrical Engineers), at 11, 2.30, and 4.30.—Discussion on Decimal Coinage—Ancient and Modern Weighing Appliances and other Appliances (Lecture)—Discussion on Metric System.

ROYAL SOCIETY OF MEDICINE (Sub-section of Proctology (Section of Surgery): Annual Clinical Meeting in conjunction with the American Proctologic Society), at 11.—Dr. Jackson: Quo vadis?—Dr. Beach: The Evolution of Proctology.—At 5.30.—Graeme Anderson and others: Discussion on The Injection Treatment of Hæmorrhoids.

RADIO SOCIETY OF GREAT BRITAIN (Informal Meeting) (at Institution of Electrical Engineers), at 6.—P. R. Coursey: The Manufacture of Condensors.

THURSDAY, July 10.

INSTITUTION OF SANITARY ENGINEERS (at Royal United Service Institution), at 10 A.M. and 2.—International Conference.

INSTITUTION OF ELECTRICAL ENGINEERS (Kelvin Centenary), at 12.30.—Dr. A. Russell: Address.

INSTITUTION OF CIVIL ENGINEERS (Kelvin Centenary), at 4.30.—Sir J. J. Thomson: Kelvin Centenary Oration.—Presentation of the Kelvin Medal, 1923, to Prof. Elihu Thomson.

ROYAL SOCIETY OF MEDICINE (Sub-section of Proctology (Section of Surgery): Annual Clinical Meeting in conjunction with the American Proctologic Society), at 4.30.—Dr. Montague and others: Discussion on The Treatment of Pruritus Ani.—Dr. Hirschman and others: Discussion on The Treatment of Rectal Prolapse.

FRIDAY, July 11.

ROYAL SOCIETY OF MEDICINE (Sub-section of Proctology (Section of Surgery): Annual Clinical Meeting in conjunction with the American Proctologic Society), at 4.30.—W. E. Miles and Mr. Lockhart-Mummery: Discussion on The Treatment of Cancer of the Rectum.

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Supplement to NATURE

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Insulin.[1]

By Prof. Hugh MacLean, Professor of Medicine, University of London.

No recent discovery in medical science has created so much interest, both in lay and in professional circles, as the advent of insulin. The great importance of this discovery lies in the fact that through its agency a fresh outlook and a new hope have been opened up to the unfortunate sufferer from diabetes—an outlook in which despair and the prospect of almost certain death have given place to health and hope. From the humanitarian point of view, this itself is no mean achievement, but insulin has many interesting features besides its success in therapeutics, and the problem of its method of action presents an intellectual puzzle, which, from its complexity and obscurity, bids fair to engage our ablest scientific minds for many years to come.

Before discussing the results obtained from the use of insulin in diabetes, it is essential that certain points bearing on the metabolism of our foodstuffs should be clearly understood, for diabetes is nothing more than an interference with the normal mechanism which burns up our food in the body. Unlike the healthy individual, the diabetic subject cannot utilise his food, and, in consequence, becomes thin and ill. He presents the curious anomaly that the more food he eats the thinner and weaker he becomes, for, as the result of the perverse process of metabolism from which he suffers, much of the food that he is unable to use is changed into poisonous bodies which circulate in the blood, and cause destruction of body tissue, soon to be followed by death.

Though one of the most important symptoms of diabetes is glycosuria, or the presence of sugar in the urine, it is important to appreciate the fact that diabetes is a disease not of sugar or carbohydrate metabolism alone, but that the metabolism of all our foodstuffs is involved.

Metabolism of Foodstuffs in the Body.

Our knowledge of the various changes which the different foodstuffs undergo in the body is unfortunately very meagre, but we know sufficient to enable us to understand the main points in diabetes. Our food consists largely of starchy material or carbohydrate, with a certain amount of fat, and a fair proportion of such products as meat, fish, eggs, and other related bodies known as proteins.

Fats and carbohydrates are used simply as fuel for the body, and as the result of their combustion, heat and energy are generated. Both ultimately produce end-products which are removed from the body largely in the expired air as water and carbon-dioxide. Proteins also supply heat and energy, but they are used for another purpose as well; they form the bricks for building up the waste tissues of the body. That part of the protein molecule which is not required for the renewal of waste tissue is utilised for the production of heat and energy, just as in the case of fats and carbohydrates.

If we endeavour to follow the course of carbohydrate metabolism in the body, we are at once presented with many difficulties, but a few main features are fairly clear. It is certain that starch, no matter in what form it is taken in, is broken down in the intestinal canal by enzyme action into the simple sugar known as glucose. This glucose is then absorbed into the blood, and before getting into the general circulation, passes through the liver. If a great deal of glucose is present, the liver stores part of it for future use, and thus prevents an excessive amount of glucose from being present in the blood at one time. The storage substance which the liver forms from glucose is a starch-like body known as glycogen. Though the chief depot for glycogen is the liver, a good deal is found in the muscles as well. This glycogen is gradually converted into sugar again in response to the requirements of the body, so that a certain amount of sugar is always available for oxidation by the tissues. There is now a good deal of evidence that another storage product besides glycogen is formed during sugar metabolism—the lactacidogen of Embden—but it is doubtful whether this substance, which appears to be of the nature of a compound of sugar and phosphoric acid, ever gives rise to sugar again in the muscles after it is formed. When sugar reaches the tissues it is burnt up and forms carbon-dioxide and water. Many investigations have been carried out in an endeavour to find the intermediate substances between these end products and the larger sugar molecule, but of this phase of metabolism we know nothing with certainty.

Fat is also acted on by the intestinal juices and absorbed as free fatty acids and glycerin; it is largely stored as fat in the body. Before final oxidation, fat is broken down into a lower four-carbon fatty acid—oxybutyric acid—together with diacetic acid and acetone. These substances are then oxidised, forming the usual end-products, carbon-dioxide and water.

It is probable that both fat and carbohydrate have a definite and separate mechanism for metabolism, but that protein, on the other hand, does not possess a separate mechanism. When tissue waste is restored, the remaining protein is broken down into substances similar in nature to the intermediate products of sugar and fat metabolism, which are probably oxidised by the same mechanism as is used for fat and carbohydrate.

[1] Discourse delivered at the Royal Institution on March 28.

Metabolism in Diabetes.

In diabetes the carbohydrates are as usual hydrolysed to glucose in the intestinal tract, but after absorption the glucose tends to accumulate in the body, with the result that a certain amount of it is excreted in the urine. This excess of sugar in the body in diabetes depends on two causes. In the first place, the liver and muscles are unable to store the excess of sugar as glycogen, while in the second place, the tissues have lost to a great extent the power of oxidising sugar. The consequence is that a great deal of glucose is always present in the blood, resulting in a great waste of sugar through the kidneys. It is an interesting fact that one of the earliest manifestations of diabetes appears to be a lack of power on the part of the liver to store sugar as glycogen. This difficulty may be in evidence long before any symptoms of diabetes manifest themselves. In severe cases, oxidation of the sugar is also markedly interfered with, a phenomenon which depends on a lesion of the pancreas; this defective oxidation is most marked in the later stages of very severe diabetes. Generally speaking, sugar passes into the system of the diabetic and is largely passed out again without being utilised. Why this should be so is at present unknown, though various suggestions have been made.

The chemical researches of Fischer and of Irvine have demonstrated the existence of a more active form of glucose than the ordinary variety found in diabetic urine, and it has been surmised that this more active γ-glucose might be the form which the body requires for metabolism. If the body can utilise glucose only after it has been changed into the more active form, it is obvious that a defect in the mechanism responsible for this change would result in a condition similar to what we have in diabetes. The body would be supplied with a variety of sugar which it could not metabolise, with the result that this sugar would be excreted in the urine like any other foreign body. Attractive as this theory appears, it must be admitted that, so far, no convincing evidence of the existence of γ-glucose in the body has been advanced.

With regard to the metabolism of fat in diabetes, it appears that the breaking down of the large fatty acid molecule goes on as usual to the stage of ketone bodies, but that these bodies fail to be oxidised; they therefore accumulate in the blood and are largely excreted in the urine.

As already explained, the oxidation of protein probably takes place partly along the path of carbohydrate metabolism, and partly along the path of fat metabolism. The result is that protein may give rise to both sugar and ketone bodies in the diabetic urine, about 60 per cent. of the amino acids of protein being capable of forming sugar, while 40 per cent. may be excreted as ketone bodies.

The total result of these changes in metabolism is that the urine of the diabetic subject frequently contains large amounts of glucose together with oxybutyric acid, diacetic acid, and acetone.

The diagram (Fig. 1) indicates roughly what happens in metabolism in both the normal and diabetic person. These observations make it clear that no change in the particular class of food-stuffs taken will necessarily result in the elimination of sugar and ketone bodies from the urine.

Blood Sugar Changes in the Normal and in the Diabetic Subject.

Some knowledge of the physiological changes which the blood sugar concentration undergoes in the body is essential in the study of diabetes. In the normal subject, when the blood is examined two or three hours after a meal, it is found to contain about 0·1 per cent. of glucose. As a rule the blood sugar does not sink appreciably lower than this in ordinary circumstances. After the ingestion of carbohydrate food, however, it rises to a maximum of about 0·16 to 0·18 per cent. and then quickly falls to the former level of about 0·1 per

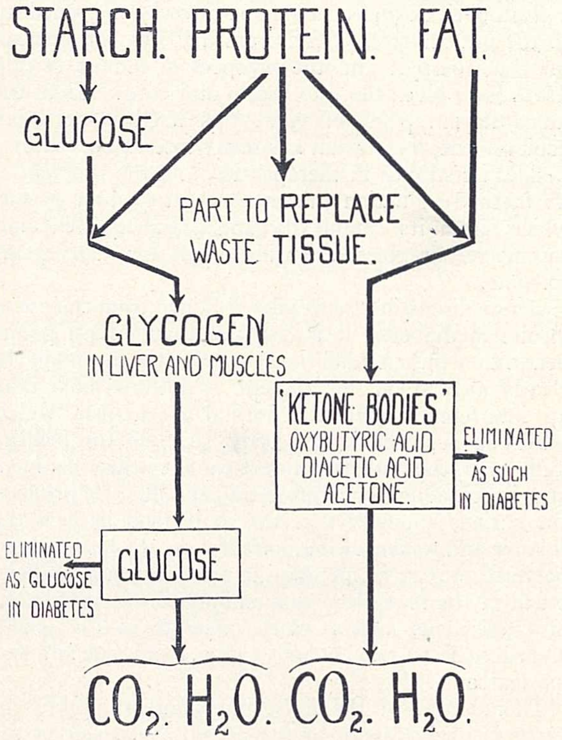

Fig. 1.—Metabolic paths of food-stuffs in the body.

cent. Usually the maximum rise takes place within one-half to three-quarters of an hour after a meal, and generally the blood sugar content is found to be normal in about one and a half to two hours. These changes are best observed after a meal consisting of from forty to fifty grams of glucose. It might be thought that the early rise just described is due simply to increased absorption of sugar into the blood and that the fall towards the normal level merely indicates that absorption is complete. This is by no means the case, as can easily be shown by experiment. Indeed, it would seem that absorption of sugar may be going on just as rapidly after the blood sugar falls to the normal level as it was when the blood sugar was at its maximum.

The explanation of the phenomenon appears to be that, after some absorption of sugar into the general circulation has taken place, a special mechanism comes into action which stores the sugar as glycogen and so reduces the amount in the blood; this mechanism resides chiefly in the liver. In connexion with this storage action it is interesting to observe that it is generally quite impossible to raise the blood sugar concentration beyond 0·18 per cent. or so. No matter how much sugar is taken, no greater quantity than this will be found in the blood. Whenever the concentration reaches this point, the liver storage mechanism becomes so strongly developed as to prevent any further rise. The interest of this observation lies in the fact that whenever the blood sugar rises above 0·18 per cent., the kidney begins to excrete sugar in the urine. Until this concentration is reached no sugar is excreted. The difficulty of raising the blood sugar beyond 0·18 per cent. or so indicates that glycosuria in the normal subject should be very difficult to produce as the result of ingesting large amounts of sugar, and experiments show that no sugar appears in the urine of the healthy subject however much sugar he eats.

From these statements it will be clear that the presence of sugar in the urine indicates that the blood sugar concentration is in the region of 0·18 per cent. or higher. Though the normal kidney does not excrete sugar until this concentration is reached in the blood, it sometimes happens that the kidney may leak and allow sugar to pass into the urine when the concentration in the blood is much lower than the figure given. This condition, which is fairly common, is known as renal glycosuria; obviously it has nothing whatever to do with diabetes. It gives rise to no symptoms and produces no bad effects.

In diabetes the glycosuria is always due to an increased amount of sugar in the blood—a hyperglycæmia—and the changes in blood sugar concentration after eating starch or sugar are very different from those in the normal subject. If fifty grams of glucose are given to a diabetic subject, the rise in blood sugar is much higher than in the normal, and it continues high for a much longer period. Generally, of course, it happens that the blood sugar in the diabetic is much higher to begin with than it is in the normal subject, but it may often be reduced by appropriate dieting to the region of 0·1 per cent., and when this is done and sugar is taken, the blood sugar soon shoots over the 0·18 per cent. mark and often reaches 0·3 per cent. or more, at which high level it may remain for hours. The curves in Fig. 2 represent the effect of 50 grams of glucose on the blood sugar of a normal and a diabetic subject. It is interesting to note that the only sugar which does not raise the blood sugar in the normal subject is lævulose; in the diabetic, however, lævulose acts just as any other sugar. An appreciation of these facts is necessary in order to understand the action of insulin.

Glycosuria not Diabetes.

Though glycosuria constitutes an important symptom of diabetes, it must be clearly understood that the finding of even large amounts of sugar in the urine does not necessarily mean that diabetes is present. When glycosuria results from a leakage of sugar through the kidney, the condition is obviously of little or no importance, as already explained. Temporary glycosuria is not infrequently produced as the result of such conditions as mental excitement and fear. The explanation that has been suggested by physiologists to account for the increase of blood sugar caused by fear, is, that under primitive conditions some degree of fear was generally a preliminary to active muscular exertion of a defensive nature, and that the sugar was provided as fuel for the production of the required energy. Again, it is very common to find sugar in the urine of students after an examination. An interesting observation bearing on this point was reported some years ago by certain American observers. They examined the urines of a number of male students after an examination and found sugar in 18 per cent. of them. On extending the experiment to female students, contrary to expectation, no such result was in evidence, but since these latter students were all much younger than the males, it is probable that the irresponsibility of youth rather than any fundamental lack of emotion

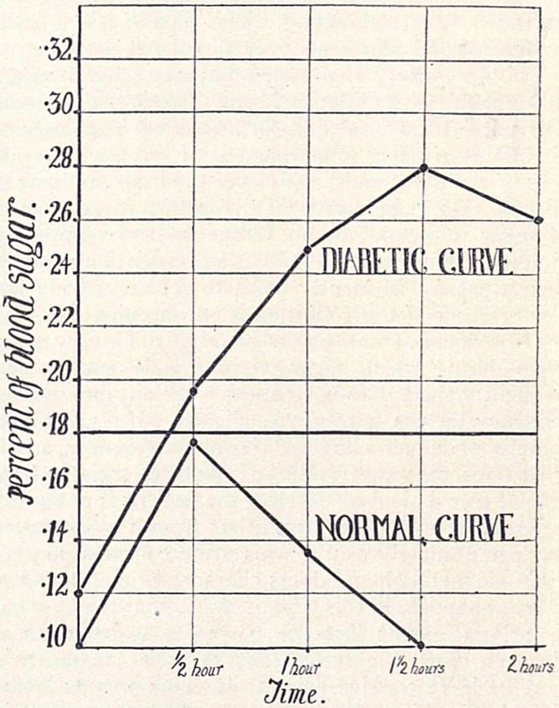

Fig. 2.—Curves of blood sugar concentration obtained from a normal and a diabetic subject after giving each 50 grams of glucose by mouth.

was the cause of the difference. Glycosuria also appears as the result of taking various drugs, and is not very uncommon in elderly patients who practise the belief so widely prevalent that rejuvenation and restoration of bodily and mental vigour may be obtained by the ingestion of large amounts of thyroid gland extract. Another cause of glycosuria not infrequently encountered is the excessive use of alcohol. After long dinners in which alcohol may play but a moderate part, glucose is frequently found in the urine on the following day. All these conditions are dependent on a temporary hyperglycæmia, but they disappear whenever the condition giving rise to them is removed. This glycosuria must not be regarded as of a diabetic nature.

Chief Symptoms of Typical Diabetes.

Along with the blood and urine changes described above, the diabetic suffers from general weakness, marked emaciation, great mental depression, thirst, hunger, and a very great tendency to the onset of a most serious condition associated with drowsiness and ultimately resulting in unconsciousness and death; this latter state is the fatal condition known as diabetic coma. It is liable to appear sooner or later in every case of severe diabetes, and apart from accidental complications, is the usual cause of death in the diabetic subject.

Though this is the general course in typical diabetes, it must be admitted that the progress of the malady varies much in different individuals, and that many varieties of the disease, from a chronic slowly progressive type to what might almost be called fulminating diabetes, are encountered. Before the advent of insulin it was quite the exception for a patient suffering from well-marked diabetes to live for more than five or six years, though sometimes this period could be extended by careful dieting. This class of case is easily recognised and represents typical diabetes mellitus.

Another variety of so-called diabetes is by no means uncommon in middle-aged and elderly individuals. The patient may feel quite fit, or more frequently he complains of being somewhat out of sorts, with weakness of the limbs and a feeling of tiredness and lack of energy. On examination of the urine a large amount of sugar is found, but no ketone bodies are present. Unlike the true diabetic, there is no emaciation; indeed such a patient frequently tends to get excessively fat. The presence of this condition is not incompatible with the enjoyment of more or less good health for very many years during which sugar is continually passed, and frequently there does not appear to be any progressive tendency on the part of the disease. In such cases there is no danger whatever of coma intervening, and it is obvious that the condition differs essentially from that of true diabetes. Indeed, the patient is not really suffering from diabetes at all, but from a well-marked and persistent glycosuria; his urine contains none of the toxic metabolic products characteristic of diabetes.

What happens in this type of case is that the liver has to a large extent lost the power to store sugar as glycogen, with the result that there is constantly a more or less excessive amount of sugar present in the blood, giving rise to glycosuria. Unlike what occurs in true diabetes, where a definite defect in the pancreas is present, there is here apparently no difficulty in oxidising sugar or fat in the tissues, hence the absence of ketone bodies in the urine. The constant excess of blood sugar probably stimulates the pancreas to produce more insulin, with the result that a good deal of this sugar is stored as fat in the same manner as the diabetic patient treated with insulin tends to put on fat. Occasionally, though not very frequently, this type of persistent glycosuria develops after many years into a true diabetes. This somewhat rare contingency appears to depend on the fact that the large amount of blood sugar constantly present stimulates the pancreatic cells to an over-activity which sometimes results in exhaustion. While true diabetes is probably always associated with a pancreatic lesion, the type of so-called diabetes just described appears to be dependent on a disturbance of the liver. Though, in true diabetes, the liver also fails to store sugar, yet this is but one part of the condition; the most important point is that oxidation of sugar and other foodstuffs is defective. In the glycosuria of elderly individuals the defect appears to be limited to the liver.

The Cause of Diabetes.

The older observers appear to have been impressed by the frequency with which patients dying from diabetes showed definite lesions in the pancreas, and the older literature contained many statements emphasising this point. It was not, however, until 1889 that the relationship of the pancreas to diabetes was definitely established. In that year, von Mering and Minkowski, in an epoch-making paper, showed that the removal of the pancreas from an animal resulted in a condition which was practically the same as severe human diabetes. Removal of part of the gland might or might not produce glycosuria according to the amount of healthy tissue left behind, but complete extirpation was followed in every case by intense symptoms and a fatal termination in coma within a few weeks. Evidence was obtained that this result was not dependent on the loss of the ordinary pancreatic tissue, and it is now generally accepted that certain small islands of special cells found in the pancreas—the Islets of Langerhans—are connected with carbohydrate metabolism and that their destruction or removal results in diabetes. These important experiments constitute the foundation on which all subsequent advances in our knowledge of diabetes, including the discovery of insulin, are based.

Attempts to obtain Pancreatic Extracts for the Treatment of Diabetes.

The discovery that destruction or removal of the pancreas in animals gave rise to diabetes at once suggested the idea that this disease might be successfully treated by giving pancreas or pancreas extract to the patient. It was obvious that the pancreas must contain some active principle which was necessary to prevent diabetes, and the natural inference was that if this substance could be supplied to the diabetic, the symptoms of diabetes would disappear. At first, fresh pancreas or various extracts of the gland were given by mouth, but without any apparent effect. Later, various special preparations were tried by injection, but the results, though by no means always negative, were variable and unsatisfactory. It may with confidence be said that practically every investigator interested in diabetes has at some time or other tried the effects of pancreatic extracts.

It soon became clear that no effect whatever was produced when the preparations were given by mouth, but several observers had quite marked results when hypodermic or intravenous administration was used. Thus, for example, Zuelzer in 1908 prepared an extract which he injected into diabetic patients, with the result that, though no change was made in the diet, the sugar and ketone bodies previously present in the urine were much reduced or, indeed, in some cases disappeared altogether. At the same time the patients improved in general health. The method was, however, given up on account of the frequency with which injections were followed by more or less serious disturbances in the patients, some of whom became very ill, while others showed high fever, rigors and prostration. Zuelzer's product was prepared from the pancreas by the use of alcohol. He assumed that the active principle was easily destroyed by the pancreatic ferment, and took the view that this might be prevented by treatment with alcohol. Later, Scott, working in America on somewhat similar lines, obtained a preparation which was definitely active though rather weak and inconstant. Various observers had somewhat similar experiences, but nobody was able to prepare a trustworthy non-toxic substance for clinical use in diabetes, and a few years ago it seemed as if the problem was insoluble. The disappointing results of so many investigators tended to substantiate the impression that further work on the problem was not likely to produce results, and our earlier hope of being able to treat diabetes successfully by pancreatic extracts had to a large extent vanished.

This was really the position when Banting took up the subject. Banting adopted the view propounded by many earlier investigators that the trypsin of the pancreas destroyed the internal secretion or hormone necessary for normal carbohydrate metabolism, and that the failure to obtain an active substance depended on this digestive action of trypsin. The difficulty was to devise some means by which this destructive action of trypsin during extraction of the pancreatic tissue could be avoided. It was well known to physiologists that the ordinary pancreatic tissue which secretes enzymes for the digestion of food underwent degeneration after ligature of the pancreatic duct, while on the other hand the islets of Langerhans were not affected. Banting therefore tied the duct in an animal and after several weeks removed the degenerated pancreas. If the theory mentioned was correct, an extract of this pancreas should contain an active substance for the treatment of diabetes since no digestive enzymes would be present. This actually proved to be the case, for a simple saline extract of this pancreas when injected into a diabetic animal lowered the blood sugar and reduced the amount of sugar passed in the urine.

This result was exceedingly interesting, but its practical application on a large scale was obviously impossible. Fortunately, however, it was soon found that the initial tying of the duct was unnecessary, for further experiment on the lines of Zuelzer's work showed that quite active preparations could be obtained from the normal pancreas. Ox pancreas was macerated as soon as possible after the death of the animal and left standing for several hours in 95 per cent. alcohol. The mixture was then filtered and the clear fluid obtained evaporated to dryness by means of a current of warm air. The residue was then dissolved in saline and used for injection. To this active substance Banting gave the name "Insulin."

It is not quite certain whether Banting's original view is correct, but this is of little importance from the practical point of view. Banting's success was largely dependent on the ease with which blood sugar can now be estimated, for it was essential in judging of the effect of insulin on animals that blood sugar estimations should be carried out at frequent intervals. Some years ago this was practically impossible, but now blood sugar may be estimated in the same animal every few minutes if necessary. To Banting belongs the credit of having prepared an active extract of pancreas suitable for the treatment of diabetes, but it must not be forgotten that this great achievement was rendered possible only by the laborious work of many earlier observers. Banting's final triumph was no doubt largely brought about as the result of modern developments in biochemical methods, but, taking everything into consideration, it still remains a mystery why insulin was not isolated many years ago.

As was the case with all former investigators, Banting's earlier products frequently gave rise to more or less alarming symptoms when injected into patients, so attempts were made to obtain a purer substance. These attempts were successful, and samples of insulin were soon prepared which possessed little or no toxic effects. The present method of manufacture depends on the isolation of a crude product by fractional precipitation of pancreatic extract with alcohol; this impure body is treated with picric acid, and insulin picrate precipitated, from which a fairly pure substance suitable for clinical work is obtained. This method requires the use of large amounts of alcohol and is somewhat tedious and expensive; also, it takes several days to complete the extraction and preparation of the insulin. Quite recently, Dodds, at the Middlesex Hospital, worked out a process for the isolation of insulin which possesses many advantages over the usual method in vogue. The principle of this method is based on the earlier observation by Dudley, that insulin could be most conveniently separated as the picrate. In the modification suggested by Dodds, the fresh pancreas is thoroughly ground up with solid picric acid, thus converting the insulin directly to picrate and so reducing the time during which tryptic action may occur. By this process the old tedious filtration of the alcoholic extract is rendered unnecessary. The pancreas-picric acid creamy mixture is treated with acetone, which dissolves out the insulin picrate. The picrate is then purified on the usual lines. Not only is this method more expeditious, but also it actually gives a higher yield of insulin.

Standardisation of Insulin.

The effect of insulin in reducing the blood sugar is not confined to diabetic animals, for it reduces the blood sugar of normal animals as well. This effect of insulin is used in the standardisation of the product for clinical use, and the present unitage is based on the dose required to reduce the blood sugar of a normal rabbit to about 0·04 per cent. An average dose for a diabetic patient is 10 units, but the amount given depends on the gravity of the condition.

Symptoms produced by Insulin.

In both the normal and the diabetic individual, insulin may produce definite symptoms when given in excess. The chief of these symptoms are hot flushes especially on the face, weakness of the limbs, giddiness, sweating, tremulousness, and ultimately, if the condition is not relieved, convulsions, coma, and death. This property of insulin makes the remedy a very dangerous one unless great care is used in its administration, and no doubt explains many of the difficulties encountered by the earlier investigators.

The occurrence of these clinical phenomena is associated with the action of insulin in reducing the blood sugar. When the blood sugar gets too low, the fact is indicated by the appearance of these symptoms, but it is now certain that patients differ greatly as to the exact blood sugar concentration that may be present when the symptoms come on. Taking the normal resting sugar as about 0·1 per cent., it would seem that in certain subjects, even a slight decrease to about 0·08 per cent. or so may be associated with insulin symptoms, while, in others, the blood sugar concentration may be so low as 0·05 per cent., and yet the patient may feel quite well. In a general way, it is now established that the train of symptoms induced by insulin do not appear when the blood sugar is normal or above this level, but that they are liable to manifest themselves whenever the blood sugar sinks to a sub-normal value; the exact level at which they appear depends on some unknown factors present in the patient. The association of these insulin symptoms with a more or less lowered blood sugar concentration—a hypoglycæmia—is, however, so pronounced that they are generally referred to as hypoglycæmic reactions. It may be taken for granted that when insulin symptoms do come on, the lower the blood sugar the more severe are the symptoms likely to be. Fortunately, these symptoms are very soon relieved if some glucose is taken, so that, generally, this insulin hypoglycæmia is not dangerous, provided that the patient is warned as to the nature of the symptoms, and takes glucose immediately they come on. In certain circumstances, however, the condition may be a very real danger, as every one who has treated many patients must have found.

The curious variation to the influence of insulin which exists in normal individuals is well shown by the results of an experiment carried out in my laboratory on two young healthy medical men each about the same build, age, and weight. For a day or two before the test, both subjects took the same amount and the same kind of food. On the morning of the experiment each received 50 grams of glucose by mouth, and shortly afterwards 20 units of insulin were injected hypodermically. Samples of blood were then taken at frequent intervals for blood sugar estimations. One subject showed no symptoms whatever after the insulin, while the other developed symptoms so severe that it was difficult to get blood for sugar estimations. A further 50 grams of glucose given by mouth had a marked but only a temporary effect in relieving these symptoms, so that very soon the condition was as severe as before and indeed somewhat alarming. A further 60 grams of glucose was then administered with the result that the insulin phenomena passed over once again, though some slight symptoms reappeared later. So far as blood sugar concentration was concerned, there was little difference between the subjects; in both the blood sugar fell to the region of 0·07 to 0·08 per cent. The description of his symptoms given by the subject who suffered from insulin symptoms was as follows: "The first noticeable symptom was profuse sweating of the face, scalp, and neck. This was very quickly followed by inability to perform fine movements with the hands, and weakness of the legs, which, however, was only noticed when standing up. General symptoms were dizziness, and an impression as of all near objects being far away and having a swaying movement. On recovery after glucose, the sweating, dizziness, and swaying sensations were the first to go; the sense of weakness in the limbs remained for the longest time."

In the treatment of insulin hypoglycæmia, there is no difficulty in administering sugar provided the patient is still conscious; on the other hand, when the patient is unconscious, it may be very difficult indeed to get sugar into the system. In such cases the patient may generally be brought round by the injection of 1 c.c. of 1 in 1000 adrenalin solution. A dose of pituitrin (1 c.c.) given subcutaneously will also produce the desired result. If, however, consciousness is not soon restored by these methods, glucose must be injected into the circulation through a vein. This procedure never fails to bring the patient round, provided the hypoglycæmic condition has not lasted too long.

Though severe hypoglycæmic phenomena with unconsciousness were observed fairly often some time ago when our knowledge of the action of insulin was very limited, they are very seldom encountered at the present time, and should never ensue when the use of insulin is founded on a correct perception of its action and properties.

The Use of Insulin in Diabetes.

From what has already been said, it is obvious that insulin does not cure diabetes. Insulin merely replaces a missing substance in the body of the diabetic, and so long as a suitable dose of insulin is being administered, the patient is free from symptoms and feels well both physically and mentally. When the administration of insulin is stopped, the old symptoms reappear. In a typical case of diabetes the results produced by insulin are frequently dramatic. From being a weak, depressed, emaciated wreck, the diabetic very soon becomes a strong, energetic individual. The sugar and ketone bodies disappear from the urine, and there is nothing to indicate that the patient had ever been the subject of diabetes.

Suggestions have been brought forward in some quarters that the vigorous use of insulin may so rest the pancreas that a great improvement in tolerance may be established, and that in some cases a cure may be effected. In my opinion, there is no basis for this expectation, and it is unlikely that insulin will do more in this direction than will a carefully regulated diet. There is a feeling among the public that once insulin is used, it must be administered permanently, for it is believed that the condition of the patient who stops taking insulin is worse than if he had never begun it. This, however, is not so, for a patient may cease to take insulin and be no worse than he was before. Insulin is given by hypodermic injection, the average dose being from 10 to 20 units twice daily. It is usually injected about a quarter to half an hour before food, and is given in the morning and at night, before breakfast and dinner respectively.

One of the most important points in the use of insulin is that the diet should be carefully correlated with the insulin dosage. As a rule, one unit of insulin will "look after" about two to three grams of carbohydrate, so that it becomes most important that an excessive amount of food should not be taken. It is just as necessary for the patient on insulin to follow definite rules as regards food, as it is for the diabetic patient who is being treated by diet alone. The only difference is that the insulin patient can take a more liberal diet. Once the diet is fixed, it must be adhered to, for a difference in diet would necessitate a difference in dosage of insulin, with the result that at one time the patient might be passing large amounts of sugar, while at another time the insulin might be in excess in relation to the diet, and the patient might suffer from the insulin symptoms already described. I have seen a patient who was taking a fairly large dose of insulin (20 units twice daily), but paying no attention to his diet, pass into diabetic coma.

Insulin and Pancreatic Preparations given by Mouth.

Insulin has practically no effect in lowering the blood sugar when given by mouth; the reason for this is that insulin is very easily destroyed by the ferments present in both the stomach and intestine. These ferments produce their injurious action very rapidly, so that insulin is destroyed before it can be absorbed. Various attempts have been made to give insulin by mouth in association with some substance known to undergo very rapid absorption, and, in this connexion, claims have been put forward that when insulin is taken in alcohol a fair amount of it is absorbed and produces, to some extent, its usual effect of lowering the blood sugar. These claims, however, have not been generally substantiated.

At present there are numerous pancreatic preparations on the market for which the claim is advanced that when taken by mouth they relieve the symptoms of diabetes. It is not always quite clear whether the vendors of these preparations claim that their products contain insulin, but since insulin is destroyed in the alimentary tract, it is obvious that any such claim is of no importance, for even if these preparations did contain insulin, they would be of no therapeutic value when taken by mouth. It is conceivable, however, that pancreatic preparations given by mouth might exert a beneficial action on diabetes apart altogether from the action of insulin. With the view of investigating this point I have tried nearly all the well-known preparations of this kind on the market. So far as my observations go, it would seem as if all these products given by mouth are of no value whatever in the treatment of diabetes.

Some Difficulties accompanying the Use of Insulin.

Naturally, the injection of insulin two or three times a day causes some physical discomfort, but when sharp fine needles are used this is not an important feature, and patients do not mind the slight pain of the injection. Sometimes there is a definite local reaction which may give rise to marked swelling and redness at the site of injection. This reaction generally persists for about twenty-four hours, after which it gradually disappears. As more experience in the manufacture and purification of insulin is gained, these local reactions appear to be less and less frequently encountered, and at the present time no great amount of trouble is experienced on this account. Sometimes, especially during the early stages of insulin treatment, the legs begin to swell somewhat, but this soon disappears.

Continuous administration of insulin over long periods tends to produce a hardening of the skin around the site of injection, so that after some months, a large area of the arm or leg may be markedly indurated. By varying the site of injection, and using different parts of the body, this difficulty may be largely overcome. It must be admitted, however, that the continuous administration of insulin to children is not always an easy problem, for the available surface for injection is not very large, and the skin of both arms and legs sometimes becomes so hard that it is difficult to insert the hypodermic needle. It is usually found that adult patients can inject themselves quite satisfactorily. On the whole, injection of insulin when carefully done does not give rise to so much difficulty as might perhaps be expected, but, on the other hand, there is no doubt that the advent of an effective preparation that could be given by mouth would be a very great practical advance in diabetic therapy.

Diet in Insulin Therapy.

In order to obtain the best results from insulin, it is necessary to put the patient on a special diet containing but a small amount of carbohydrate, the rest of the diet being made up of protein and fat. The amount of food required by a diabetic patient varies according to many conditions such as age, weight, and the amount of work done. It is now customary to express dietetic values, not by the weight of material consumed, but in terms of heat value or calories.

For practical purposes it may be accepted that 1 gram of protein or 1 gram of carbohydrate is equivalent to 4 calories, while 1 gram of fat is equivalent to 9 calories. Now a patient requires roughly a diet that will contain from 10 to 15 calories for each pound he weighs. Thus a patient weighing 140 pounds would require a diet containing from 1400 to 2000 calories, or he would probably do quite well on a diet containing about 1700 calories. In ordinary circumstances, he would no doubt consume considerably more than this. It is essential that the diet should contain some protein, and 0·5 gram or somewhat less for each pound the patient weighs is generally required. Since the carbohydrate allowance is necessarily small, insulin diets usually contain a fairly large amount of fat. Carbohydrate should, if possible, be given in moderate amount, for it ensures safety in the use of insulin, especially during the earlier stages of treatment, and makes the diet more palatable.

Prevention of Insulin Symptoms.

Since insulin symptoms do not come on until the blood sugar is reduced considerably below 0·1 per cent., it follows that no such symptoms are ever in evidence so long as the diabetic passes even a very small amount of sugar in his urine. Some medical men give just sufficient insulin to keep the urine almost but not entirely free from sugar, and thus guard against the onset of any insulin symptoms. Where facilities for blood sugar estimations are available, it is best, however, to give sufficient insulin to reduce the blood sugar to about the normal level.

Though some failures in the use of insulin have been recorded, it is my experience that this remedy never fails to act in typical diabetes; whereas, if the patient is suffering from some other malady as well as diabetes, good results cannot always be expected.

Mode of Action of Insulin in Diabetes.

Insulin very soon reduces the blood sugar in diabetes and eliminates glycosuria even in some patients when comparatively large amounts of carbohydrate food are taken. Strange as it may seem, it appears to be definitely established that the sugar which disappears from the blood as the result of insulin injection does not form glycogen. In rabbits fed on carbohydrate and treated with insulin, little or no glycogen is present, while in well-fed ordinary rabbits not treated with insulin, large amounts of glycogen are found. It is, therefore, obvious that the carbohydrate metabolism of the normal individual may be different in degree at any rate from that which obtains in the patient whose metabolism is helped by the use of insulin.

One of the most impressive features of the insulin patient is the extreme tendency to put on fat. Experiment shows that the sugar which has disappeared does not form fat *directly*, though there is little doubt that it does so indirectly. If we accept the view, which appears to be fairly well established, that insulin does not form glycogen from sugar and does not *immediately* and *directly* form fat from sugar, we are confronted with the problem as to what does happen to the sugar. Increased combustion will not account for the disappearance, so part of it must be stored in some form in the body. There is a good deal of recent evidence that some of it, at any rate, is stored in the body as a combination of glucose and phosphoric acid—Embden's lactacidogen—for experiment seems to show that insulin increases the amount of this substance in the body. Very probably this complex represents an intermediate product on the way to fat formation. The problem of the action of insulin is, however, far from settled, for insulin has a profound effect on both fat and protein metabolism.

The Future of Insulin Therapy.

That insulin relieves the symptoms of diabetes there is no doubt whatever, but, unfortunately, its action is very liable to be interfered with by such causes as cold, an attack of influenza, a mild gastric upset, or almost any slight departure from normal health. The use of gas for removal of a tooth may cause a similar disturbance. In such cases, patients who were free from glycosuria and progressing satisfactorily may begin to pass large amounts of sugar in the urine, and may even suffer from marked diabetic symptoms. In these patients the dose of insulin must be very largely increased, but the correct dose may be difficult to determine. These interferences with the action of insulin render it necessary to keep patients treated with insulin under careful observation. Again, the fact that injection is necessary for the rest of the patient's life makes the use of insulin tedious and not altogether free from physical discomfort. It is difficult to contemplate children going on for forty to fifty years or more having two injections of insulin daily, and no doubt, in spite of insulin, many diabetic children will succumb to intermittent affections.

It is, of course, too early to say what the ultimate effects of insulin will be in the general treatment of diabetes. There is already a good deal of evidence pointing to the conclusion that some patients become, to some extent, accustomed to its action, so that larger and larger doses are necessary. This necessity for larger doses may only indicate a steady progression of the lesion, but a somewhat similar phenomenon is encountered in normal rabbits, which, when injected on several occasions with insulin, gradually show a markedly decreased response to each administration. Recently, some experimental evidence has been brought forward suggesting that, in normal circumstances, carbohydrate metabolism may be somewhat different from what it is under artificial insulin injection. Thus, when a dog is rendered diabetic by total removal of the pancreas, it is apparently impossible to prolong life *indefinitely* by the use of insulin, though, naturally, the dog can be kept alive by insulin for many months.

It might, therefore, be argued that there may be some cases of human diabetes comparable with the condition in the dog in which no active pancreatic tissue is present. In the ordinary diabetic subject there are, of course, some more or less active pancreatic islets left, and further, there is no evidence that the production of pancreatic digestive ferments is at all interfered with. In the depancreatised dog no pancreatic digestive ferments are present, and so intestinal digestion is markedly upset. It has, therefore, been suggested that the inability to prolong the life of the depancreatised dog indefinitely by means of insulin depends on the absence of digestive ferments, and chiefly on the inability to hydrolyse fat.

While this is a possible explanation, it does not seem to be a very probable one, for it has been shown that the depancreatised dog may apparently be kept alive indefinitely, provided a *very small part* of the pancreas is left behind. If these experiments are substantiated, it is not likely that the absence of digestive ferments plays much part in the depancreatised animal, for the amount of digestive ferment secreted by a very small piece of pancreas would scarcely be sufficient to influence the fat metabolism. Indeed, the evidence available at the present time points strongly to the probability that the pancreas forms another hormone essential for the process of normal carbohydrate metabolism besides insulin, and that unless this hormone is present, insulin alone will not sustain life for a long period.

From the clinical point of view, the above assumptions appear to be strongly borne out, and it appears certain that the use of insulin does not serve as a substitute for the normal mechanism. There are such marked differences between a normal individual and a diabetic under treatment with insulin that it is quite certain that the processes in the normal individual are in some way very different from those occurring in the diabetic individual. On the whole, so far as our present experience goes, it would appear that the average human diabetic patient can be kept alive for long periods by the use of insulin, so that, in the absence of accidental circumstances, the diabetic on insulin treatment may expect to live to a normal average age.

Great as have been the results obtained by insulin therapy, it has not yet provided a substitute for the normal process from the clinical point of view, and much has yet to be achieved. On the other hand, the marvellous success of insulin in the treatment of severe and otherwise hopeless cases of diabetes is one of the most striking triumphs in the whole field of modern therapeutics.

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