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National Museums of Natural History

AT the present day most States possess their national museums, in which are exhibited long ranges of animals, plants, fossils and rocks. Many of their larger cities support their own local museums, regarding them as centres of culture and of education. Such smaller museums cater for a local population, and for the most part their exhibits centre round their own localities. They are generally connected with the local education authority and with a local university if such exists. The interests of national museums, on the other hand, extend farther afield. They usually attempt to show a world range in their exhibits, while displaying with especial care the organisms of their country. They thus are associated with the higher education of their nation, specialists in the biological sciences usually passing some part of their student days in study within their walls.

This association of natural history museums and teaching is well seen in the study of their foundation and history. Sir Richard Owen, in a Royal Institution lecture in 1862 "On the Extent and Aims of a National Museum of Natural History", after discussing the foundation by Prof. Louis Agassiz of the Museum of Comparative Zoology at Cambridge, Massachusetts, went on to remark (p. 110) that "the instances of the most rapid advance and perfection of Natural History Museums have all been associated with the fact of their curatorships by professors notable for their successful public teachings of the science; as, for example, the Botanical Museum at Upsal, under Linnæus; the Anatomical and Palæontological Collections at Paris, under Cuvier; the Zoological Collections at Paris, under Geoffroy St. Hilaire, Lamarck and Latreille". Sir Richard Owen, whose advocacy extending over twenty years induced the Government in 1877 to vote £70,000 for the erection of

the Natural History Museum, South Kensington, himself lectured for a long period at the Royal College of Surgeons, where the professor is by the statutes required to give annually not less than twenty-four lectures, a combination of the functions of professor and curator which he urged "on every suitable opportunity".

Owen made the Natural History Museum a national institution, and he was succeeded by Sir W. H. Flower, who had been Hunterian professor at the Royal College of Surgeons, while two of the subsequent four directors had previously been teachers in universities. The reason is obvious; such teaching officers have necessarily to keep themselves abreast of the most recent developments of their science—and such developments constitute the section in any museum most interesting to the public. An art museum may leave very many exhibits on display permanently; indeed, only altering them when a better piece by the same artist is obtained. In contrast a science museum, except in historical exhibits, must be for ever changing as its science evolves. It may be in advance of its public where the perspicacity of its director makes this possible, but it must never lag far behind or it will be deemed to be a collection of 'dry bones', worthy of a visit perchance but useless for study.

In national museums there is, however, a secondary function to which we more particularly wish to refer. Advances in biological science are often founded on definite specimens of animals and plants, living or fossil. Those specimens are the authority upon which the advance is based, and, as at once acquiring historical importance, should be preserved. Universities and teaching institutions may attend to this, but their changing personnel with new interests too frequently

neglect or disperse the material on which their predecessors' work was founded. Clearly the only place for a permanent historical record, representing the advances of the nation, is in the national museum, the bias of which is preservative.

Often such research material consists of long series of animals or plants, systematic or taxonomic collections, as they are termed. The species is the unit in biology, because it is something definite in structure, to which a name can be given with a full meaning thereby implied. Besides its exhibition series, a great museum collects and preserves examples of as many species of animals and plants as it can obtain, so that the inquirer has the inestimable advantage of seeing the concrete form rather than being dependent on written description. There are millions of species, and a museum sets out to contain as many type specimens, both male and female, as there are species, or as many as it can secure.

The museum is thus a 'library' of species brought together so that the basal accuracy of science can be maintained. But single specimens of species are not sufficient. There must be added a series of specimens illustrative of such variations as are induced by climate, nutrition and other external factors. These for the same species fluctuate in different countries, and the species from each may have to be preserved. The museum curator is a cataloguer and, so great are the number of species and the diversity of phyla of animals and plants, that he may spend all his life in becoming a specialist in one narrow groove. He may be extraordinarily capable in his own line, but he is in danger of thinking of his organisms as dead material, which is to be merely catalogued on its anatomies. This may be corrected by sending him into the field to collect and study, as is done by most museums, greatly to their and his advantage. Yet withal, he gets little opportunity of thinking of his creatures as essential entities in that single realm of Nature, for which the museum, both in its exhibitions and in research, must stand.

Ideally there should be one great clearing house of species for all countries, but this, with the rivalries of nations and the delays involved by distance, is impossible to attain. Museums try to preserve as many of the specimens used for the original descriptions of species as may be obtained—'types' as they are termed. In practice, museum specialists compare specimens with these original types, and these, if proved by a competent specialist to be the same species, become almost

as useful as 'types', the possession of which is only of importance should doubts arise. Each continent has its own museums, many specializing in its fauna and flora, but it is only in Europe and the United States where there are museums—and they are few in number—which try to embrace all species of all countries and which alone can act as efficient clearing houses. Such necessarily great collections can only be developed on national lines, being quite beyond the means of private institutions. This is well illustrated in the British Museum (Natural History) at South Kensington, which employs more than fifty scientific officers mainly in conserving and cataloguing its immense cosmopolitan collections.

Of course naturalists can do without museums in countries where their more happily situated neighbours can give them hospitality in such. Thus difficulties and dangers to science need scarcely be felt in Europe or North America. In South America the accurate determination of the flora and fauna is generally impossible since there are not the necessary central collections. South Africa depends partially on Cape Town, while collections from the tropical and northern parts must mostly be referred to London, Berlin or Paris. At present, London has larger collections from their localities than either the Indian or Australian museums, the sole institutions representative of the life of their continents. Here are four museums founded on British culture, of which those of London and Calcutta are in heavy centres of population, while those of Sydney and Cape Town may well one day represent nations in importance akin to the United States.

What relationship, beyond the ordinary courtesies of friendship, exists between these institutions? We know of no such ties, and we wonder whether the interests of science in our Commonwealth of Nations would not be best served by attempting to develop such links. A free interchange of co-types could do much. The same specialist could determine the species of his group from all the four regions with a distribution of the named specimens to all. But more is wanted, for the taxonomists in all must have the same methods and ideas as to species in their work, and this can be secured by the periodical interchange of members of their staffs. Most are in the employment of their States and would welcome such an interchange. Is it not worth while for their Governments to regularize and encourage such visits, the effects of which may well extend far beyond the limits of pure science?

The Theory of Dimensions

The Theory of Dimensions and its Application for Engineers

By Dr. F. W. Lanchester. Pp. xxiv + 314. (London: Crosby Lockwood and Son, Ltd., 1936.) 12s. 6d. net.

"THE first business of an author," says Dr. Lanchester in the preface, "is to state clearly the object of his work. . . . This book is written with the primary object of helping the young engineer to acquire a sound knowledge of dimensional theory, a subject which he can no longer afford to ignore." Although the subject forms a part of the curriculum of the engineering courses in all universities, the author maintains that subversive doctrines are being taught, and one of the avowed objects of the book is "to extirpate heresy of this kind", a job which he sets about with evident zest.

Of the 314 pages, about a hundred are devoted to tables of physical constants of the atmosphere, water, steel, fuels, etc., weights and measures, and although they contain much useful information, many of these chapters make little or no mention of dimensions. The rest of the book may be divided into two parts, mechanical and electrical. In the former, the author is evidently on his native heath; he hits out with no uncertain aim and speaks with an authoritative air. In the latter he is admittedly an explorer, feeling his way, asking directions from others, and quoting their opinions. As he says, "No attempt is made in the present work to decide between one system and another; the author has endeavoured to keep an open mind—only he declines to subscribe to any system that does not conform to his axiom," the axiom being that any one physical entity cannot have assigned to it more than one dimensional expression. In the preface he makes the somewhat enigmatic statement that "the fundamental dimensions recognised by physicists are (1) length, (2) mass, (3) time. There are really no others." It is not quite clear whether this is intended to mean that if physicists did recognize any other they would be sinning against a Lanchester axiom, but this doubt is dispelled when, with reference to Everett's statement that the choice of fundamentals is a matter of convenience, he says that it may be so, but, if true, is of little more than academic interest.

After showing that the entity and its dimensions are not one and the same, and that even the concept of velocity is not necessarily associated

with length and time, but only becomes so by our definitions and methods of measurement, the author launches into an attack on the 'slug', a unit of mass introduced about fifty years ago by Prof. Perry and apparently still used by some misguided folk. A five-page appendix on the same subject is a sermon on the text, "the evil that men do lives after them".

The chapters dealing with the application of dimensional theory to a large variety of mechanical problems are excellent. In discussing thermal entities, the author regards entropy as a dimensionless numeric, whereas Kaye and Laby give it dimensions; temperature is regarded as having dimensions L^2/T^2 , and the heat imparted to a mass to raise its temperature becomes ML^2/T^2 , the dimensions of energy. This matter is also discussed in an appendix.

Only forty pages of the book, excluding appendices, are devoted to electric and magnetic dimensions, but the whole of Rucker's paper on "The Suppressed Dimensions of Physical Quantities" is reprinted as an appendix, as is also Fitzgerald's paper on "The Dimensions of Electromagnetic Units", and a paper by Sir J. B. Henderson on "Fundamental Units in Electrical Science".

It is on p. 104 that the author leaves his native element and enters the electromagnetic world. In his opening sentence he says, "Electrical entities depend upon the three fundamentals L , M , and T , as do other derived physical entities discussed in the preceding chapters". It would have been more explanatory of the history of the subject if he had said that they may be made to appear to depend upon L , M , and T , by making certain arbitrary assumptions about which scientific workers have been squabbling for the last fifty years. The same is true of the subsequent statement that "it is agreed by all authorities that electrostatic units and electromagnetic units have different dimensional values although the entities represented may be the same". Is it not that they are made to appear to have different dimensional values by the adoption of different arbitrary assumptions? The electrostatic units of inductance or capacitance may differ largely in magnitude from the corresponding electromagnetic units, but they cannot really have different dimensional values.

Although the author expresses strong disapproval of the unit pole, he has not been bold enough to free himself entirely from it. Much of the confusion and uncertainty which pervade the

electric and magnetic units is due to the fact that the classical system is based in part upon an ill-defined unreality, namely, the pole strength of a permanent magnet. If we assume that ferro-, para-, and dia-magnetism are all due to the orbital movements of electrons superposing their effects upon the externally applied magnetomotive force, we are justified in regarding all magnetic phenomena as electromagnetic, and as being manifested in 'non-magnetic' space. In iron, the value of H is enormously increased by the molecular currents, but the relation between B and H is really the same as in air. It is usual, however, among engineers to retain the symbol H for that small component of the magnetizing force which can be ascribed to the externally applied ampere-turns, and to ask no question about the molecular mechanism whereby it produces in iron a magnetic induction B so much greater than in air. In discussing the fundamental relations between electric and magnetic concepts it is very desirable to exclude such complex phenomena as the magnetization of iron and steel and, above all, such a fictitious complexity as a permanent magnetic point-pole of unit strength.

If one must have a magnet of unit pole strength, let it at least be an electromagnet—a coreless solenoid, the current in which can be adjusted to the correct value: a much more convenient procedure than stroking a knitting needle the requisite amount with a bar magnet, even in imagination. Moreover, one is not then likely to pretend that, having measured the force on the unit pole when placed at a given point in the magnetic field, one has determined something called H , whereas, if one had measured the force on a length of wire carrying a current one would have determined something called B . With a solenoid the assumption that the 'polarity' is concentrated at a point is the end of the make-believe, but with a permanent magnet it is but the beginning, for it is assumed that, if immersed in another medium of different permeability, the pole strength is unchanged; but seeing that 'pole strength' is a fiction which has only been defined in air, it is meaningless to say that it remains unchanged in another medium. When driven to be precise, most physicists would probably admit that they assume the total flux to remain constant, but such an admission undermines the basic nature of the unit pole.

In my opinion, we are concerned in reality with only two forces, namely, that between charges at rest and that between charges in motion, that is, between currents. Just as we write the gravitational formula

$$f = G \frac{M.M'}{L^2}$$

with a dimensional constant, so for the same reason we write (omitting trigonometrical coefficients and signs of integration)

$$f = \frac{1}{K} \cdot \frac{q}{r^2} \cdot q \quad \text{and} \quad f = \mu \cdot \frac{ids}{r^2} \cdot ids.$$

The classical formula $f = mm'/\mu r^2$ is merely the latter formula wrapped in mystery.

These two fundamental formulæ may be written

$$f = \frac{1}{K} \cdot 4\pi D \cdot q = \mathcal{E} \cdot q, \quad \text{where} \quad \frac{q}{r^2} = 4\pi D \quad \text{and}$$

$$\mathcal{E} = \frac{1}{K} \cdot 4\pi D,$$

and

$$f = \mu \cdot H \cdot ids = B \cdot ids,$$

$$\text{where} \quad \frac{ids}{r^2} = H \quad \text{and} \quad B = \mu H.$$

We are here confining our attention to space and not considering the numerical effects of a change of medium on K and μ . It is quite a mistake to imagine that the distinction between H and B is necessarily associated with ferromagnetism or with any assumptions as to its nature. The same applies to the distinction between D and \mathcal{E} , which is not necessarily associated with phenomena in material dielectrics.

The above formulæ are, of course, linked by the relation $i = dq/dt$, from which it follows that both \mathcal{E}/B and H/D have the dimensions of velocity.

It will be seen from the above formulæ that \mathcal{E} and B are measurable characteristics of the electric and magnetic fields, the former by the force on a stationary charge and the latter by the force on a current or moving charge, irrespective of the medium. D and H , however, are not directly measurable concepts. The displacement D is calculable at any point by dividing a charge by the square of a distance, that is, by an area; and similarly the magnetizing force H is calculable by dividing a current by a length. The latter is often expressed in ampere-turns per centimetre and is regarded as a localized cause producing at every point a magnetic induction B depending on the medium. *Similarly D appears as a calculated localized cause producing at every point a condition of space designated by \mathcal{E} depending on the medium; this is a reversal of the usual conception.*

Some readers may object to the time-honoured magnetizing force H being relegated to the realms of unmeasurable concepts, and may quote from Prof. F. A. Lindemann's recent Guthrie Lecture (*Proc. Phys. Soc.*, 823; Nov. 1, 1936) that "a concept is meaningless unless it is in principle possible to observe the quantity which it typifies", but since both current and length will presumably be conceded as observable, their quotient can scarcely be dismissed as meaningless.

The procedure is analogous to that followed in the theory of elasticity and indeed throughout the whole of mechanical engineering. A load, that is, a force, is applied to a member, say, a tensile test specimen, and produces a strain or displacement at every point. One conceives this strain to be due to the stress at the point, this stress being an unmeasurable concept having the dimensions of a force divided by an area. Just as the mechanical engineer pictures the strain at a point as being due to a localized cause which he calls stress, so the electrical engineer pictures the magnetic condition at a point which he calls the magnetic induction B as being due to a localized cause which he calls the magnetizing force H . As the area integral of the stress is equal to the total applied force, so the line integral of the magnetizing force is equal to the total applied magneto-motive force or ampere-turns (neglecting numerical constants). If any reader feels disinclined to agree that mechanical stress is an unmeasurable concept I would refer him to p. 114 of Prof. R. V. Southwell's recently published "Theory of Elasticity", where he says:

"External loads can be measured, and the displacements of points on the surface of a body (in the case of transparent materials we can make some attempt to measure the displacements of internal points); but *stress* (or internal action) has never been measured directly, and we can assert with some confidence that it never will. In these circumstances all that we can do is to construct a theory on assumptions which are consistent with experimental observations, and to look for confirmation of that theory to tests of particular conclusions—namely, predictions regarding displacements which can be measured."

It is to be noted that the one circuital equation

$$\frac{d\Phi}{dt} = A \frac{dB}{dt} = E = \mathcal{E} \cdot l$$

involves only the directly measurable concepts, whilst the other

$$4\pi A \frac{dD}{dt} = m.m.f = H \cdot l$$

involves only the non-measurable concepts.

On p. 299 of his book, Dr. Lanchester says, "In the opinion of the author it [μ_0 the permeability of space] is a mere number, a numeric". We can only say that we have failed to find anywhere in the book any valid reason, other than convenience, for this assumption, and that we have set out the above formulæ with the intention of showing clearly that there is no more reason for regarding μ_0 as a numeric than there is for making this assumption with regard to K_0 . If,

however, one assumes either explicitly or implicitly that a permanent magnet pole measures H , whilst a current-carrying conductor measures B , and then assumes that a permanent magnet is a conglomeration of molecular currents, it is little wonder that when one puts $B = \mu H$, one is able to prove that μ is merely a numeric.

In Appendix V, Sir James Henderson quotes Maxwell in support of the view that μ_0 is a dimensionless numeric, but the support is very unconvincing and one sentence is definitely against this view. The author attempts to brush this aside with the suggestion that Maxwell was nodding when he wrote the sentence, and he even goes so far as to rewrite it for him—to "re-mould it nearer to the Heart's Desire". We prefer to adopt a humbler role and to suggest that the quotation is by no means convincing that by "identical" Maxwell meant dimensionally and not merely numerically identical in the electromagnetic system of units, as the sentence which he dislikes certainly suggests. When Maxwell appears to support his view his "vision was wonderful"; when the support appears doubtful Maxwell's "clear view was obscured".

In Appendix VII Dr. Lanchester disagrees with Giorgi and the S.U.N. Commission of the International Union of Pure and Applied Physics and concludes that "the M.K.S. or Giorgi system requires that the new unit of μ_0 shall be 10^7 c.g.s. units and not 10^{-7} as given in the various reports and memoranda". μ_0 is not a symbol for permeability but for one special permeability, namely, that of space, and we do not know what the author means by "the new unit of μ_0 ". He seems to have been confused by the unfortunate wording of the Report of the S.U.N. Commission, which stated that "the 'fourth unit' of the M.K.S. system is 10^{-7} henry per metre, the value assigned on that system to the permeability of space". This is very misleading. In the M.K.S. Giorgi system in which the absolute units of current, resistance, etc., are the ampere, ohm, etc., a medium to have unit permeability must be 10^7 times as permeable as space, and therefore the permeability of space, μ_0 , is 10^{-7} , if expressed in M.K.S. Giorgi units. A further source of confusion is probably the introduction of the unit of inductance, the henry, into the definition, for although the dimensions of inductance are those of permeability multiplied by a length, its numerical value involves such things as the number of turns, and we have always regarded its inclusion in the Report as meaningless. It is not surprising that Dr. Lanchester has found it very confusing.

How much trouble has been caused by the persistent attempts to force by hook or by crook the electromagnetic concepts into the framework

of L , M and T ? Nothing in this book is more reasonable than the concluding paragraph of Rucker's paper, namely, that by not suppressing the secondary fundamental units such as μ and K ,

"I think that the symbols are thus made to express the limits of our knowledge and ignorance on the subject more exactly than if we arbitrarily assume that some one of the quantities involved is an abstract number."

The Giorgi suggestion to regard one of the electromagnetic concepts as fundamental is in keeping with this. If permeability be thus adopted as fundamental, there can be no question of its dimensions. The dimensions of length, mass, time and permeability are then L , M , T and ' μ ', and just as certain values of the first three (C.G.S. or M.K.S.) are taken as units, so in the Giorgi system, unit permeability is 10^7 times that of space. All the electromagnetic concepts can be expressed dimensionally in terms of L , M , T and ' μ ' without ambiguity and without making arbitrary and

unjustifiable assumptions. If, in the future, Nature divulges some secret whereby the limits of our knowledge are extended so that we are able to express ' μ ' in terms of L , M and T , the dimensional expressions can then be readily reduced to these three fundamentals; but in the meantime let us be honest with ourselves and not pretend to knowledge that we do not possess.

In Appendix VI Dr. Lanchester attempts to obtain light on the subject by calling in relativity, but seeing that it leads him to the conclusion that "a wave generated by a static charge undergoing acceleration will, in free space, be a wave having only magnetic characteristics, but which when arrested will revert to the static form", whereas "radiation from a magnetic pole or doublet would be wholly static in its manifestations until received and brought to rest", I am forced to conclude that in his search for light Dr. Lanchester has wandered into the outer darkness. In my opinion the author was unwise to include this section in a book the avowed object of which is to help the young engineer.

G. W. O. HOWE.

Gmelin's Inorganic Chemistry

Gmelin's Handbuch der anorganischen Chemie Achte Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft.

(1) System-Nummer 4: Stickstoff. Lief. 2. Pp. 283-506. 35 gold marks.

(2) System-Nummer 4: Stickstoff. Lief. 3. Pp. 507-854. 55 gold marks.

(3) System-Nummer 4: Stickstoff. Lief. 4. Pp. 855-1038. 25.15 gold marks. System-Nummer 23: Ammonium. Lief. 1. Pp. 242. 28.10 gold marks.

(4) System-Nummer 35: Aluminium. Teil A, Lief. 3. Pp. 451-534. 14 gold marks.

(5) System-Nummer 35: Aluminium. Teil A, Lief. 4. Pp. 535-682. 24 gold marks (Ausland preis, 18 gold marks).

(6) System-Nummer 55: Uran und Isotope, mit einem Anhang über Transurane. Pp. xviii+x+279. 46 gold marks. (Ausland preis, 34.50 gold marks.)

(Berlin: Verlag Chemie, G.m.b.H., 1935-36.)

(1, 2 and 3) **T**HE various hydrides and oxides of nitrogen comprise the subject matter of parts 2 and 3 of the volume on nitrogen, but aqueous solutions of ammonia and the oxyacids are not included. Prominence is given to the preparation of the raw materials used in the

industrial synthesis of ammonia. It is pointed out that nitrogen extracted from air is very much cheaper than hydrogen, which comes chiefly from water-gas (51.8 per cent), coke-oven gas (30 per cent) and electrolytic plants (16.67 per cent). The Linde, Claude and Messer processes for extracting hydrogen from coke-oven gas are given very fully, as well as the synthesis of ammonia by the Haber-Bosch, Claude, Fauser and Mont Cenis methods. There is also an account of heavy ammonia, ND_3 , which has been obtained pure by the action of deuterium oxide on magnesium nitride.

The action of different types of electric discharge upon air and other mixtures of oxygen and nitrogen is fully discussed, but the well-known processes of Birkeland-Eyde and Pauling are not described, since it is reported that they have been largely superseded and indeed contribute at present less than one half per cent of the world's production of synthetic fixed nitrogen. There is, however, a long list of publications upon the processes.

The fourth section of the volume on nitrogen contains an account of the oxyacids and their derivatives. It is stated that nitrous acid is still unknown in the free state, but its importance has attracted the attention of many investigators. Of the three possible structural formulæ, that one

which has a semi-polar double bond is supported by evidence derived from the parachor. Among less familiar substances described are the somewhat evanescent compound nitroxyl, NOH, which polymerizes to hyponitrous acid, and pernitrous acid, O:N.O.OH, an isomer of nitric acid, arising from the interaction of hydrogen peroxide and sodium nitrite.

Compounds of the radical ammonium are so numerous and important that a whole volume has been devoted to its consideration. Sir Humphry Davy was the first to use the term ammonium and to point out its metallic properties, in particular its power of forming an amalgam, although the free radical is not yet known. That the ion has a tetrahedral structure was deduced by W. H. Mills from the optical activity of its quaternary salts. The present issue (Lief. 1) contains a full account of investigations of the system $\text{NH}_3 : \text{H}_2\text{O}$ and of the difficult problems connected with the basicity of ammonia. The extensive use of ammonium nitrate as an important constituent of high explosives was responsible for much work upon the properties of this polymorphic salt, a useful summary of which has been included.

(4 and 5). The production of special surface coatings to aluminium has become so important industrially that a whole part (A 3) is devoted to it, while numerous alloys of aluminium are described in another part (A 4). Both metals and non-metals are used for surfacing the metal, but

whereas the former are chiefly used for decorative effects, the latter are mainly protective and greatly increase the usefulness of aluminium. Of particular interest is the electrochemical oxidation of the surface, the chief electrolytes used being chromic acid (in England), oxalic acid (in Germany and Japan) and sulphuric acid (in America). The last-named process is particularly adapted to the application of organic dyes to the oxide layer.

Alloys of aluminium have also attracted the attention of research workers in recent years to such an extent that some deviation from the general plan of the handbook has been adopted in order to collect together all those alloys which contain more than 50 per cent of aluminium. Special attention is given to alloys with silicon, which mixes with aluminium in all proportions in the liquid state, a simple eutectic system resulting on solidifying. The texture of the valuable eutectic alloy can be greatly improved by the addition of sodium or sodium fluoride.

(6) The technical uses of uranium are still very small in comparison with the amount of material rendered available as by-products in the extraction of radium. Uranium is used as a catalyst in the synthesis of ammonia, in the manufacture of steel, glass and ceramics and in dyeing and photography. A summary is given of the investigation of its isotopes, particularly of actino-uranium, with a probable atomic mass of 235, and of the synthetic radio elements beyond uranium.

Mohammedan Marriage Customs

Marriage Conditions in a Palestinian Village
By Dr. Hilma Granqvist. Vol. 1. Pp. vi + 200. 75 Fmk. Vol. 2. (Societas Scientiarum Fennica : Commentationes Humanarum Litterarum, III, 8 and VI, 8.) Pp. 366. 160 Fmk. (Helsingfors : Akademische Buchhandlung ; Leipzig : Otto Harrassowitz, 1931, 1936.)

DR. HILMA GRANQVIST'S book is important both from a methodical point of view and on account of facts recorded in it. Her field studies were restricted to the village of Artās, situated south of Bethlehem at the edge of the Judæan desert and inhabited by Mohammedan Arabs. She examined all the information she was able to obtain regarding the marriages that had been contracted in the village during a period of a hundred years—in all, 264 marriages entered into by 199 men—and also procured information concerning a smaller number of marriages contracted

by Artās women with men in other places. On the basis of her family lists she worked out statistics and compiled tables which formed a complement to the genealogical trees, and round this foundation the rest of her material was grouped.

This method has no doubt obvious advantages. The author writes: "In registering and discussing all the people in the village during four to five generations, we came upon a great many facts which would probably not otherwise have come to light, and the material appeared quite naturally, without having to be suggested in any way." On the other hand, it is a drawback that the genealogical method can be applied only to very limited areas, and it must also be admitted that it has not proved to be a key to so many doors as it has sometimes been supposed to unlock. Dr. Granqvist has widened the outlook by quoting numerous parallels or contrasts, remarks and references, found in printed sources relating both to Palestine and to

other Mohammedan countries; but she has wisely relegated them to footnotes in order not to blur the picture given in the text.

Most of Dr. Granqvist's information was obtained from two native women recommended to her by Miss Louise Baldensperger, whose knowledge of Artās, where she had lived more than thirty years, was "of inestimable help and value" to the author. Those two informants learned to relate so slowly that their statements could be taken down word for word. The material is thus to a large extent a direct translation of the literal reports given by the women, but very frequently the translation is followed by the Arabic original. This is particularly the case with the copious songs, proverbs and formulæ found in the text, which, consequently, also should make the book a valuable contribution to Arabic dialectology.

The importance of Dr. Granqvist's investigations is enhanced by the fact that they have been made by a woman among women. In a society where the sexes are so secluded from each other as they are in the Mohammedan world, I think that the women can be properly studied only by members of their own sex; but in most cases the writers on Mohammedan marriage customs have been men. The author writes that those who have women as informants are in a specially favoured position, because "the women are very much interested in their conditions and linger with pleasure over things which the men glide over lightly". But as marriage is an institution in which both sexes are concerned, I also think that there are aspects of it which can be properly studied only by men.

A Mohammedan marriage is a complicated procedure, and Dr. Granqvist gives a graphic description of its successive stages. She has chapters on the age of marriage and child betrothal; the choice of a bride; the exchange of bride for bride and the bride price; the betrothal ceremonies and the making of the marriage contract; preparations for the wedding; the fetching of the bride; her arrival in the bridegroom's house; and the wedding week. There are chapters on the married woman in her husband's house and on her relation to her father's house, which are the more interesting since they deal with subjects that have not generally been sufficiently noticed in the literature on Mohammedan marriages. A woman is even after her marriage closely bound to her father's house, and her position in her husband's house is dependent on the esteem she enjoys and the support she can count upon in her old home. In critical situations she takes refuge there; when she is dissatisfied with the manner in which her husband treats her or when she is divorced by him. So also she is protected by her brother:

"a man is even more responsible for his sister than for his wife and children".

The people themselves are said to find with surprise how well marriage generally turns out. Polygyny is certainly a disturbing factor; there is a saying that "the co-wife is bitter even if she were honey in a jar". But polygyny is not frequent in Artās, and in one great clan altogether lacking. A reason for this is the deficiency of women, which has compelled many men to take wives from other places. The author raises the question whether this deficiency may be due to the high percentage of cousin marriages, in accordance with my finding that in various cases inbreeding is combined with an excess of males. Thus, according to statistics of 1901, the small community of Samaritans at Nablus, who never marry outside of their own body, consists of 97 males and 55 females. Divorce is even less frequent in Artās than polygyny, which is contrary to the opinions generally held about Mohammedan peoples. While of the 199 married men 26 are or have been polygynous, only 10 have divorced their wives. The author admits that the infrequency of divorce is probably connected with the poverty of the village and the small number of women, but thinks available statistics would prove that the prevalence of divorce in the Mohammedan world has been greatly exaggerated. This is an altogether exceptional case in which Dr. Granqvist's study of the little Palestinian village has led her to such far-reaching speculations. A chapter on widower and widow concludes her remarkable book, which also contains excellent illustrations from photographs taken by the author.

EDWARD WESTERMARCK.

Die Fermente und ihre Wirkungen

Von Prof. Carl Oppenheimer. Supplement. Lief. 5. (Band 1: Spezieller Teil: Haupt-Teil 12.) Pp. xii+641-781. (Den Haag: Dr. W. Junk, 1936.) 10 fl.

THE fifth delivery of this supplement continues the description of those enzymes which attack proteins, namely, the proteases and peptidases. It commences with two chapters of particular and general interest, one containing a discussion of some special questions relating to protein structure and the other being devoted to the question of the simplification of the true proteins by these enzymes. Both are of considerable value at the present time, when so much is uncertain in this intricate field of knowledge, and their study, though far from easy, will be helpful for those workers who are trying to bring some clarity into the subject.

The proteases are described in some detail under the headings of their qualitative and quantitative detection and their separation. About half the volume is devoted to the properties of the peptidases from a number of different aspects.

Magneto-optik (ohne Zeeman-Effekt)

(Handbuch der Experimentalphysik. Herausgegeben von W. Wien und F. Harms. Band 16, Teil 1.) Von Prof. Wilhelm Schütz. Pp. x+378. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1936.) 32 gold marks.

PROF. SCHÜTZ has ably carried out the task of co-ordinating and discussing the numerous experimental and theoretical researches on magneto-optics published up to the early part of the year 1936. More than half the book is naturally concerned with the Faraday effect. Since the appearance of Voigt's account of magneto-optics in 1916, much experimental and theoretical work has been done, not only on the normal diamagnetic rotation but also on the selective diamagnetic, the paramagnetic and the ferromagnetic rotations, and a convincing account of these topics is given. An interesting summary of various theories of the Faraday effect begins with the classical electron theory and goes up to the quantum-mechanical theories of Rosenfeld for atoms, and of Serber for molecules. The section under the heading of the transverse magnetic double refraction of light directs attention to the Voigt effect, but is particularly devoted to the Cotton-Mouton effect, for Prof. Cotton's powerful electromagnet has enabled him and his collaborators to obtain and measure effects beyond the ken of other observers. It is interesting to note (p. 218) how the measurement of the transverse magnetic double refraction in nitro-benzol can serve as a measure of the efficiency of an electromagnet.

A third section deals with the magnetic double refraction and dichroism of colloidal suspensions (Majorana effect), and of coarse suspensions of powdered crystals in liquids. In addition to Cotton's work, that of Procopiu at Jassy, Rumania, is prominent here. Experimental work on the magneto-optic Kerr effect is considered under the headings of polar, meridional and equatorial Kerr effects. The Voigt and Snow theories linking up the Kerr and Faraday effects to various optical constants of metals are amply discussed. Adequate mention is made throughout of the researches carried out in various countries, and Prof. Schütz's own important work is modestly treated.

The term 'gauss' is still preferred to 'oersted' as the name of the unit of magnetic intensity, and the plane of the electric vector is called the plane of polarization. Apart from a few trifling mis-spellings of proper names, the book appears remarkably free from defects.

N. D.

Keris and other Malay Weapons

By G. B. Gardner. Second edition. Pp. 138. (Singapore: Progressive Publishing Co.; London: Bernard Quaritch, Ltd., 1936.) 6s. 6d.

THE author provides a complete survey of the *Keris*, enumerating its parts, main types and processes of manufacture. His general classification is clear and convincing, and marks a distinct advance in the study of oriental arms; it will be of special use to museum curators. It is noteworthy that his defini-

tions are given in detail and used consistently. It is now, therefore, possible to classify this interesting local weapon and to discuss its typology with an agreed terminology.

As to its origins, Mr. Gardner quotes the use of the ray sting [*Ikan Pari*] as a *keris*, and directs attention to the thumb and finger grip it demands. He, also, follows Dr. van Stein Callenfels in his early dating (seventh century A.D.) for the all-metal, anthropomorphic *keris* Majapahit. Apart from this strange little weapon, the hilts of *keris* seem to fall into two main groups, based on a bird type and a demon type, both of which are found on the mainland, extending to the Shan area. Both these basic types, when over-foliated, would seem to merge in the well-known Madura 'flower'-hilt, which would, therefore, appear to be secondary. In any event, the *keris* Majapahit remains a little anomalous.

Mr. Gardner's notes upon *keris* magic are of special interest; sword magic has been somewhat neglected in the Orient, and is commoner than extant publications would suggest.

K. de B. C.

The Official Year-Book of the Scientific and Learned Societies of Great Britain and Ireland;

with a Record of Publications issued during the Session 1935-1936. Compiled from Official Sources. Fifty-third Annual Issue. Pp. vii+170. (London: Charles Griffin and Co., Ltd., 1936.) 10s. net.

THE fifty-third annual issue of this year-book maintains the high standing that its predecessors have achieved, thus making it an indispensable guide in scientific, technical and other libraries, laboratories, universities, research institutions, etc. The learned societies are classified under fifteen headings, and this, together with a very full index, makes reference a very easy task. Under each society, association, etc., are given the list of officers, details of membership, arrangements for meetings, titles of publications, etc. The fact that all this information is gleaned from official sources makes the volume authoritative and one which is almost unique among the annual publications of reference literature.

Reactions of the Human Machine

By John Yerbury Dent. Pp. 288. (London: Victor Gollancz, Ltd., 1936.) 8s. 6d. net.

THE author of this lively and well-written book, besides being a medical practitioner, is quite clear that a doctor should also be something of a psychologist. The type of psychology which appeals to him is sufficiently indicated by the title. He has no use for "the older subjective language" which includes words like sensation, consciousness and will. Equally little use has he for the psycho-analytic libido and censor. He sees nothing in the "human machine" except the structure of the organism and its responses to environment. Few psychologists will agree with him; but his method of psychological approach has not prevented him from writing an extremely good book on its own lines, quite intelligible to the layman, and useful also to medical men.

Radium Beam Therapy and High-Voltage X-Rays*

By Prof. A. S. Eve, C.B.E., F.R.S., and L. G. Grimmett,
Radium Beam Therapy Research, London

THE quantity of radium now employed in the treatment of cancer, by the 'beam' method alone, exceeds 120 gm., with a value in excess of £800,000. The Continental names for this method are *telecurietherapie* and *Radiumfernbestrahlung*, while 'radium beam therapy' is the

collected to celebrate the jubilee of King Gustav V. It is a building of five stories, measuring about 170 ft. × 190 ft., well provided with radium and X-ray apparatus, together with all modern conveniences for examining, treating and nursing patients. There are arrangements for keeping records of all cancer cases in Sweden. The institute has an able staff of therapists, pathologists and physicists, and the whole organization is part of the new University Hospital at Stockholm. Any country desirous of establishing an efficient radiological institute would do well to study the Swedish scheme. A full description of the building is given in a booklet published by Norstedt and Söner, Stockholm.

A great weakness of radium beam therapy in the past has been the lack of a good system of dosage units. Now, however, thanks to the physical research of the last few years, it has become possible to express gamma-radiation in the international 'röntgen' or r unit, already so well established in X-ray therapy. The röntgen (r) is that quantity of radiation which, when secondary electrons are fully utilized, and wall effects avoided, produces ionization in air at 0°C. and 760 mm. mercury pressure, such

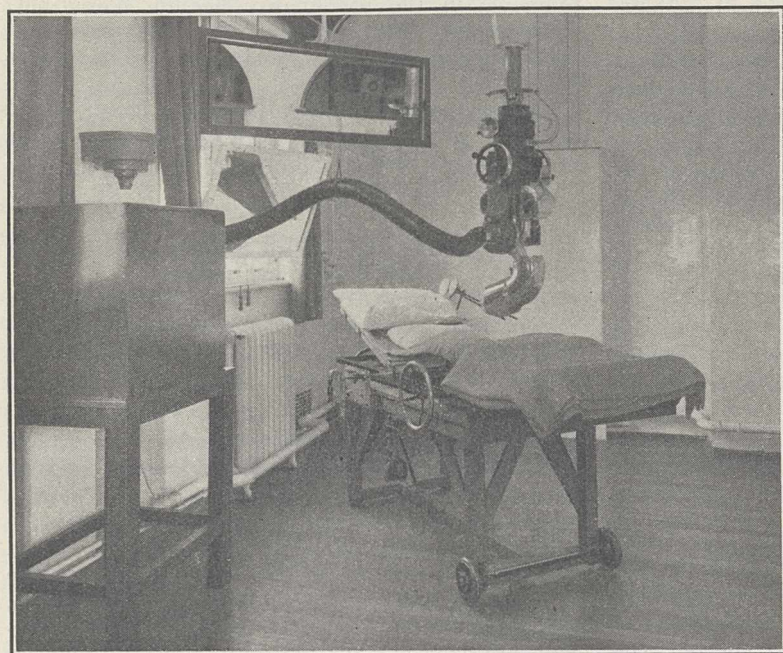


Fig. 1.

THE LATEST 5 GM. RADIUM UNIT OF THE RADIUM BEAM THERAPY RESEARCH, LONDON. THE RADIUM CAPSULE IS TRANSFERRED PNEUMATICALLY TO AND FROM THE LEAD STORAGE-SAFE TO THE UNIT, WHERE THE GAMMA RADIATION IS CANALIZED BY A MASS OF DENSE TUNGSTEN ALLOY. THE BEAM CAN BE ORIENTATED IN ANY DESIRED DIRECTION BY SCREW ADJUSTMENTS, AND THE DOSAGE CAN BE MEASURED AT ANY POINT.

term commonly used in Great Britain. In this method of treatment a considerable quantity of radium (2-10 gm.) is surrounded by a large mass of lead or of tungsten alloy, and a beam of gamma-rays passes from the radium through a hole or window in the lead and is directed at the tumour or glands as may be desirable. A typical modern apparatus is shown in the photograph (Fig. 1).

In Table 1 is a list of institutions which are equipped for radium beam treatment.

One of the most complete radiation institutes is that recently built at Stockholm with funds

* This article has been published with the approval of the Executive Committee of the Radium Beam Therapy Research, on behalf of which we are glad to acknowledge the generous loan of 10 gm. of radium by the Union Minière du Haut Katanga.

that one electrostatic unit of charge per cubic centimetre is liberated at saturation current. The unification of X- and gamma-ray dosage units is a great step forward, and will hasten the solution of many of the controversial problems of radiology.

It is of the utmost importance that the beam of rays shall be suitably directed, that the dosage-rate at any particular part of the tumour or glands shall be known, and that the dosage shall be repeatable, or modified at will to any desired degree that experience may dictate. These purely physical problems have now been solved, and there is no longer any excuse for slipshod or haphazard treatment.

In planning for the future, it is impossible to ignore the rival claims of radium and X-rays. Many radiologists believe that gamma-ray therapy is superior to X-ray therapy in its biological effects, and they attribute this superiority to the shorter wave-length of the gamma-rays; encouraged by this belief, they are striving after X-rays generated at higher and higher voltages, which approach the gamma-rays of radium in their nature. While there are many who would contest this point of view vigorously, yet since it is the motive which prompts the building of high-voltage X-ray plants, we may be permitted, without entering into a discussion of such controversial points, to inquire how far an X-ray tube working at, let us say, 1 million volts is capable of imitating the radiation emitted by radium.

TABLE 1.

Country	Institution	Quantity of radium	Number of units
Austria	Municipality of Vienna	gm.	1
	Colombo	3	1
	Canada	4	1
France	Toronto Hospital	4	1
	British Columbia Cancer Foundation, Vancouver	3.5	1
	Institut de Radium, Paris	11	2
	Centre de Strasbourg	8	2
	Centre de Lille	6	2
Great Britain	Institut de Radium, Villejuif	5	1
	Centre de Bordeaux	4	1
	Centre de Lyon	3	1
	Radium Beam Therapy Research, London	10	2
	Cancer Hospital, London Westminster Hospital, London	5	1
Hungary	Municipalité de Budapest	4	1
	Norway	3	1
Sweden	Norske Radiumfond	3	2
	Radiumhemmet	8	2
U.S.A.	Michael Reese Hospital, Chicago	6	2
	Belle-Vue Hospital, New York	5	1
	Memorial Hospital, New York	4	1
	American Oncological Hospital, Philadelphia	4	1
	New York Institute for the Study of Malignant Disease, Buffalo	4	1
	Veterans Bureau	2	1
	Dr. Williams Cameron, New York	2	1

The nature of the radium spectrum has been known for a long time. It consists of a small number of sharp monochromatic 'lines' with energies ranging from a few kilovolts up to 2.2 million volts. They are represented in Fig. 2 by a number of vertical lines the heights of which are proportional to the intensity of the radiations. These data have been taken from "Radiations from Radioactive Substances" by Rutherford, Chadwick and Ellis, in conjunction with the latest values of the photoelectric coefficients.

An X-ray tube working at 1 million volts yields a continuous spectrum with a sharply defined short-wave limit at 1 million volts. The bulk of the radiation output corresponds to a

voltage considerably less than 1 million volts. No data have as yet been published on the spectral distribution obtained with high-voltage X-ray tubes, but we can obtain some idea of its nature by extrapolating Kramer's law, which holds very well for lower voltages of the order 100 kv. According to Kramer's law, the energy in the continuous spectrum which is included between the frequencies ν and $(\nu + d\nu)$ is given by:

$$I d\nu = \frac{8\pi}{3\sqrt{3}l} \times \frac{e^2 h}{mc^3} \times Z (\nu_0 - \nu) d\nu;$$

where ν_0 is the frequency of the short-wave limit, l is a numerical factor of order 6, Z the atomic number of the target, and the remaining symbols have the usual significance. If we fix the material of the target, and change the variable from the frequency ν to the wave-length λ , we may write:

$$I_\lambda = \text{const. } V^2 (V_0 - V);$$

where V_0 is the maximum voltage applied, and V is the voltage corresponding to the wave-length λ . The relative values of I_λ calculated in this way for the unfiltered radiations are given in Table 2, together with the relative values of I_λ after filtration with 1 mm. and 2 mm. lead. The latest available absorption data of Read and of Jones have been used in calculating the transmission through the filters.

TABLE 2.

Probable Energy Distribution in Continuous Spectrum of a Million-volt X-ray Tube, based on Kramer's Law.

Wave-length	Equivalent Voltage	Relative Intensities I_λ		
		Unfiltered	1 mm. Pb	2 mm. Pb
	kilovolts			
12.35 X.U.	1000	0	0	0
13.0	950	452	407	387
13.8	900	810	725	645
14.5	850	1080	961	855
15.4	800	1280	1146	1000
16.5	750	1410	1240	1100
17.6	700	1470	1290	1120
19.0	650	1480	1280	1120
20.7	600	1440	1240	1060
22.5	550	1370	1160	990
24.6	500	1250	1040	870
30.8	400	960	745	580
41.1	300	630	405	260
49.3	250	470	243	128
61.5	200	320	111	29
82.2	150	19.1	2.1	2.3
123.5	100	9	0.2	—

The three curves corresponding to no filter, and filters of 1 mm. and 2 mm. lead respectively, are drawn, together with the radium spectrum, in Fig. 2. The great disparity between the radium spectrum and that of the million-volt X-ray tube is evident. The peak of the X-radiation output occurs at a value between 600 and 700 kilovolts. There is very little radiation at 1 million volts and nothing at all beyond this value. On the other hand, a considerable portion of the radium spectrum is located above 1 million

volts, with a particularly intense line at 1.8 million volts. To generate radiation comparable in quality with the gamma-rays of radium a voltage approaching 3 million would be required! Assuming that the engineering difficulties were overcome, it is not certain that electrons driven by 3 million volts on to a target would expend all their energy in the production of röntgen rays, as other transmutations might take place.

The greater energy emitted by an X-ray tube is of some advantage. It is not difficult to make an X-ray tube the output in ergs of which is equivalent to that from some hundreds of grams of radium.

water, at a distance of 10 cm. below the surface for various kinds of radiation at different distances from the surface.

TABLE 3.
Depth Doses Measured in Water.

Radiation source	Filter	Distance from surface	Percentage depth dose 10 cm. below surface
X-rays, 370 k.v.	5 mm. Cu.	75 cm.	43 per cent
X-rays, 200 k.v.	0.5 mm. Cu.	75 cm.	36
Radium point source	0.5 mm. Pt.	5 cm.	11
[Radium point source	0.5 mm. Pt.	75 cm.	58]

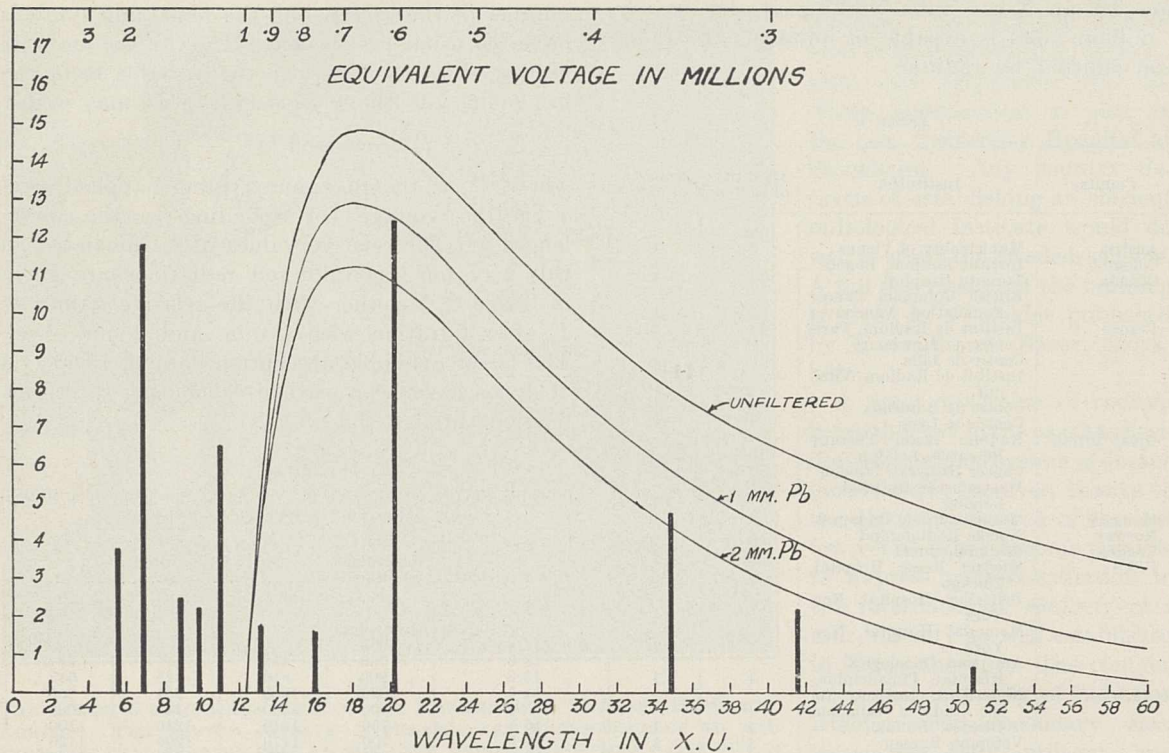


Fig. 2.

COMPARISON OF THE GAMMA-RAY LINE SPECTRUM OF RADIUM WITH THE CONTINUOUS SPECTRUM FROM A MILLION VOLT X-RAY TUBE, CALCULATED ACCORDING TO KRAMER'S LAW, FOR DIFFERENT FILTRATIONS.

This allows the tube to be used at a distance of 1-2 metres from the patient's skin, giving a practically parallel beam resulting in a high 'depth dose', that is, a high ratio between the tumour-dose at a depth, and the surface-dose on the skin. For it must be remembered that the skin reaction is the limiting factor in treatment. With the relatively small quantities of radium which are available for beam treatment, it is necessary to work with the radium sources so close to the skin as 5-10 cm. in order to obtain intensities capable of producing biological effects. This results in a strongly divergent beam, and a poor depth-dose. This point is well illustrated in Table 3, which gives the percentage depth-dose, as measured in

We thus have the paradoxical situation that the more penetrating radiation appears to penetrate less. The fact is that both radium and X-ray treatments are governed by the inverse square law, and that the superior penetrating power of gamma-rays cannot be exploited unless prohibitive quantities of radium are available to make it possible to work with large radium-skin distances (cf. last line of Table 3). Even radiologists themselves are apt to lose sight of this important point and often stress, unduly and erroneously, the high penetration of gamma-rays.

The true advantage of radium treatment would therefore seem to depend on the property that a great part of the electromagnetic waves proceeding

from radium are shorter in wave-length than those that emerge from any X-ray tube at present in use.

It is possible that in a few years time the new discoveries of physics, the neutron and artificial radioactivity, will find a place in radiation therapy. Already, in the United States, neutron beams are available of sufficiently high intensity to produce strong biological effects; their mode of action must differ in many respects from the radiations with which radiologists are familiar. Also it is now possible to obtain gamma-rays from artificial radioactive substances with energies far in excess of anything which radium emits. Radio-sodium, for example, disintegrates with emission of gamma-rays having energies in excess of 3 million volts. This substance has already been produced in

weighable quantities; if it should prove possible to make it cheaply in bulk, it could be inserted daily into a radium unit of conventional design, and used for treatment in place of radium. All the knowledge which has been accumulated for radium beam therapy in the past could be brought to bear on the powerful new radiation.

In the meantime, it is of the greatest importance that there should be competent comparisons of the effects of radium and X-ray treatment, in which therapists, pathologists, biologists and physicists may make a thorough study of the results produced in living tissue, whether healthy or diseased, and explore to the full the new methods which the advance of physics is making available.

Biological Work of the Oxford University Expedition to North-East Land, 1935-36

By D. B. Keith

NORTH-EAST LAND is the second largest island of the Spitsbergen archipelago and lies astride the parallel of 80° N. Until a few years ago, it remained virtually an unknown land of evil repute. It was thought to lie outside the influence of the Gulf Stream and therefore to suffer from a far severer climate than the rest of Spitsbergen. The Oxford University Expedition, under the leadership of A. R. Glen, was the first expedition to winter in the country, and besides the radio research work, glaciology, survey and other activities of the expedition (see NATURE, Jan. 2, p. 10), biological work was carried out through the year.

It may be said at the start that the animal life of North-East Land is incredibly meagre, and the reason for the great difference between there and the rest of Spitsbergen is the very much colder summer conditions prevailing on the island. The winter, too, is severer, but this has not the same effect on the animal life; but when it is realized that the temperature in the summer months very rarely rises above 40° F., that snow storms are liable to occur at any time and that strong winds are almost continuous, it is not hard to see the reason for the paucity of animal life. It is probably not quite true to say that the Gulf Stream has no effect on North-East Land, for it now seems almost certain that the north-western coast does come under its influence, but its effect here is so small that the air temperature is invariably low and the weather usually windy and misty.

The difference between North-East Land and even the nearest areas of New Friesland is at once apparent in the vegetation. In North-East Land, the vegetation type most common is so open that it seems impossible to believe that biotic factors have played any part in its formation, whilst even in such areas as Treurenberg Bay and Lomme Bay, close plant communities are fairly extensive. In fact, the only areas in North-East Land where anything approaching close formations are to be found are in such places as the scree slopes below bird cliffs, areas (usually small islands) where colonies of eiders or terns are nesting, or, in a smaller way, round old nests of eiders, brent geese or glaucous gulls. Much of my biological work this summer was carried out in Murchison Bay, a large bay on the western coast, thickly dotted with islands, but one of which almost all the surrounding country is composed of dolomite. The sterility of the vegetation in such an area defies description. The rock weathers into fragments which are found covering great areas and lying loosely over the surface, entirely prohibiting any plant growth. Here and there a few specimens of *Saxifraga oppositifolia* or *Papaver radicum* may have been able to take root; but it is almost true to say that the only places where plants are found are those where there has been manuring in some form or another.

My main work was a study of the birds, and here again the same may be said with regard to

the paucity both of species and individuals. So far, only twenty-seven species of birds have been recorded from North-East Land, and of these only

March 31 they were arriving at 1 or 2 a.m., but leaving again at about 7 a.m. Gradually they began to arrive earlier and stay later. This curious habit of deserting the cliffs in the afternoon was not followed by the fulmars, which began to arrive after April 7. In the night and morning the cliffs were shared by guillemots and fulmars, but in the afternoons the latter were in solitary possession; and this continued until the end of April, when guillemots began to stay at the cliffs throughout the day.



Fig. 1.

SLEDGING DOWN EQUIPMENT FOR THE BIOLOGICAL STATION IN MURCHISON BAY. PASSING AN ICEBERG WHILE TRAVELLING OVER THE FROZEN LADY FRANKLIN BAY.

some sixteen breed regularly. As the base hut was built on a small area of level ground at the foot of a wall of towering basaltic cliffs, which in the summer were tenanted by nesting fulmars and Mandt's guillemots, I had a good opportunity for watching the arrival of these birds in the spring, which was of particular interest for the fact that the guillemots used at first to spend only certain hours each day at the cliffs.

The first sign of life in 1936, apart from a few solitary bears and one or two reindeer, was when a fulmar was seen flying silently along the face of the cliff in the half light of February 15, more than a week before the sun rose. Nothing else was seen until March 10, when four Mandt's guillemots visited the cliffs. This was the beginning of a long series of visits, for the guillemots arrived every night and left again early in the morning. As the month progressed they spent longer times at the cliffs, but these were always deserted in the afternoons. By March 19 the numbers had increased and the birds were staying until about 11 a.m. By

breeding at all. This non-breeding, which this year was found in the case of the eider and brent geese, is a regular feature of arctic bird life and one of great interest. From work done all over the

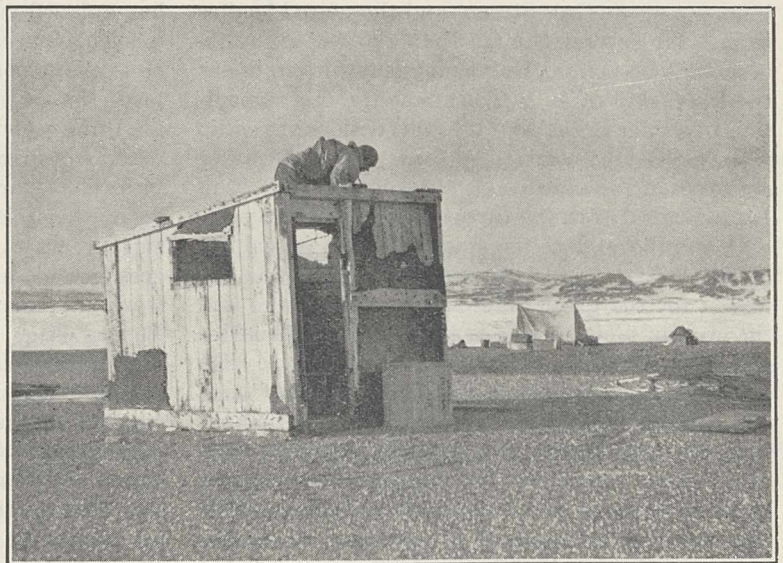


Fig. 2.

THE BIOLOGICAL STATION ON RUSSIAN ISLAND IN MURCHISON BAY OCCUPIED BY KEITH AND GODFREY FROM APRIL UNTIL JULY, 1936.

Arctic, notably in Greenland and Spitsbergen, it seems fairly certain that every fourth year or so certain species of birds are affected, and of these

species many less than the normal percentages are found breeding. The birds most commonly found to be affected are the ducks, geese and divers, but in North-East Land the divers were breeding in normal numbers.

It is as yet difficult to account for this phenomenon. Many and varied suggestions have from time to time been put forward. It would appear that it must bear some relation to changing climatic conditions, as these must be assumed to be the only variable factor in the environment of the birds until some variation at present unknown is shown to take place in their marine food supply. But this leaves us with the difficulty of explaining the regularity of the occurrence of the non-breeding years by climatic changes which have not yet been shown to follow the necessary cycle of 3-4 years. The late melting of the sea-ice and disappearance of the snow from the land might in some cases give an explanation, but this cannot find universal acceptance because in a non-breeding year the birds that do breed do not usually begin to nest any later than usual. Again, such a condition could scarcely affect the ducks without to some extent also affecting the red-throated divers. It is also impossible to suppose some general factor which affects reproduction throughout the Arctic, because species such as the waders and passerines have never yet been shown to be affected in this way. During the earlier part of the summer, I examined the gonads of many eiders, and the general result was that the ovaries were scarcely enlarged at all, but that the testes of the drakes were developed to the normal size of a breeding bird. It would be unwise as yet to argue from this one case, but if similar observations are carried out elsewhere and the same result found, the reason for the non-breeding will have to be found in some factor which affects the sexual development of the female and not of the male. It was noticeable throughout the first part of the summer how much more sexually excited the drakes were than the ducks.

Even in normal years North-East Land has a large non-breeding population, but this is entirely

different from that which I have been describing above. The island lies at the extremity of the breeding area of most birds visiting it, and it seems to a large extent to be populated by birds which were bred elsewhere and have had to move out from the more favoured areas of their range to this uninviting marginal territory. Only by this supposition can I account for the large non-breeding population which seems to be a normal feature in every species. It is difficult to estimate non-breeding percentages among cliff nesting species, but it was abundantly clear that large



Fig. 3.
RED-THROATED DIVER ON NEST.

numbers of non-breeding Arctic skuas, terns, grey phalarope, purple sandpipers and snow buntings were a normal feature of the ornithology of North-East Land. It was also clear that the numbers of each species which were breeding were quite inadequate to maintain the status of that species with anything like a normal rate of mortality.

This question of non-breeding both in normal and abnormal years is one of the most interesting confronting the ornithologist visiting North-East Land, and I have but touched on it here. Another problem is that of distribution. North-East Land is an excellent field for this and other inquiries, as the factors which have to be considered can be so much more easily seen there than in more temperate regions with their more complex bird communities.

Obituary Notices

Sir Grafton Elliot Smith, F.R.S.

WITH deep regret we record the death of Sir Grafton Elliot Smith, the famous anthropologist and former professor of anatomy in the University of London (University College), which took place at Broadstairs on January 1 after a prolonged period of ill-health, at the age of sixty-five years.

Grafton Elliot Smith was born on August 15, 1871, at Grafton, New South Wales, and was educated at the Universities of Sydney, where he obtained the degree of doctor of medicine in 1895, and Cambridge, where he was a fellow of St. John's College, on which foundation he afterwards became an honorary fellow. On obtaining his degree in medicine, he devoted himself especially to the study of the comparative

anatomy of the brain. Not only did this orientation of his studies largely determine his future achievement by directing his attention to human palaeontology and the problems of the evolution of man, but also the publication of the results of his early researches in the *Journal of Anatomy* and other professional periodicals speedily won him wide recognition as one of the foremost authorities on the anatomy of the brain.

Of little less importance, however, in influencing the development of Elliot Smith's thought and the direction of his studies was his appointment to the chair of anatomy in the Egyptian Royal School of Medicine, Cairo. Here he was brought into contact with a number of problems arising out of investigation of the history and culture of the ancient Egyptians, which were germane to his own studies. Skeletal remains from predynastic and dynastic burials in almost countless numbers, and mummies from the various periods of Egyptian history, were studied on his own initiative or were brought to him for examination and report. In particular, he was deeply impressed by the character of the skeletal remains obtained by G. A. Reisner from his Nubian excavations. With this material under his hand, Elliot Smith was attracted inevitably to the consideration of such questions as the racial origins and composition of the ancient Egyptian population, their pathology and the incidence of diseases among them, as well as the history and development of the practice and technique of mummification as manifested in the anatomical evidence. Nor did his active mind rest there; he was drawn on to examine the cultural and religious ideas with their modifications in course of time, which were implicated in all this material. In communications, for example, submitted to Section H (Anthropology) of the British Association so long ago as the Dublin meeting of 1908 may be discerned the germ of ideas and concepts which were to play a very important part in the work of his later years.

In 1907 Elliot Smith was admitted a fellow of the Royal Society. His services to scientific studies in Egypt were recognized by the award of the Order of the Mejidie. In 1909 he left Egypt to occupy the chair of anatomy in the University of Manchester. Apart from a number of papers contributed to scientific journals, the most important of his publications arising directly out of his work in Egypt was "The Royal Mummies", which as a result of the anatomical examination of well-known examples from the Royal burials, threw a new light on certain dynastic problems of Egyptian history. It was published in 1912.

Of more immediate consequence in Elliot Smith's career was the publication in 1911 of his "Ancient Egyptians", which was received with enthusiasm by many anthropologists, notably the late W. H. R. Rivers. Here, working largely on evidence afforded by the skeletal material obtained by Reisner, to which he had had access though it long remained unpublished, as well as on material from burials at Gizeh, he deduced the intrusion of a new racial element of

Asiatic (Armenoid) origin into the population of early dynastic Egypt. To these people he attributed the introduction of metal tools, facilitating the working of stone, and consequently, as he had been led to believe by his study of the *mastaba* and other forms of Egyptian burial practice, leading up to the erection in stone as a sepulchral monument, of which the idea had been carried far and wide in the early world to give rise to the widely distributed megalithic monument. The publication of this book is a landmark in Elliot Smith's development as an anthropologist.

In the following year (1912) Elliot Smith presided over Section H (Anthropology) of the British Association at the Dundee meeting. Through his personal influence with former pupils and friends, as well as by his own contributions, the proceedings of the Section on this occasion gave the members of the Association a remarkable review of certain aspects of Egyptological studies at the time.

Elliot Smith's most noteworthy part in the proceedings at Dundee, however, and at the same time his most considerable contribution to anthropological science on this occasion, as perhaps might be expected, lay in his presidential address. In this he dealt with the identification of the neopallium, the associational area in the frontal region of the brain, and demonstrated its bearing upon the evolutionary problem in man, views then made known to a wider public for the first time. Notwithstanding the fact that subsequent neurological research has led to the very considerable modification of Elliot Smith's views on this localization of function, the conclusions which were there put forward on the development of man's faculties in the evolution from lower forms of life afforded a great stimulus to further research on such questions as the development of stereoscopic vision, of speech and generally on the evolution of form and function. This address, in fact, marks a stage in the study of the brain of early man, of which the development, more especially by the use of the endocranial cast, was probably Elliot Smith's greatest and most lasting contribution to the study of human palaeontology.

The announcement, which followed shortly after, of the discovery of the Piltdown skull, brought Elliot Smith into the discussions which followed on the reconstruction of that early relic of man, and it was under his supervision and with his collaboration that the late Dr. J. Hunter, after the Great War, effected a reconstruction of the cranium, which once and for all brought the chimpanzoid jaw into sufficiently harmonious relation with the rest of the skull to place the individual and human character of both elements, which had been questioned, beyond doubt.

Elliot Smith by now was recognized as one of the foremost authorities on early man, and with Sir Arthur Keith divided the honours of arbiter in pronouncing upon the character and importance of any new discovery. He was the first to demonstrate the Rhodesian skull before the Zoological Society and the Royal Anthropological Institute in 1921, and he described the "Lady of Lloyds'", the primitive skull found in the City of London in 1925, which, as he showed at the International Congress of Prehistoric

and Protohistoric Sciences in London in 1932, may possibly be the earliest known example of the 'modern' type of man. An account of this skull appears in the second edition of his "Evolution of Man", first published in 1924. It is perhaps worth while to recall that Prof. Raymond Dart, whose sensational discovery of *Australopithecus* in South Africa in 1925 caused no little controversy, was one of the many pupils whom Elliot Smith inspired with his own enthusiasms.

It was, however, in connexion with the discovery of Peking man that Elliot Smith was perhaps most active. He spared himself no pains to become fully acquainted with this early type of man in all its bearings, and to make it known to his colleagues and a wider public. He was able to speak with especial authority, as not only was he kept fully informed of the progress of investigation through his friendship with the late Davidson Black, but in his visits to the Far East he personally examined the relics of Peking man and informed himself on the geological and topographical conditions of discovery. Only a few weeks ago, in December last, a letter to *The Times* confirmed the importance of the latest discoveries and gave full credit to the work of Prof. Franz Weidenreich, the new director of the Cænozoic Laboratory, an appointment which Elliot Smith himself had recommended to the Rockefeller Trustees, although the nominee had been an acute critic of his own work.

In the meantime, while Elliot Smith had attained a commanding position as an authority on the evolution of early man, his activities in other directions had involved him in violent and sometimes embittered controversy. The ideas which were adumbrated in his view of the spread of the megalith put forward in his "Ancient Egyptians" in 1911 had undergone a wide development. In his study of mummification he had been much impressed by the similarities, or identities as he saw them, in the technical methods employed by the ancient Egyptians and in those which had been practised on the mummies brought back by the Cambridge Expedition to the Torres Straits in 1900. Further study of the ethnographical record of primitive peoples and of the peoples of antiquity convinced him that similarities in the cultures of the world at large were to be explained as the result of a wide diffusion of culture which had Egypt as its starting point. The earliest full statement of this theory, from which sprang the 'Historical School', appeared in a paper in the proceedings of the Manchester Literary and Philosophical Society, afterwards published (1915) as "The Migrations of Early Culture". It was developed further in "The Evolution of the Dragon" (1919), "Elephants and Ethnologists" (1924) and other works; it finds its best and most philosophical expression perhaps in "Human History" (1930). The development of this school of thought, which was opposed by its originator to the Tylorian system, or 'Evolutionary School', as Elliot Smith termed it, owed much to the work of W. J. Perry, an assistance of which Elliot Smith was ever generous in acknowledgement.

This is neither the occasion nor the place to enter into any critical examination of Elliot Smith's views on the subject, nor to dwell upon the opposition which they aroused. In fairness to him, two things must be said, one personal and one in relation to the development of his work at University College, where he succeeded the late G. D. Thane as professor of anatomy in the University of London in 1919. Elliot Smith was a man capable of inspiring in those who were well acquainted with him an admiration and affection which never faltered; but he had a nature which was extremely sensitive and reacted to criticism in the release of a pen which knew no mercy. Hence he frequently involved himself in unnecessary and acrimonious debate which might and should have been avoided with better understanding.

On the broader issue, it has perhaps too seldom been noted to how great an extent Elliot Smith's theories on the diffusion of culture were a counterpart of, and were influenced by, his views on the origin and distribution of races. Not indeed that he would have pressed too hard his conception of racial filiation and affinities. No one who heard his impressive denunciation of the misuse and misinterpretation of racial theory in the interests of political prejudice, when he presided over the Section of Physical Anthropology at the International Congress of Ethnological Sciences in London in 1934, could have remained under any misapprehension on this point. But there can be no doubt that he looked upon culture very much as an original stock spreading over the world from one centre of origin, which he found in Egypt, as a concomitant and an analogue of the spread of the stock of *Homo sapiens* to develop into the variety of the races of man in a diversity of local conditions. Such a filiation of racial characters, for example, was his hypothetical "Brown Race" extending from the Mediterranean to India and beyond, which has afforded physical anthropologist and archæologist alike a valuable theoretical basis for racial argument, in unravelling the ethnic and cultural history of the Mediterranean and Near and Middle East.

It was this concept of the fundamental unity and parallelism in the study of man, which was clearly before Elliot Smith's mind when he proceeded to remodel his Department at University College with the assistance of the grants which had been received from the Rockefeller Trustees. There he planned that the study of man's evolution and physical structure in the Department of Anatomy should proceed side by side with the study of the development of culture on the lines which he had worked out. This scheme he was able to bring to fruition with the appointment of Dr. W. J. Perry as reader in cultural anthropology in 1927.

When Elliot Smith retired owing to failing health at the close of the academic year 1935-36, he had been the recipient of many honours in recognition of his services to science. In 1934 he was knighted. He had been a member of the General Medical Council, and was formerly a vice-president of the Royal Society, from which he received a Royal Medal;

he received the Hon. Gold Medal of the Royal College of Surgeons of England, and the Prix Fauvelle of the Anthropological Society of Paris. He had delivered the Croonian Lecture, the Arris and Gale Lecture, the Huxley Lecture of Birmingham, the Imperial College and the Royal Anthropological Institute, as well as lectures of like standing in the medical colleges of Edinburgh, Dublin and the University of New York. He had been president of the Anatomical Society and the Manchester Literary and Philosophical Society among other societies concerned with his special studies, and his work had been recognized on the Continent by honorary fellowship or corresponding membership of the academies and more important anthropological societies of France, Holland, Belgium, Germany and Italy.

Dr. C. V. Jackson

DR. C. V. JACKSON, who at the early age of thirty years lost his life in a sleigh accident at St. Moritz on December 30, was a spectroscopist of considerable ability who had made valuable contributions to the establishment of accurate standards of wave-length. A graduate of the University of Oxford, he joined the Imperial College of Science and Technology about six years ago for the purpose of carrying on research in this subject under the direction of Prof. A. Fowler. On Prof. Fowler's retirement in 1934, he remained at the Imperial College as an honorary lecturer. His work included very precise interferometric measurements of iron, silicon, krypton and other spectrum lines, which were published in the *Proceedings of the Royal Society*, and he gave a considerable amount of attention also to the investigation of possible sources of light for the production of more satisfactory primary and secondary standards than those now accepted.

Dr. Jackson was a man of considerable financial resources, which he expended freely in the purchase of apparatus of the highest quality. His scientific work was characterized by quickness of mental apprehension and by an extreme fastidiousness in measurement which was in surprising contrast to the somewhat bewildering vagaries of his general temperament. He would alternate periods of intensive physical research with horse-racing and other social activities which are not usually found in such close association therewith. He was a member of the Commission on Wave-Length Standards of the International Astronomical Union, and attended the meetings of that body in Paris in 1935.

Dr. J. M. H. Munro

BEFORE 1884, basic slag was a 'waste product', of which extensive spoil heaps had accumulated. It was the refuse of Bessemer steel converters which had been lined with basic mineral matter to abstract phosphates from the molten iron, and it contained about twenty per cent of phosphorus pentoxide (P_2O_5) combined mainly with lime. About forty years before that time, Lawes and Gilbert had

demonstrated that the value of 'rock phosphate' as a fertilizer was greatly increased by treatment with sulphuric acid. The discovery by Wrightson and Munro of the fertilizing value of ground basic slag was of almost equal value to agriculture, and added vastly to the productivity of large areas of what were previously very poor pastures.

John May Herbert Munro, who died at Bath on November 6, at eighty-one years of age, matriculated at the age of seventeen and was one of the youngest men, if not the youngest, to graduate D.Sc. London five years later in 1877. His record included distinction in logic, botany and chemistry. In the early 'eighties, after having for a few years held an appointment in the Patent Office, he joined John Wrightson and William Fream in founding what was then the second of the English agricultural colleges, at Downton in Wiltshire. John Wrightson was a brother of Thomas Wrightson, whose firm of steel manufacturers was one of those which had used the basic process and accumulated spoil heaps of slag. The high phosphate content of the slag was, of course, known, but it did not occur to anyone that it could be used as a fertilizer until Wrightson and Munro demonstrated the fact by a series of agricultural and laboratory experiments at Downton in 1883 and 1884.

I came to know Munro and to visit him at Downton about that time when he was working out methods of determining the solubility of the P_2O_5 of the slag, its availability as a plant nutrient and the degree of 'fineness of grind', on which both depended. His extreme modesty prevented him, so far as I know, from ever claiming credit for this demonstration of the value of finely ground basic slag, which later became well known from experiments by Gilechrist and Somerville at Cockle Park, in Northumberland. At the same time, Munro was working in collaboration with Warington on problems connected with nitrogen fixation by the nodules of leguminous plants, a subject then in its infancy, and on which he published papers in the *Journal of the Chemical Society*. In 1892, I was fortunate in obtaining his collaboration in a long series of experiments at Warminster on the factors of productivity and of malting quality in barley, and in the forty years following, during which they have been in progress, I have had the inestimable benefit of his advice on the chemical problems involved. Later on, he deserted professional agriculture (except as an analyst) for medicine and bacteriology, and did valuable work on the composition and therapeutics of Bath mineral water.

E. S. BEAVEN.

We regret to announce the following deaths:

Prof. Louis M. Dennis, emeritus professor of chemistry in Cornell University, an authority on gas analysis, on December 9, aged seventy-three years.

Prof. D. F. Fraser-Harris, formerly professor of physiology in Dalhousie University, Nova Scotia, on January 3, aged sixty-nine years.

Geneviève Lady Watson, local secretary in Palestine to the Palestine Exploration Fund, on December 31, aged eighty-two years.

News and Views

Prof. V. L. Komarov

THE presidential chair in the U.S.S.R. Academy of Sciences, which became vacant last year owing to the death of Prof. A. P. Karpinsky, is now filled by the election of Prof. V. L. Komarov. The new president is an eminent botanist, particularly well known for his exhaustive studies in the flora and vegetation of Kamtchatka, Manchuria and the Far East generally. During the last few years, Prof. V. L. Komarov occupied the post of vice-president of the Academy and took an active part in various aspects of its work. It may be hoped that his election to the presidency will mean substantial developments in the natural history researches, which lately has remained somewhat in the background, since the main attention of the Academy, as a whole, has been directed to technical and engineering problems, which have to be studied in connexion with the 'socialistic reconstruction' of the country.

Alfred Willett (1837-1913)

THIS eminent London surgeon was born on January 3, 1837, the second son of William Catt of Brighton, who afterwards took the name of Willett. His medical education was carried out at the Sussex County Hospital, where he was a pupil for three years, and at St. Bartholomew's Hospital, London. After qualifying in 1859 he held a number of junior appointments at St. Bartholomew's Hospital, where he was successively elected assistant surgeon, surgeon in charge of the orthopædic department, full surgeon and lecturer in surgery. In 1897 he delivered the Bradshaw Lecture on "The Correction of Certain Deformities by Operative Measures upon Bones" at the Royal College of Surgeons, where he served on the Council from 1887 until 1903 and as vice-president in 1894 and 1897, but declined nomination for the presidency. Among the other appointments of distinction which he held were those of president to the Royal Medico-Chirurgical Society and of surgeon to Queen Charlotte's Lying-In Hospital and the Evelina Hospital for Children. Willett was an excellent example of the transitional period between the pre-Listerian era and that of antiseptic surgery. Undeterred by the unsympathetic attitude of his colleagues, he studied Lister's methods, and in the early eighties was the only surgeon in the hospital to perform systematic abdominal operations in conjunction with the celebrated gynaecologist, Dr. Matthews Duncan. The interest which he took in orthopædic surgery was rewarded by his successful treatment of deformities. His death took place twelve years after his retirement from St. Bartholomew's Hospital, on June 20, 1913. A silver medal named after him is awarded annually to the winner

of the highest marks in operative surgery at the Brackenbury Surgical Examination at St. Bartholomew's Hospital.

Solar Eruptions and Radio Fade-outs

THE associated phenomena of a bright hydrogen eruption on the sun on December 3 and a radio fade-out, described in NATURE of December 12, p. 1017, had an interesting sequel 27 days later. On December 30, the sun was under continuous observation with the spectrohelioscope at the Royal Observatory, Greenwich, from 9^h 45^m to 12^h 55^m U.T., and at first attention was concentrated on a region near the central meridian which showed signs at 9^h 45^m of having been recently active. At 10^h 30^m, a bright eruption began rapidly to develop there and lasted until about 11^h. At 10^h 57^m, on turning to another part of the disk, a very bright and extensive hydrogen eruption was seen to have begun at a position about 55° west of the central meridian in latitude 22° north; in about 20 minutes this bright eruption had spread southwards to about latitude 14° north, so that the eruption when fully developed was spread over a distance of about 60,000 miles in latitude. (This active region was nearly identical in position with the region that was active on December 3.) It is shown by a whole disk spectroheliogram, taken in hydrogen light ($H\alpha$) by Mr. Evershed at his observatory at Ewhurst, that at 10^h 34^m this second and larger eruption on December 30 had not begun, though another spectroheliogram taken at 11^h 20^m (after information had been received from Greenwich) shows the eruption near its full development. The most probable time of the beginning of the eruption, derived by extrapolating an intensity curve given by photometric measures made at Greenwich after 10^h 57^m, is about 10^h 50^m. The declining stages of the eruption were relatively slow, and by 12^h 50^m the streaks of emission were of the normal brightness of ordinary flocculi.

It is of considerable interest that three radio fade-outs were reported later as having occurred during the morning of December 30 on short-wave (of the order of 20 metres) wireless transmission between certain stations in the earth's sunlit hemisphere. The first of these occurred about an hour before the sun could be observed at Greenwich with the spectrohelioscope, but the disturbed appearance at 9^h 45^m of an area near the sun's central meridian may be significant; further solar data from observatories east of Greenwich may possibly be forthcoming. The second radio fade-out occurred from 10^h 31^m to 10^h 45^m, and the third from 11^h 0^m to 11^h 20^m. The agreement in time between the last two radio-fadings and the two

bright hydrogen eruptions on the sun appears to be highly significant in view of the other occurrences to which attention has already been directed in NATURE. It must be mentioned, however, that radio experiments conducted in England on December 30, while the solar eruptions were in progress, indicate that the disturbed conditions of the ionospheric layers evident on December 3 were not reproduced on December 30.

"The Kiss Precise"

IN NATURE of June 20 last, we published some verses by Prof. F. Soddy under this title. Shortly afterwards, Mr. E. B. Wedmore sent two verses generalizing Prof. Soddy's equations for the circle and the sphere to space of n -dimensions, and more recently Mr. C. C. Mason has submitted a verse on similar lines. Prof. Soddy informs us that he received a verse (dated July 17, 1936) from Mr. Thorold Gosset, of 136 Chesterton Road, Cambridge, generalizing his equations, and, in response to his request, Mr. Gosset furnished a formal proof of the proposition later in the same month. Mr. Gosset seems to have extended the geometry of all the semi-regular figures to n -dimensions in a lengthy paper some forty years ago, but it remained unpublished, except for a few results which appeared without proofs in the *Messenger of Mathematics*. The existence of these figures has recently been rediscovered, some in Holland, some in England, and a paper by Dr. Coxeter on the subject has been published by the Royal Society, so that all are now known. Prof. Soddy's development of "The Kiss Precise" and "The Hexlet" appears elsewhere in this issue (p. 77). Dr. F. Morley has also recently furnished a formal proof of the hexlet, which is printed on p. 72. Mr. Gosset's fourth verse to the "Kiss Precise" is appended:

And let us not confine our cares
To simple circles, planes and spheres,
But rise to hyper flats and bends
Where kissing multiple appears.
In n -ic space the kissing pairs
Are hyperspheres, and Truth declares—
As $n + 2$ such osculate
Each with an $n + 1$ fold mate
The square of the sum of all the bends
Is n times the sum of their squares.

Museums and their Type Specimens

THE *Annals of the Transvaal Museum* (18, 349-413; 1936) contain four papers by Dr. R. Broom. The list of the Karroo reptiles is increased by 15 new genera and 23 new species. Many of these are to be described in further detail elsewhere, and this information leads us to wonder with what object Dr. Broom now publishes abbreviated descriptions, the day for seeking priority in the accounts of new species being assuredly passed. The species are described almost exclusively on their skulls, and most of these, to judge by the figures, were capable of restoration. This process is obviously a fine art as seen in the occiput of *Notaelurops*, pictured as preserved and as restored. Clearly, in dealing with such a large and widely distributed fauna as that of the Karroo, it is best for the collector

to reserve his more imperfect specimens rather than to describe such as "types". In this matter of "types" Broom has much to say in his "Review of some Recent Work on South African Fossil Reptiles" where he considers the publications of ten workers. The most prolific of these was Boonstra, who has contributed no less than twenty-four papers in the last six years.

OBVIOUSLY this output can only have been possible on a very different technique from the laborious chipping away of the matrix in which the skull is embedded, this being usually regarded as the safest method in developing a skull. Boonstra worked in the British Museum, and we learn how he dealt with a type specimen of *Theriongnathus* Owen (1876), fracturing it in several places with a hammer and chisel. "The specimen now is of more value to the morphologist", but surely such an operation should only have been performed by the skilled preparators of the Museum. In another specimen Boonstra failed to find two small canines which had been figured and so ground down the type to see their roots. Broom regards these operations on type specimens carried out by a visitor as "a gross breach of trust" on the part of a Museum to which "types" are supposed to be sacrosanct. This is a serious statement, damaging in that it is likely to deflect the flow of material to the Museum. Obviously it calls for a statement on behalf of the Museum as to whether the operations are correctly described and were specifically authorized by its responsible officers.

Radio Research in India

MANY readers of NATURE will recall that, during his recent visit to Great Britain, Prof. S. K. Mitra expressed a desire to see a Radio Research Board established in India to carry out research of a fundamental nature on radio communication in a manner analogous to the working of the corresponding British Board. While this scheme had the enthusiastic support of eminent British authorities, there appears to be some difficulty in getting the Government of India to take a favourable view of the project. An article in the *Amrita Bazar Patrika* refers to a speech made recently on this subject in the Physics Department of the University of Allahabad. It is reported that in the opinion of the Government, the research station attached to the All-India Radio Organization will be able to conduct all the research work required for the time being. As Prof. Mitra points out, however, there is a great need for the setting up of a fully equipped Radio Research Board laboratory where more fundamental work can be conducted by experienced workers from the universities without in any way overlapping or interfering with the more applied work of the broadcasting organization. In England, the British Broadcasting Corporation conducts research on its own particular problems independently of the wider and more fundamental work of the Radio Research Board. Arrangements are in force whereby close liaison is maintained between the two organizations as necessary, and this is found to be of mutual advantage.

THE article referred to above also records a speech by Prof. M. Saha of the University of Allahabad, who is closely associated with Prof. Mitra in his efforts to obtain more support for research on radio problems. Prof. Saha complains, however, that the apathetic attitude of the authorities towards scientific research is not confined to radio matters. Many research chemists and physicists in India have to carry out their research while working in ill-equipped laboratories under various difficulties arising from insufficient financial provision. In these circumstances, it is certainly very creditable that some of these workers have been able to achieve international renown, but it is highly probable that a little more encouragement on the financial side would be amply repaid in the increase in knowledge and its resulting benefits both to India and the world at large.

Problems of Industrial Recruitment

SOME account of discussions between the Minister of Labour and his predecessor in office and representatives of employers' organizations and the Trades Union Congress General Council on conditions of employment and hours of work in particular industries with reference to unemployment from January 1935 onwards is given in a paper presented to Parliament (Cmd. 5317. London: H.M. Stationery Office. 2*d.*). In the earlier discussions, the Minister directed special attention to the possibility of increasing the number employed by reducing the hours of work, limitation of overtime, rotation of shifts, regular holidays and the effects of such measures on wages and costs. Difficulties in filling vacancies, the actual or potential shortage of trained work-people and the determination of the effective labour supply among the unemployed nominally attached to various industries were also suggested for investigation, and in later discussions the Minister directed special attention to the need for ascertaining accurately the size and nature of labour supply and unemployment in particular industries, as well as in regard to recruitment, training and hours of work.

REPRESENTATIVES of several industries undertook to supplement the available information in such matters, but the Minister directed attention to the lack of balance in the age distribution or in the labour supply or rate of recruitment which exists between different branches of industry. Evidence of present or prospective shortage of skilled labour in some industries was also discussed, including its bearing on the absorption of other workers in the same or in ancillary industries, and the attention of industries was directed to the necessity of considering the new circumstances which would result from the raising of the school-leaving age and the reduction in the number of juveniles who would be available for employment. The discussions have made available a valuable amount of industrial information which should afford a basis for Government or other action if the industries concerned prove unmindful of the responsibilities in regard to the absorption of the unemployed which have thus been brought into

prominence, and they illustrate in a striking manner the need for some attempt to handle industrial recruitment on quantitative lines.

The International Commission of Snow

A NEW section of the Association of Scientific Hydrology to deal with the varied problems of snow and ice was organized in time to hold its first meeting in Edinburgh last September a few days before the official opening of the International Congress of Geodesy and Geophysics. A very large number of papers from all over the world were on the programme, and it was felt that the manifold activities of this new Commission will go far to remove the reproach that the study of snowfall, unlike that of glaciation, has been neglected in most countries, even in those which have much snow. The president, Prof. J. E. Church (U.S.A.), who was unfortunately not able to reach Edinburgh in time for the Conference, being detained in Moscow by illness, presented a valuable address on "Snow Surveying: its Methods and Principles", in which he showed the economic importance of the snowfall in the high mountain ranges of the western United States to the semi-arid plains below. The papers will all eventually appear in the *Proceedings of the Association of Scientific Hydrology*. The next meeting of the International Snow Commission will be in Washington, D.C., in 1939. Meanwhile, the various national sections will carry out group work in the problems of snow. In view of the first meeting of the International Snow Commission being held in the Scottish capital, the question of British co-operation in the work naturally came into prominence. A British group of members under the chairmanship of Mr. G. Seligman was formed during the early part of 1936, and by the time of the Edinburgh Conference totalled sixteen, of whom ten attended the Conference. Four papers were presented by the British group, two of which, appropriately to the occasion, dealt with snowfall in the British Isles, one by Captain W. N. McClean on the influence of snow and ice on river discharge in the Scottish Highlands, and the other by Mr. L. C. W. Bonacina on problems of drifting snow in mountainous districts with special reference to the Scottish Highlands.

Index of Geographical Literature

IN 1918, the Royal Geographical Society found it necessary on the grounds of economy to abandon the practice hitherto followed of including in each issue of the *Geographical Journal* a list of additions to the library. These lists from then onwards have been published as separate pamphlets from time to time and distributed to such fellows as expressed a desire to receive them. Up to December 1932, forty-one of these supplements had been published. The entries in these supplements, especially as regards books, atlases and papers, though nominally additions to the catalogues of the Society, in effect comprise a fairly exhaustive list of all geographical literature outside the pages of the *Geographical Journal*. The Society has now published an "Index to Supplements

to the *Geographical Journal*, Vols. 1-5, Numbers 1-41: 1918-1932" (London: Royal Geographical Society, 16s.: to fellows, 12s. 6d.). The terminal date is chosen as coinciding with the termination of the "Fourth General Index" to the *Geographical Journal*. The volume also serves as an index to much of the contents of the annual volumes of the *Bibliographie Géographique Internationale*, for which decennial tables have not recently been issued, the volume numbers in the Index giving the date of publication to within five years.

THE Index which is thus made available is under one alphabet, giving authors and regional names in heavy type. Comprehensive headings are subdivided by italic headings, thus greatly facilitating reference. Thus under British Empire the subdivisions are agriculture and forestry, communications, defence, economics, education, history, mineral resources, politics, population, power, survey, text-books and travel. The lack of a rigid plan of subdivision and the adoption in each large grouping of one suitable for the character of the entries, are useful features. Considerations of space have limited each item to one subject entry. Titles in the less familiar languages are given in the language used in the summaries appended to the articles. Maps and photographs in the Society's collection are omitted, but all atlases are included.

Composition of Scientific Papers

EACH of our two leading medical contemporaries—the *British Medical Journal* and the *Lancet*—includes in the issues of January 2 some helpful suggestions to writers of scientific papers upon styles of composition and typographical conventions. The *British Medical Journal* is given a much more attractive appearance than it has had hitherto by the use of a cover of grey paper with a scarlet design upon it, and the type of the journal has been entirely changed, being now that created a few years ago for the printing of *The Times*. This type is more legible than that formerly used and is particularly suitable for comfortable reading. The *British Medical Journal* announces in the same issue that, in future, the Harvard system of references to scientific literature will be used, instead of numbered references, such as are used in NATURE. Examples are given of these two systems of references to papers. The *Lancet* publishes a special supplement containing advice to authors on the preparation of scientific papers, words and phrases to avoid, summaries, abbreviations, references, and related matters. If these instructions were followed generally, the work of editors would be greatly relieved.

Air Raid Precautions

AIR RAID PRECAUTIONS HANDBOOK No. 4 is entitled "Decontamination of Materials" (London: H.M. Stationery Office, 1936. 6d.), and deals with contamination caused by chemical substances capable of giving off poisonous gases. These gases are classified as non-persistent and persistent, the book dealing

chiefly with the latter, which include the tear gases (ethyl iodoacetate or *K.S.K.*, and bromobenzyl cyanide or *B.B.C.*) and the blister gases (mustard gas and lewisite). Decontamination of tear gases can be effected by using water, earth or a mixture of glycerin and caustic soda according to circumstances. Decontamination due to blister gases includes ventilation, hosing with water, removal by solvents, several methods of applying bleaching powder, immersion in boiling water, covering with earth, and destruction of the contaminated article by burning. In all cases, identification of the poison gas should precede attempts towards decontamination, and the latter should therefore be carried out only by persons specially trained and thoroughly protected. Appendixes in the manual deal with the equipment of a decontamination squad and methods of dealing with road surfaces, the structures of buildings, household articles and vehicles.

Colorado Potato Beetle

IN consequence of the spread of the Colorado potato beetle from France and Belgium into Germany and Luxemburg, the Ministry of Agriculture and Fisheries has made an order "The Importation of Plants (Amendment No. 2) Order of 1936" regarding plant imports into Great Britain. The Order imposes restrictions on the importation from Germany and Luxemburg of certain kinds of horticultural produce as from January 11. The restrictions are similar to those already in force with respect to like produce from France and Belgium. The provisions of the order require a certificate in one of two forms to accompany living plants, potatoes, raw vegetables and cider apples imported from the countries mentioned. Copies of the Order (S. R. and O. 1936, No. 1288), price 1d. each net, may be obtained from H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2.

Campaign against Noise

THE Leningrad Institute for the Protection of Labour is doing much useful work in combating the noise of machinery in Soviet factories. Some two hundred silencers of special design have been fitted to the automatically driven lathes of Leningrad factories manufacturing electrical apparatus. It is claimed that these silencers reduce the noise of the machines to the loudness of the normal human voice. The Institute is also carrying out experiments to reduce the noise of machinery at other types of works and factories and on the motor-ships of the Black Sea. During the past year the Institute has received more than twenty different designs for silencers from Soviet engineers and factory workers.

Earthquake in Kent on December 29

AT about 1.30 p.m. on December 29, a very slight earthquake, accompanied by a rumbling sound, was felt in the east of Kent. The villages in which it was observed (Adisham, Nonington, Snowdown, etc.) are close to the centre of the area disturbed by the much stronger Canterbury earthquake of November 27,

1776, that was felt with some intensity (about 6, Rossi-Forel scale) at Canterbury, Sandwich, Deal, Dover, Folkestone and Ashford, and, though very slightly, at Calais, thirty-four miles from the centre.

Sands, Clays and Minerals

THE most recent issue of this journal (3, No. 1, November 1936. A. L. Curtis, Westmoor Laboratory, P.O. Box 61, Chatteris, Cambridgeshire, price 3s. 6d.) has been considerably enlarged and contains articles covering a wide range of subjects. Topics of economic importance dealt with in this number include nickel, silica sand as a basis for phosphate deficiency tests on lettuce, minerals of Brazil, titanium oxide in industry, boron, soils, industrial water supply, barytes in Greece, mining resources in Tanganyika, etc. The articles are written by authors actually engaged in research on the subject, thus making them authoritative. A contribution by A. L. Curtis on the history and activities of the Fuel Research Station at Greenwich makes interesting reading. The journal is attractively produced, and is an excellent source of information, especially for mineralogists, chemical engineers and other men of science and technology concerned particularly with the mineral resources of the British Empire.

Physical Society's Exhibition Catalogue

THE Catalogue of this Exhibition, which was open on January 5-7, now covers nearly 200 pages and is well provided with indexes of exhibitors and of apparatus, plans, stall numbers on the outer top corner of each page, marks for new apparatus and for demonstrations, all of which help a visitor to find readily what he wants particularly to see. Illustrations are plentiful, but many are limited to views of the outsides of the boxes containing the instruments, while the interest of the visitor is more often centred in the principle of the instrument itself. The division of the catalogue into two sections devoted respectively to trade exhibits and research and educational exhibits is maintained, and the award of prizes to apprentices for exhibits of work done is continued. A new announcement is made of the intention of the Council to apply part of the legacy bequeathed to the Society by the late Herbert Spencer, for grants to fellows for the purchase of special research apparatus. The order of the stands in the catalogue and their stand numbers are arranged geographically to facilitate reference, and the asterisk which now marks a new exhibit in the body of the catalogue might with advantage in future years appear also in the apparatus index.

Announcements

SIR WILLIAM BRAGG will open the new extension to the Research Laboratories of the British Association of Research for the Cocoa, Chocolate, Sugar Confectionery and Jam Trades and the British Food Manufacturers' Research Association at 2 and 4, Dalmeny Avenue, Holloway, London, N.7, on January 19. There will be a reception from 3 until 6 p.m.

THE King has been pleased, on the recommendation of the Secretary of State for Scotland, to approve the appointment of Prof. Lancelot Hogben, professor of social biology in the University of London, to be regius professor of natural history in the University of Aberdeen, in succession to Prof. James Ritchie. Prof. Hogben was formerly assistant professor of zoology in McGill University, Montreal, and professor of zoology in the University of Cape Town.

MR. N. B. KINNEAR and Dr. H. A. Baylis have been appointed to deputy keeperships in the Department of Zoology of the British Museum (Natural History). Mr. Kinnear was born in 1882 and is a great-grandson of Sir William Jardine, the early nineteenth century naturalist. He is well known as an ornithologist, and prior to his appointment to the Museum sixteen years ago was in charge of the Bombay Natural History Society's Museum. He is the editor of the *Bulletin of the British Ornithologists' Club*. Dr. Baylis was born in 1889 and was educated at Epsom College and Jesus College, Oxford. He entered the Museum in 1912, and has specialized throughout his career in parasitic worms. He is the author of many scientific papers on this subject, and has built up a very large collection of these organisms, of which, before his time, the Museum possessed only a few specimens.

PROF. P. M. S. BLACKETT will deliver the Cantor Lectures before the Royal Society of Arts on January 18, 25 and February 1. The subject of the lectures will be "Cosmic Rays".

THE Sir Halley Stewart Trust has placed at the disposal of the Medical Research Council a sum of £500 a year for three years for a senior fellowship tenable in the Neurological Research Unit at the National Hospital for Nervous Diseases, Queen Square, London. This arrangement has been gratefully accepted by the Council with the concurrence of the Medical Committee of the Hospital, and the position has been awarded to Dr. Joseph Doupe.

THE seventy-first volume of the *Journal of Anatomy* is termed the "Elliot Smith Volume" and is dedicated to Sir Grafton Elliot Smith (see p. 57). Appropriately enough, Part 1, which was issued last October, contains his portrait as a frontispiece and commences with a biographical sketch of his early career by Prof. J. T. Wilson, who, in his early years in the Challis chair of anatomy in the University of Sydney, included Elliot Smith among his students.

MR. B. D. W. MORLEY, of Holy Trinity Vicarage, Madeira Road, Bournemouth, Hants, asks anyone who has been studying, or has at any time studied, communication among ants, to get in touch with him.

WILL Mr. Paul Molde, of Copenhagen, who sent a communication to the Editor entitled "On the Atomic Structure of Living Matter: A Biole Hypothesis", kindly communicate his address.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 73.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

The Ancestors of the Diptera

IN a previous communication to NATURE some years ago (May 18, 1929) I gave a short description of a remarkable genus *Permotipula*, represented by a complete forewing from Warner's Bay, N.S.W., and of Upper Permian Age. Although very primitive by comparison with existing types of Diptera, this wing was regarded by me as being definitely Tipuloid and lying well within the order. I added the following

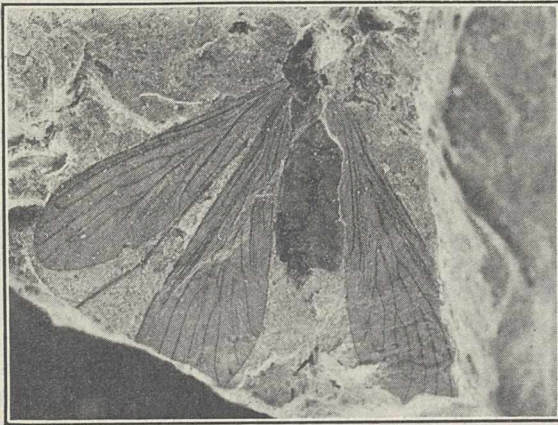


Fig. 1.

NEARLY COMPLETE SPECIMEN OF A PROTODIPTERON, ALLIED TO *Permotipula*, FROM THE UPPER PERMIAN OF WARNER'S BAY, N.S.W. LENGTH OF HINDWING ABOUT 5 MM.

remarks: "The wing is of the greatest interest, because any student of venation would classify it as dipterous and nothing else, and yet we do not know whether the insect to which it belonged had four wings or only two! Also, it is the oldest known dipterous type of wing by many millions of years."

It has always been my hope that, one day, a complete specimen of this insect, with its wings conveniently outspread, might be found at Warner's Bay by some lucky stroke of fortune. After many visits to that locality, and after the discovery of a fair number of dipterous wings, more or less allied to *Permotipula*, but, for the most part, too crumpled by the action of water to add much to our knowledge, I had almost begun to despair of ever finding a complete insect or of solving the problem of the nature of the hindwing in Permian times. But, on a recent visit, I had the good fortune to discover, right on the very edge of a large block of rock, an almost complete specimen of a genus extremely close to *Permotipula* (Fig. 1). This specimen had been preserved with the two wings on the right side superimposed in the normal way for a stegopterous insect, but, on the left side, the hindwing had slipped under

and forward of the fore, so that the venations of both wings can be clearly made out, the only missing portion being the extreme apex of the forewing. We thus discover the remarkable fact that, apart from size, the forewings and hindwings are almost exactly alike; if the hindwing had been found fossilized by itself, it would almost certainly have been considered to be the forewing of a primitive Tipuloid Dipteron. In order to show this more clearly, a drawing of the separate hindwing is shown in Fig. 2, with the names of the veins marked on it.

It can be said at once that the venation is very close to that of the living family Tanyderidæ, though the fossil form is slightly in advance of the living types owing to the great reduction of the primitive fork of R_{2+3} . Further, we note the remarkable fact that the forewings and hindwings are attached to the thorax very close together, so that we are bound to conclude that the metathorax was already greatly reduced in the fossil form, in spite of the fact that the hindwing was large and fully functional. Finally, in view of the fact that a true Dipteron, closely allied to the Tanyderidæ, has now been discovered in the upper Triassic beds of Mount Crosby, Queensland, we are able to state definitely that the loss of the hindwing occurred during the period between the Upper Permian and the Upper Trias. But we are still as much in the dark as ever concerning the manner in which the reduction to a halter took place.

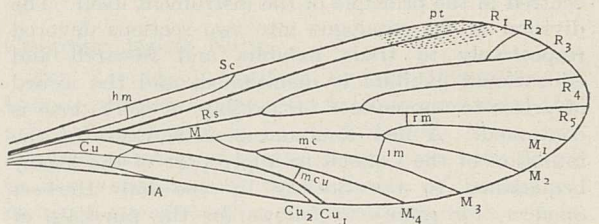


Fig. 2.

VENATIONAL SCHEME OF HINDWING OF THE SPECIMEN SHOWN IN FIG. 1. THE VENATION OF THE FOREWING IS SIMILAR, BUT *Sc* IS CONSIDERABLY LONGER.

As the new fossil cannot be placed in the order Diptera, and as it is clearly a specialized Paratrachopteron possessing a reduced anal area and only a single anal vein, I propose to term the group to which it belonged Protodiptera. The evolutionary series leading to the Diptera is now as follows:

(1) Order MECOPTERA (s.str.), family PERMORCHORISTIDÆ.

Rs with four or more branches, *M* with five or more branches, usually six; three anal veins present. All four wings present.

(Lower Permian to Upper Permian.)

(2) Order PARATRICHOPTERA.

Both *Rs* and *M* with four branches only, arranged dichotomically; three anal veins present. All four wings present.

(Upper Permian to Lias.)

(3) Order PROTODIPTERA.

Rs with four or three branches; *M* with four branches; anal veins reduced to two or one only. *Cu*₂ becoming obsolete and approaching *Cu*₁ closely. All four wings present.

(Upper Permian.)

(4) Order DIPTERA.

Rs and *M* both archetypically with four branches, but many forms show reduction. Anal veins at most two, generally only one. *Cu*₂ obsolescent or obsolete, usually indicated merely by a faint groove just below *Cu*₁. Hindwing reduced to a halter or balancer.

(Upper Triassic to Recent.)

In the above evolutionary sequence, it is important to notice that the first cubitus (*Cu*₁) is a simple, unbranched vein right through from (1) to (3) and also for the earliest types within the Diptera, but that, soon after the establishment of this latter order, the capture of vein *M*₄ by way of the cross-vein *mcu* produced a large number of forms (most of the recent Diptera) in which, as in the Trichoptera and Lepidoptera, the vein *Cu*₁ appears to be forked.

As the gaps in the fossil record are now all but filled, it is impossible to continue to maintain the Paratrachoptera and Protodiptera as fundamentally distinct from true Mecoptera. I therefore consider it advisable to treat these groups henceforth as specialized suborders of an enlarged order Mecoptera, to which all the four-winged forms with a simple *Cu*₁ are now relegated.

R. J. TILLYARD.

Canberra, Australia.

Oct. 25.

Combustion Levels

THEORETICAL flame temperatures and explosion pressures calculated upon the basis of the quantum specific heats (which have been shown to be substantially correct¹) are never reached in flames and explosions. Even when measurements of the actual flame temperatures and explosion pressures are postponed for such length of time as to make it certain that chemical combination is complete and full allowance is made for heat loss, there is still a defect of the measured temperatures and pressures below the calculated—a defect which remains constant in amount during the whole of this time. In short, in flames and explosions, definite ceiling temperatures and ceiling pressures are reached which fall short of the calculated temperatures and pressures.

The defect of the ceiling flame temperatures and explosion pressures below the calculated has been shown² to be dependent upon the nature of the combustible gas, the nature of the diluent gases and notably the pressure at which combustion takes place—the higher the pressure the less the defect.

The defect in the explosion pressures is much less than the defect in the flame temperatures. (In ordinary flames the defect of temperature amounts to many hundreds of degrees centigrade.) A completely satisfactory correlation is obtained, however, if it be assumed that the pressure that really matters is the instantaneous pressure in the flame front³.

Demonstration of the correctness of this view is provided by some photographic studies by Bone and Frazer of flame travel in long tubes closed at one end only—the firing end. Two of these will suffice for our purpose, namely, Figs. 1 and 4, plates 13 and 14, *Phil. Trans. Roy. Soc., A*, 230, 363 (1931). These relate to flame travel in 2CO + O₂ mixtures and are reproduced here in Fig. 1 through the courtesy of Prof. W. A. Bone and Mr. R. P. Frazer.

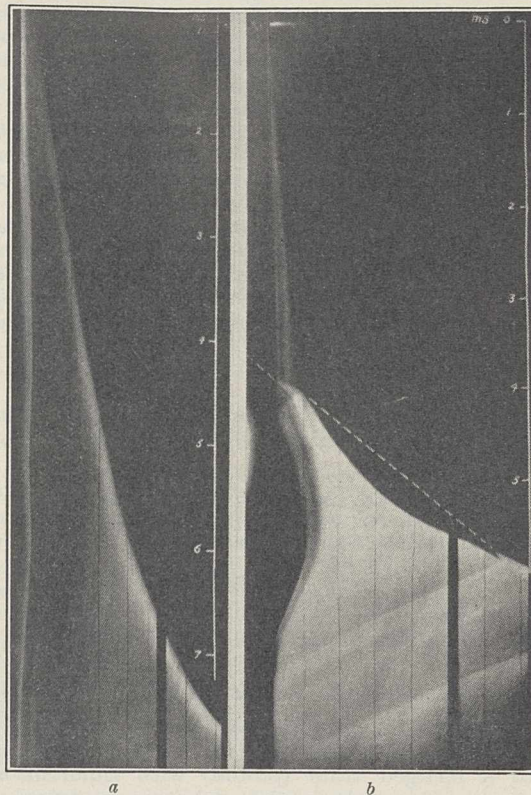


Fig. 1.

It will be seen from Fig. 1, *a*, that not only the flame front luminosity, but also the intensity of the after-glow in the flame gases left behind, increases with distance of travel of the flame front and therefore with pressure in the flame front. The intensity of the after-glow has been shown to be dominated by the temperature of the flame gases⁴ and it may fairly be inferred that the temperature of the flame gases resulting from the combustion of any given inflammable mixture increases as the pressure in the flame front increases. This is very vividly demonstrated in Fig. 1, *b*, in which the pressure in the flame front after travelling some short distance is artificially increased by an overtaking shock wave. It will be seen that not only is there a marked and sudden increase in the luminosity of the flame front but in the after-glow also.

The combination of the mixture 2CO + O₂ is complicated by dissociation in the flame gases, but this does not affect the interpretation of the photographs given above.

It has been suggested that a long-lived and stable form of latent energy resides in flame gases (as long as they remain in the homogeneous phase) which is probably located in metastable molecules of some

kind or other formed in the flame front⁵. For many purposes the term 'combustion level' is a more convenient one, by which is meant the ratio of the energy which can be accounted for in flame gases on the assumption that they are normal gases to the heat of combustion of the inflammable gaseous mixture.

Measurements show that the combustion level in ordinary flame gases (which are assumed to be similar to those left behind the initial slow movement of flame during its passage through inflammable mixtures at atmospheric pressure) is of the order of 72 per cent in carbon monoxide - oxygen - argon mixtures, 80 per cent in carbon monoxide - air mixtures, 83 per cent in methane - air mixtures and 85 per cent in acetylene - air mixtures⁶. The combustion level in flame gases left behind a 'detonating' flame front would approach 100 per cent owing to the high pressure in the flame front.

The combustion level in any given mixture may apparently have any value between some lower limit and a higher limit approaching 100 per cent. The not very intense luminosity of many oxy-gas flames suggests much lower combustion levels than those measured in air-gas flames.

W. T. DAVID.

Engineering Department,
University,
Leeds.
Dec. 9.

¹ *Phil. Mag.*, **18**, 307 (1934); **22**, 513 (footnote) (1936).

² *Phil. Mag.*, **21**, 280 (1936); **22**, 513 (1936); and in press.

³ *NATURE*, **130**, 930 (1932); and *Phil. Mag.* (in press).

⁴ *Phil. Mag.*, **9**, 390 (1930).

⁵ *NATURE*, **138**, 930 (1936); also *Phil. Mag.* (in press).

⁶ *Proc. South Wales Inst. Eng.*, 375 (1936).

Wave Mechanics of Couples (Neutron-Neutrino)

FERMI considers the β -decay as the transition of a 'heavy' particle from the neutral state (neutron) into a charged state (proton) with simultaneous emission of two light particles (electron, neutrino). I consider correspondingly the β -decay as a special case of processes in which a *couple of particles* (neutron - neutrino) are involved. The principal feature of these processes is the fact that the rest-mass of the single particle is not conserved, but only that of a couple as a whole. The accepted methods of quantum mechanics do not apply to this case; some new principle is required.

I reject the idea of introducing rest-mass as a *new* observable, since there is no variable known on which the corresponding operator should be applied. I shall show that a straightforward generalization of Dirac's method leads to a consistent theory of a couple of particles.

Let the co-ordinates of the two particles (in four dimensions; $x_4 = ict$) be x_k, X_k ($k = 1, 2, 3, 4$), the corresponding momenta $p_k = 1/i \delta/\delta x_k, P_k = 1/i \delta/\delta X_k$. Let $\gamma_1, \gamma_2, \gamma_3, \gamma_4$ be four Dirac matrices, $\gamma_k \gamma_l + \gamma_l \gamma_k = 0$ ($k \neq l$); $k, l = 1, 2, 3, 4$, chosen as real ($\gamma_k^+ = \gamma_k$) and normalized ($\gamma_k^2 = 1$).

Then the quantities $\gamma_{kl} = i\gamma_k \gamma_l, \Gamma = -\gamma_1 \gamma_2 \gamma_3 \gamma_4, \Gamma_k = i\Gamma \gamma_k$ are also real and normalized. We construct the most general operator Ω which is (1) a real number in the hyper-complex algebra of the γ 's, (2) linear in the p_k , (3) linear in the P_k , and for which (4) $\Psi^+ \Omega \Psi$ is a relativistic invariant ($\Psi(x, X)$ is a wave function with four components forming a

column, Ψ^+ its adjoint, forming a row); the form of Ω is uniquely determined, as

$$\Omega = A + B \sum_k \gamma_k p_k + C \sum_{kl} \gamma_{kl} (p_k P_l - p_l P_k) + D \sum_k \Gamma_k P_k + E \Gamma,$$

where A, B, C, D, E are real constants.

In analogy with Dirac's theory, we subject Ω further to the

Postulate: Ω^2 is free from spin quantities.

Since Ω^2 must be invariant, it must have the form

$$\Omega^2 = A^2 + B^2 \sum_k p_k^2 + C^2 \sum_{kl} (p_k P_l - p_l P_k)^2 + D^2 \sum_k P_k^2 + E^2.$$

The analysis of this postulate leads to the

Theorem: The necessary and sufficient condition for Ω^2 being free from spin quantities are the relations

$$A = 0, BD - CE = 0.$$

They reduce the five constants to three. As the dimensions of Ω do not matter, we can choose one constant as unity, say, $E = 1$. For the only two arbitrary constants left we introduce the notations $B = \lambda_0, D = \Lambda_0$ (Compton wave-lengths); then $C = \lambda_0 \Lambda_0$, and

$$\Omega = \Gamma + \Lambda_0 \sum_k \Gamma_k P_k + \lambda_0 \sum_k \gamma_k p_k + \lambda_0 \Lambda_0 \sum_{kl} \gamma_{kl} (p_k P_l - p_l P_k).$$

Here p_k and P_k have to be replaced by $p_k + \alpha \Phi_k$ and $P_k + \beta \Phi_k$, where the electromagnetic potentials Φ_k are symmetric functions of $x_k - X_k$ and α, β operators which transform any function of x_k, X_k into its symmetric resp. antisymmetric part. Then the wave equation can be derived from the variation principle

$$\delta \int \Psi^+ \Omega \Psi dx dX = 0.$$

For treating an assembly of particles one has to consider Ψ, Ψ^+ as observables (non-commuting quantities), and to apply the method of second quantization.

I have proved that this theory represents the electromagnetic forces and the nuclear 'exchange' forces by the same formalism.

MAX BORN.

University,
Edinburgh.
Nov. 26.

Interaction by Resonance of Radio Waves

DR. MARTYN and I have already given a quantitative theory of the phenomenon known as the interaction of radio waves¹. This theory has been found to be in good agreement with observation, and has in particular led to conclusions about the acoustic distortion of the impressed modulation which the subsequent observations of van der Pol and van der Mark adequately confirmed. There is, however, in this theory an inaccuracy of which I became aware about a year ago while engaged in a related investigation, and which at first sight appears of no great importance.

On revising the theory and establishing it on a more rigorous foundation, however, an unexpected and interesting consequence emerged, namely: that in regard to the amount of modulation which a wave W can impress on another wave W' , there may occur

a notable degree of resonance when the angular frequency ω of the wave W passes through the value Ω , where $\Omega = He/m$ is the 'gyro-frequency' corresponding to the total terrestrial magnetic force H in the part of the ionosphere concerned.

The theory also deduces, from the generally accepted body of knowledge about the propagation of radio waves and about the motions of electrons in air, that a radio-station the wave of which has an angular frequency within about 5 per cent of the local gyro-frequency can produce observable interaction with suitable medium and long waves when this station radiates power at the rate of about one or two kilowatts.

Among conditions favourable to the occurrence of such resonance-interaction the following are indicated: The received sky wave W' should be reflected from a region of the ionosphere the horizontal projection of which lies within about 200 kilometres from a 'gyro-station' and should have a minimum wave-length λ_m which depends on the distance D , between the radiator of W' and the receiver, somewhat as follows:

D (km.)	400	600	1,200
λ_m (metres)	2,000	1,200	500

These estimates of λ_m are made for the average nocturnal circumstances which Martyn² supposes to occur in the lower part of the E -layer, and much lower values of λ_m may be expected to correspond to certain abnormal conditions which are known to occur occasionally³.

After reaching these conclusions, I looked over some old issues of *World Radio* and was agreeably surprised to find the following report⁴ by the secretary of the World Radio Research League: "Mr. L. Thompson, of Ambleside, Westmorland, reports a background of Dublin (222.6 m., 0.2 kW.) on Athlone (531 m., 60 kW.). Here is apparently a shorter-wave affecting a longer-wave station. This was observed by Mr. Thompson on another occasion".

From such magnetic data as are available to me at present, the resonant wave-length in the E -layer half-way between Athlone and Ambleside is estimated to be about 232 metres, which differs by only 4 per cent from the wave-length of Dublin's radiation. Also the power radiated at the time of Mr. Thompson's observations might well have been 0.5 kilowatt, for that is the power officially assigned to Dublin's station in the issue of *World Radio* published two weeks after that in which the observations were reported.

The fact that the radiation interfered with has a wave-length as low as 531 metres leads to the conclusion that in those parts of the E -layer concerned with the interaction, a gradient of ionization existed which considerably exceeds those adopted by Martyn².

A survey of contemporary European and American wave-lengths and powers shows that among others the following broadcasting stations may be found to produce by resonance-interaction observable backgrounds in the waves received from other sources: Monte Ceneri (257.1 m.), Freiburg (251), Frankfurt (251), Lille (247.3), Radio Marconi (245.5), Cork (241.9), Saarbrücken (240.2), Nürnberg (236.8), Klagenfurt (231.8), Vorarlberg (231.8), Malmö (228.7), Kiel (225.6), Hanover (225.6), Stettin (225.6), Dublin (222.6), Oklahoma City KOMA (202.7), Nashville WLAC (204.1), Los Angeles KECA (209.8). It would be of great interest to know whether any readers

of NATURE have already observed this interaction by resonance, or can observe it in connexion with any of the stations given above.

If observations could be made with a station the frequency of which may be varied about the gyro-frequency, they could be used to determine at least two important quantities, namely, the values in the E -layer of the electron collision frequency and of the earth's magnetic force. In Australia there are unfortunately no stations suitable for this purpose, but I hope shortly to visit Europe and would be glad to have reports, on any relevant observations that may be made, addressed to me at the Queen's College, Oxford.

A fuller discussion of the theory will be published elsewhere in due course.

V. A. BAILEY.

Department of Experimental Physics,
University, Sydney.
Nov. 5.

¹ Bailey, V. A., and Martyn, D. F., NATURE, 133 (Feb. 10, 1934); *Phil. Mag.*, 18 (Aug. 1934).

² Martyn, D. F., *Proc. Phys. Soc.*, 47, 323 (1935).

³ Appleton, E. V., *Proc. Roy. Soc. A*, 126, 567 (1930).

⁴ *World Radio*, Feb. 8, 1935, p. 22.

Radio and Magnetic Observations at North-East Land during the Total Solar Eclipse of June 19, 1936

RADIO observations on the solar eclipse of June 19, 1936, were made by the Oxford University Arctic Expedition 1935-36 in North-East Land at 80° 23' N., 19° 31' E. in accordance with the programme arranged by a sub-commission of the U.R.S.I. One complete record showing the relationship between the equivalent height of reflection and the frequency of the exploring wave was obtained in steps of 0.2 mc./sec. The records, each of which took ten minutes to secure, were centred on each hour and half-hour from 03.30 to 07.30 G.M.T. on June 18, 19 and 20, 1936 (Fig. 1). Short-period variations would not therefore be observed.

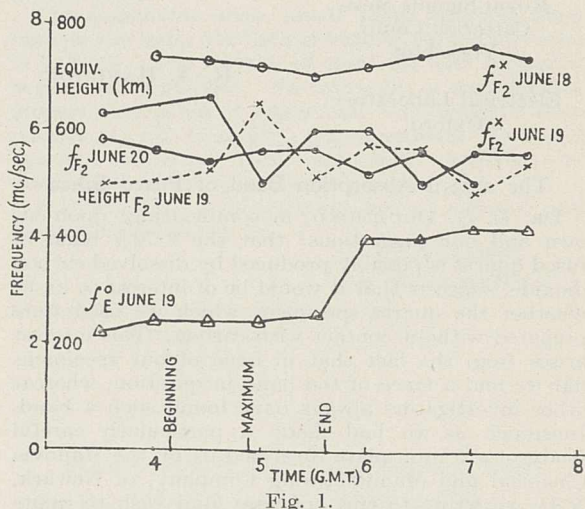


Fig. 1.

The eclipse began at 04.10, was a maximum, 25 per cent in area, at 04.54 and ended at 05.40. At the height of the reflecting layers the times of the eclipse differ by only a few minutes from those at sea-level. Conditions were magnetically quiet on June 18, but were greatly disturbed on June 19 and 20, as shown

in the declination traces (Fig. 2), and this fact makes it difficult to interpret the exact effects of the eclipse. The magnetic disturbance is reported on a world-wide scale and appears to have begun about 17.45 G.M.T. on June 18. The most significant facts emerging from our observations are:

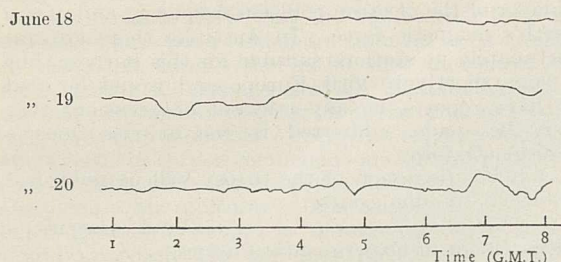


Fig. 2.

(1) On June 18 and 20, f_E^0 rose fairly steadily from 03.30 to 07.30, but on June 19 it was below the average before and during the eclipse, and rose suddenly to a value above the average of June 18 and 20 immediately after the eclipse. Previous eclipse results have shown that f_E^0 decreases when the ultra-violet light is cut off, but it is probable that in our case it was from the abnormal Region E that echoes were obtained. The persistence of echoes from the region beyond the critical frequency makes the determination of the exact value of this frequency difficult.

(2) On June 18 and 20 the ionization density of Region F increased as the day advanced. On June 19, however, after 05.30 it became vestigial and remained so until 07.30, but the ionization had increased again by 10.30, local noon.

(3) The height of Region F_2 was greater on the morning of the eclipse than on the other two mornings. At the time of maximum eclipse, it showed a marked increase in height, and $f_{F_2}^0$ decreased appreciably, showing a marked minimum.

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The 2.73μ Absorption Band of Fused Silica

DR. D. G. DRUMMOND, in commenting¹ upon his own and our suggestions² that the 2.73μ band of fused quartz is possibly produced by dissolved carbon dioxide, suggests that it would be of interest to know whether the quartz specimens which we used were prepared without contact with carbon. This interest arises from the fact that in none of our specimens did we find a trace of the band in question, whereas other investigators always have found such a band. Inasmuch as we had made a particularly careful study of a 5 mm. plate furnished us by the Hanovia Chemical and Manufacturing Company, of Newark, N.J., we wrote to this company and wish to quote them as follows: "Quartz specimens of our manufacture are prepared between carbon blocks and fusion is done with flames containing carbon dioxide. As a result, our quartz has an excellent opportunity to dissolve carbon dioxide gas." Inasmuch as we found no trace of the 2.73μ band in this company's product, it seems that the impurity which enters in

some methods of manufacture must be other than carbon dioxide. We made observations on several other samples, some of which were probably furnished by other companies, but we are unable to make a complete trace of the records of purchase.

In our previous letter², we gave our reasons for believing that the impurity involved may be water vapour. Evidence for the existence of either carbon dioxide or water vapour could doubtless be obtained either by Dr. Drummond or by some other experimenter possessing a fused quartz specimen several centimetres in thickness which shows the 2.73μ band. This could be done by locating higher overtone bands in the region of waves shorter than 2.7μ . In support of the water vapour hypothesis, we wish to point out that if this appeared as an impurity to the extent of only a few tenths of one per cent, it would account for the depths of the 2.73μ absorption band even in the cases of those earlier investigations in which the bands appeared with considerable intensity.

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¹ Drummond, *NATURE*, **138**, 248 (1936).

² Ellis and Lyon, *NATURE*, **137**, 1031 (1936).

THE note by Drs. Ellis and Lyon appears to leave no longer tenable the hypothesis of carbon dioxide impurity as the cause of the 2.73μ absorption band in fused silica. They suggest searching for higher overtone bands as a method of identifying the impurity. From my published curves¹ in the shorter wave-length region, it will be seen that though the 2.73μ band appears with considerable intensity in Section C (29.85 mm. thickness) the water vapour bands near 1.36μ and also 1.87μ are absent, though they might have been expected with intensities of the order of 10–20 per cent. The water vapour band near 6μ would not be expected to show, even if present, in Section H (0.109 mm. thickness), since here the thickness of material is much too small.

I should mention that in curve A , in my paper quoted, the resolving power was too low to decide whether narrow bands were present, the great length of this specimen preventing the utilization of the full resolving power of the apparatus.

I have observed this 2.73μ band also in emission from hot fused silica, and intend publishing a note to describe this work.

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¹ Drummond, *Proc. Roy. Soc., A*, **153**, 328 (1936).

Mechanism of the Diastole of Contractile Vacuoles

It is still not known what causes the passage of fluid from the cytoplasm into the contractile vacuole of a protozoan. In a recently published paper¹, Picken has claimed that the rate of this "infiltration" of fluid into the vacuole will be proportional, among other things, to the difference between the hydrostatic pressure of the cytoplasm (which is maintained by tension on the pellicle) and the colloid osmotic pressure of the cytoplasm, the former tending to produce infiltration and the latter to prevent it. The system which Picken has envisaged appears to resemble the excretory mechanism of vertebrates

and possibly of certain higher invertebrates, in which fluid is filtered from blood vessels under pressure from the heart through colloid-retaining membranes (for example, the glomerulus) into renal tubules.

Such an explanation is not applicable in the case of the Protozoa. During diastole, the contractile vacuole has no connexion with the exterior, and is completely surrounded by more or less fluid cytoplasm; this cytoplasm is in turn surrounded by the pellicle. Infiltration of fluid from the cytoplasm into the contractile vacuole cannot reduce the volume of substance enclosed within the pellicle; therefore tension on the pellicle, or in other words the hydrostatic pressure of the cytoplasm, cannot be the cause of infiltration.

This view is supported by my own observations. Sometimes when the marine ciliate *Cothurnia* is transferred to very dilute sea-water, it swells so violently that the pellicle bursts, and a blister is produced in which the cytoplasm is separated from the external medium only by a very thin protoplasmic membrane. It may be presumed that such a membrane could not withstand nearly so great a mechanical pressure as could the normal pellicle, and yet at first under these conditions the vacuole may increase in volume very rapidly; systole, however, is often incomplete. Again, when a *Cothurnia* is transferred from a solution of lower to one of higher osmotic pressure, it shrinks and frequently the pellicle becomes wrinkled; and yet the contractile vacuole continues to function (although at a reduced rate).

The possibility of simple osmotic uptake of water into the contractile vacuole has already been discussed and discarded². Both theoretical and practical considerations lead to the conclusion that during diastole water is forced into the contractile vacuole against the osmotic gradient by some unknown secretory process. No other hypothesis is consistent with the osmoregulatory theory of contractile vacuoles—a theory for which much evidence has already been presented^{2,3}, and for which much additional support has now been obtained in experiments on freshwater Protozoa. It has been found that the contractile vacuoles of certain freshwater peritrich Ciliates are inhibited to a large extent by cyanide, and that this treatment is followed by a swelling of the body. The results so far obtained suggest that the contractile vacuole maintains a difference of osmotic pressure across the body surface approximately equivalent to a 0.05 molar solution of a non-electrolyte.

Further experiments are in progress.

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Dec. 13.

¹ Picken, L. E. R., *J. Exp. Biol.*, **13**, 387 (1936).

² Kitching, J. A., *J. Exp. Biol.*, **11**, 364 (1934).

³ Kitching, J. A., *J. Exp. Biol.*, **13**, 11 (1936).

Inheritance of a Differential Growth-Ratio

THE relation between the sizes of two growing organs of an animal or plant is given by the equation $y = bx^k$, where y is the size of one organ at any given time, x is the size of the other organ, b is a constant, and k is the differential growth-ratio. It can be readily shown that if α and β are the relative growth-rates of the two organs, then $k = \alpha/\beta$. The

application of this formula has so far been limited almost entirely to the study of animal growth, but we have recently employed it in the study of the growth of tomatoes. We have also obtained preliminary data on the mode of inheritance of the differential growth-ratio in the first filial generation.

Populations of a tall species of *Lycopersicum* (*L. racemigerum*), and a dwarf strain of the tomato (*L. esculentum* var. "Chinaman") were grown side by side with a population of first generation hybrids (*L. rac.* × "Chinaman") which exhibited marked heterosis. Dry weight samples were taken during the flowering period up to the twenty-third week after sowing. The differential growth-ratio between stem weight and leaf weight for each of the three strains was found to remain constant over the duration of the experiment, the following values being obtained: *L. racemigerum* = 1.36; "Chinaman" = 1.06; F_1 hybrid = 1.30. k for the hybrid was not intermediate between the parental values but closely resembled that of the tall parent, so that it is inherited in the first generation in the manner of a simple dominant. Thus, in its mode of inheritance, the differential growth-ratio resembles the other physiological characteristics which have been investigated, namely, the efficiency index, assimilation rate and respiration rate.

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Permanganates and Plant Growth

IN preliminary tests carried out during the last few years, it was observed that the application of potassium permanganate to various plants was followed by a marked growth response, and in this connexion a series of controlled pot experiments was carried out with the cactus *Opuntia Leuchotricha* in quartz sand.

Permanganates were much more effective than manganous salts, but both produced marked increases in growth. The uptake of minerals also depended largely on treatment. For example, a considerably greater absorption of manganese was obtained from manganous salt than from permanganates. It would appear, therefore, that the effect produced by permanganates is not wholly manurial.

Further work is in progress, and an account will be published shortly.

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Dec. 7.

Stereochemistry of Bivalent Tin and Lead

SEVERAL bivalent metals (nickel, palladium, platinum, copper and silver) are known to exhibit a planar distribution of valencies in their quadri-valent co-ordination compounds. On the other hand, it has been shown that, in certain derivatives of quadrivalent platinum and univalent copper and silver¹, the four valencies of the metal atom have a tetrahedral arrangement, so that it appears highly

probable that the bond distribution of quadri-covalent metals is determined by their principal valency. We have now examined some derivatives of bivalent tin and lead, and find, in agreement with this view, that they are planar. It is well known that quadrivalent tin and lead, like carbon, silicon and germanium, show a tetrahedral disposition of valencies; quadrivalent tin is of particular interest, since it furnished one of the first examples² of optical activity due to an asymmetric atom other than carbon.

The bivalent tin compounds examined by X-ray methods include the isomorphous double halides $R_2[SnX_4]2H_2O$ ($R = K$ or NH_4 , $X = Cl$ or Br). The unit cell of potassium chlorostannite has dimensions $a = 12.02$, $b = 9.11$, $c = 8.23$ A., and contains four molecules. The symmetry of its space group, $Pnma$, requires the ion $[SnCl_4]^{--}$ to have either a plane or a centre of symmetry, but the former appears to be excluded by the intensities of the X-ray reflections, and the four valencies of the central tin atom are therefore centro-symmetrical, that is, coplanar. The results exclude the possibility of a hexavalent complex $[SnCl_4 \cdot 2H_2O]^{--}$.

With Mr. K. C. Webster we have also studied the following compounds of bivalent lead: potassium plumbo-oxalate, di-thiourea lead chloride, lead salicylate and lead bis-benzoylacetone. In the case of the first three, the smallest cell dimensions (4.03, 3.99 and 4.85 A., respectively) alone exclude the possibility of tetrahedral structures. Di-thiourea lead chloride, $PbCl_2 \cdot 2CS(NH_2)_2$, has cell dimensions $a = 20.67$, $b = 3.99$ and $c = 11.98$ A., and space group Pna . In addition to the space group halvings, all planes with h odd give exceedingly weak reflections, and the molecule therefore very nearly has a plane of symmetry parallel to (010). This is only possible if it is nearly or quite flat. Lead bis-benzoylacetone has cell dimensions $a = 23.41$, $b = 7.77$ and $c = 9.96$ A., the space group being Pcn . Here also additional pseudo-halvings occur, showing that the molecule very nearly has C_{2v} symmetry, which is only possible if it has a planar configuration.

The detailed results of the analysis of these compounds will be published elsewhere.

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Dec. 16.

¹ Cox, Wardlaw and Webster, *J. Chem. Soc.*, 775 (1936); Mann, Purdie and Wells, *J. Chem. Soc.*, 1503 (1936).

² Pope and Peachey, *Proc. Chem. Soc.*, 42, 116 (1900).

Realgar in Wookey Hole, Somerset

SOME two years ago, when examining relics from Wookey Hole, kept in the Wells Museum, I noticed a vessel containing a small amount of a ruby-coloured powder, closely resembling realgar or ruby sulphur. Mr. H. E. Balch, the curator and well-known authority on Wookey Hole, informed me that the powder was found in the Roman stratum of the cave floor. He courteously gave me a small sample which I later submitted to chemical tests and confirmed my first impression.

Realgar is found widely distributed in many parts of Europe, but so far as I am aware, it has never been found in Britain. How, then, did the specimen come to be in Wookey Hole? Mr. Balch, in answer to my query, stated that no mural paintings had been discovered so far in the Mendip caves, which rendered it improbable, though not impossible, that the realgar had been imported for mural decorative purposes.

Since then my attention has been directed to the belief that realgar was used medicinally by the Assyrians¹; it was recommended by the Greek herbalist Dioscorides, c. A.D. 50, under the name of sandarach, for inhaling when burned with resin; finally Pliny² in his "Natural History" refers to its use for a variety of medical purposes. Thus he says: "Taken with the food, in combination with turpentine, it is a pleasant [*sic*] cure for cough and asthma. In the form of a fumigation also, with cedar, it has a remedial effect upon those complaints."

As Wookey Hole is very damp, we can visualize its inhabitants suffering from bronchial affections; it seems reasonable to suppose that the realgar had been imported for medical use.

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Nov. 27.

¹ See Partington, "Origins and Development of Applied Chemistry", p. 317 (1935).

² Bostock and Riley's Translation, Book 34, chapter Iv.

The Hexlet

CIRCLES which touch cyclically may be called a ring. Two rings will touch when each member of the one touches each member of the other; and so for spheres.

Prof. Soddy has given in verse¹ the notable theorem that, given a three-ring of spheres, and beginning with any sphere touching it, the sphere belongs to a six-ring touching it.

A proof is as follows.

A penny on a plane can be touched by a ring of six pennies, poristically (that is, beginning where we please). Thus a unit sphere on a plane can be touched by a ring of six unit spheres. On the seven can be laid a second plane, parallel to the first plane. Under inversions, parallel planes are touching spheres. Thus we have the Soddy configuration of a three-ring touched by a six-ring, in its initial form.

When we discuss contacts of spheres, the spheres are directed. A normal, and thereby all normals, carry an arrow-head. The contact of two directed spheres is positive when the arrow-heads agree, otherwise negative. For a ring of three spheres the contacts can not be all positive. We take them all negative. Thus contact here means negative contact. In the initial case, the seven unit spheres have all negative contact. We have a ring of three spheres with bends b_1, b_2, b_3 touched by a ring of six spheres with bends b_4, b_5, \dots, b_9 .

Prof. Soddy's formula is

$$b_4 + b_7 = 2(b_1 + b_2 + b_3).$$

Initially, $b_4 = b_7 = 1$, $b_1 = 1$, $b_2 = b_3 = 0$. Thus the formula is true initially.

Under an inversion $OP.OP' = K$, if P is on a sphere with centre O and radius r , bend $b = 1/r$, then P' is on a sphere with bend

$$b' = b(OC^2 - r^2)/K.$$

If P is on a plane (directed of course) at a distance δ from O , then P' is on a sphere with bend $b' = 2\delta/K$.

Hence

$$Kb'_1 = OC_1^2 - 1$$

$$K(b'_2 + b'_3) = 4$$

$$Kb'_4 = OC_4^2 - 1$$

$$Kb'_7 = OC_7^2 - 1.$$

Also since C_1 is the mid-point of C_4 and C_7 , and at a distance ± 2 from them,

$$OC_4^2 + OC_7^2 = 2(OC_1^2 + 4).$$

Hence, in general,

$$b'_4 + b'_7 = 2(b'_1 + b'_2 + b'_3).$$

Similarly,

$$b'_4 + b'_6 + b'_8 = b'_5 + b'_7 + b'_9 = 3(b'_1 + b'_2 + b'_3).$$

The argument in this form is only good for a flat space.

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¹ NATURE, 138, 958 (Dec. 5, 1936).

Points from Foregoing Letters

THE discovery of a fossil insect (a protodipteron from the Upper Permian of Warner's Bay, N.S.W.) which throws light on the evolution of two-winged insects (Diptera) from four-winged ones, is reported by Dr. R. J. Tillyard. The author gives a list of the stages which have led to the evolution of Diptera during the period between the Upper Permian and the Upper Trias.

To explain the discrepancy between the temperatures and pressures observed in gaseous explosions (neither of which reach the calculated values), Prof. W. T. David assumes that the effective pressure is the instantaneous pressure in the flame front. He reproduces two photographs of flame travel by Bone and Frazer, from which he infers that the temperature of the flame increases as the pressure in the flame front increases. Prof. David introduces the concept of 'combustion level'—the ratio of the energy which can be accounted for in the flame gases, to the theoretical heat of combustion.

By a generalization of Dirac's method, Prof. Max Born develops a theory of the emission of electrons in atomic transformations, as a special case of processes in which a pair of particles (neutron and neutrino) is evolved, the principal feature being that the rest-mass of a single particle is not conserved, but only that of the pair as a whole. The theory represents the electromagnetic forces and the nuclear 'exchange' forces by the same formalism.

Further developments of the theory of the interaction of radio waves leads Prof. V. A. Bailey to the conclusion that a notable degree of resonance may occur when the angular frequency of the wave which causes interaction approximates to the 'gyro-frequency', corresponding to the total terrestrial magnetic force in the part of the ionosphere concerned. He further deduces that observable interaction may be caused by a station which radiates power at the rate of 1 or 2 kilowatts when its frequency is within 5 per cent of the relevant gyro-frequency. A list is given of stations which may be found to produce resonance-interaction.

Radio and magnetic observations made during the solar eclipse last June at North-East Land are reported by A. B. Whatman and R. A. Hamilton. The ionization density of the F region became very small during the eclipse. The f_{H}^o layer of the ionosphere was below the average before and during the eclipse but rose above the average after the eclipse, and the height of the $f_{F_2}^x$ layer was at a minimum during the eclipse while that of the F_2 region increased.

The origin of the absorption band at 2.73μ in certain specimens of fused silica remains unexplained. Dr. J. W. Ellis and Dr. W. K. Lyon state that a specimen which did not show this absorption band nevertheless probably contained carbon dioxide, so that carbon dioxide cannot be the cause of the absorption band. On the other hand, Dr. D. G. Drummond reports that a specimen which shows the band at 2.73μ does not show the water vapour bands at 1.36 and 1.87μ , which rules out water as the source of the former band.

The expansion of the contractile vacuoles of Protozoa cannot be explained, according to Dr. J. A. Kitching, merely by reference to the hydrostatic pressure of the cytoplasm. Experiments on freshwater Protozoa give further support to the osmoregulatory theory, which implies an active secretion at the vacuolar surface.

Dr. E. Ashby and L. C. Luckwill find that when a dwarf strain of the tomato is crossed with a tall variety of a nearly related species (*Lycopersicon racemigerum*), the growth-ratio between stem-weight and leaf-weight in the hybrid is not intermediate between that of the parents but is inherited in the manner of a 'simple dominant'. In this it resembles other physiological characteristics, namely, the efficiency index, the assimilation rate and the respiration rate.

A marked growth response of plants to permanates has been further investigated by M. E. Webster and Dr. I. M. Robertson by means of controlled pot experiments with the cactus, *Opuntia Leuchotricha*.

Dr. E. G. Cox, A. J. Shorter and Dr. W. Wardlaw state that X-ray studies of several quadricovalent derivatives of bivalent tin and lead show that those metals can possess a planar distribution of four valencies. As tin and lead with a principal valency of four have a tetrahedral distribution of bonds, it appears that in these cases, as with copper, silver and platinum, the principal valency determines the arrangement of their atoms.

Dr. J. Newton Friend suggests that realgar (arsenic disulphide) found with Roman remains at Wookey Hole, Somerset, had probably been imported for medicinal purposes.

Dr. F. Morley gives a formal proof of the hexlet, which should be read in conjunction with Prof. Soddy's article (p. 77) and the note on p. 62.

Research Items

Races on the North-West Frontier of India

THE physical anthropology of the inhabitants of central Asia is known only from the measurements taken by Sir Aurel Stein on his various journeys of exploration. To three series already recorded a fourth has now been added—measurements of the inhabitants of the valleys of Hunza in the Gilgit Agency and Swat in the North-West Frontier Province. These have been subjected to statistical analysis by Dr. G. B. Morant (*J. Roy. Anthropol. Inst.*, 66, Pt. 1). The series from the Swat Valley consists of 54 men of Torwali (classified on linguistic grounds as Dards) and 25 Pathans. The people of Hunza, which lies at the junction of India, Chinese Turkestan and Afghanistan, are the people speaking Burushaski, a tongue related to no known language. Part of their valley has been occupied by Wakhi. 75 Hunza men and 25 Wakhi were measured. The principal measurements are as follows: Torwali, cephalic index 75.3, nasal index 68.1, stature 1,688.8; Pathan, cephalic index 76.9, nasal index 72.0, stature 1,654.8; Hunza, cephalic index 79.6, nasal index 71.4, stature 1,688.1. Dr. Morant from his analysis of the material concludes that the Pathans differ from the Torwali in having smaller head-lengths, facial height and stature and relatively broader faces and noses. Between the Hunza and Torwali the significant differences are the head length, head breadth, and cephalic index, nasal height and nasal breadth. The men of Hunza have the smaller head length and the larger head breadth, so that the mean cephalic index is apparently the larger and nasal height and breadth the smaller. The Hunza-Pathan series differs significantly in head breadth, cephalic index, nasal height, nasal breadth, stature and facial height. The two elements in the Swat valley are more nearly akin to one another than either to the men of the Hunza valley. The Pathan is less variable than the Torwali and both are less variable than the Hunza—a remarkable and unexpected result.

Ivory Arrow-Straightener from Alaska

AN ivory arrow-straightener of considerable interest has recently been presented to the British Museum (Bloomsbury) by the Trustees of the Christy Fund. It has been described and figured by Mr. A. Digby (*Brit. Mus. Quarterly*, 11, 1). It resembles a spanner with an oblique rhomboid hole at one end. The handle terminates in a bear's head, the eyes of which are inlaid with wood; while at the other end beyond the hole are two smaller bear's heads. On all four surfaces small figures have been scratched with a stone point, or perhaps an iron nail. They depict either individual animals, seals and caribou, or scenes from Eskimo life. The back shows large and small deer, two of which leave footprints, an unusual feature in Eskimo art, and a hunting scene on the right-hand edge. A man paddling a kayak and flourishing a lance chases five caribou, while behind him are the floating carcasses of three more. On one edge of the left-hand side is a similar scene. These scenes depict a method of hunting frequently adopted in autumn. The other figures on this side are a lone caribou, a row of dancing figures, three conical tents,

such as are used in summer, and an Alaskan sledge. On the other side is a village scene showing summer tents, drying frames and human figures. A man is shooting at a row of birds represented by crosses. The front, or lower surface, is covered with figures, which may be seal or walrus. There are two human figures; at the lower end is the figure of a crawling man; and at the other end a man attacking a seal. The straightener is probably a tally recording the kill of the owner. The date is difficult to determine, but comparison with a drill bow in the Barrow Collection suggests the beginning of the nineteenth century.

Physiology of Flute Playing

THE rumour that players of wind instruments run the risk of respiratory diseases is still current in musical circles, although there has never been much scientific foundation. Jagic and Lipinfr (Wien, *Klin. Wschr.*, 32, 683 and 714; 1919) examined medically (including X-ray) 46 professional wind players who had played 4–5 hours a day for periods varying from 10 to 50 years. They found no case of emphysema or other lung disease among them. Dr. J. Roos ("The Physiology of Playing the Flute", *Arch. Néerland. Phon. Exp.*, 12, 1; 1936) reports data of interest bearing on the same question. Three professional flautists were submitted to a number of physiological tests while playing. The air pressure exerted was measured, in relation to the pitch of the note, and its loudness, on both of which factors it depends. The range of pressures was of the same order as those found by other workers for singing. The mechanism of giving air at well-regulated pressures through the lips is discussed. The velocity of the air leaving the flautist's mouth was equal to that of a hurricane, even for low notes.

A New Nemertine

IN 1931, W. J. Dakin and M. G. C. Fordham announced the discovery of a new type of nemertine worm with a multibranching proboscis, *Gorgonorrhynchus repens*. Now a complete description of this unusual animal is furnished by the same authors (*Proc. Zool. Soc.*, 1936). It is shown that while it undoubtedly represents a new and remarkable genus, it is a member of the family Lineidæ of the Heteronemertini. When introverted, the proboscis lies in a closed cavity, the rhynchocœlum, on the dorsal side of the alimentary canal. When everted, the proboscis is a hollow dichotomously branched dendriform structure. At the beginning of the eversion, a single stump appears; this divides into two, four and finally a large number of fine branches. The tips of fine ends can be seen during retraction through the transparent walls. It is this much-branched proboscis, without parallel in the nemertines, that is the outstanding feature of the species. In spite of this, however, the general structure of *G. repens* shows clearly its relationship. The first specimens were found on the coast of New South Wales but afterwards from farther north on the same coast, from islands in the Great Barrier Reef, from India, and recently a worm of the same genus, if not indeed conspecific, has been sent to the authors from Bermuda.

Pycnogonids from Puget Sound

THE above is the title of a paper by Harriet I. Exline (*Proc. United States Nat. Mus.*, 83, No. 2991; 1936) in which five species are described, three of which are new. All were collected on dredging expeditions of the University of Washington's research ship *Catalyst*. Pycnogonids are not commonly dredged in Puget Sound, but they are sometimes found in large numbers in certain isolated localities. In the waters around the San Juan Islands, which have been quite thoroughly investigated, probably only half a dozen specimens have been collected in the past ten years. On the other hand, with the investigation of the waters south of the San Juan, especially in the vicinity of McNeils Island, pycnogonids have been collected in large numbers among hydroids dredged from rocky bottoms. Two of the new species belong to the genus *Nymphon* and one to *Ammonothea*.

Virus Diseases of the Potato

THE number of virus diseases which attack the potato, with their permutations and combinations, render the study of this branch of science rather complicated. Viruses are, fortunately, capable of classification into definite groups, and with exchange of material between the workers in Holland, Great Britain and America, the relations of the different virus complexes are gradually being elucidated. A recent paper by Prof. P. A. Murphy and J. B. Loughnane (*Sci. Proc. Roy. Dub. Soc.*, 21, No. 40; Sept. 1936) compares some Dutch and Irish potato mosaic viruses. The diseases from Holland show the presence of the viruses designated X, B, Y, A, F, and vein-bending virus, and they occur either alone or in combinations. Slight variants from the forms A and Y were found, and the viruses X, Y and F did not always produce symptoms upon their hosts. Complex-diseases included veinal mosaic (Y or A), rugose mosaic or leaf-drop (X + Y), crinkle (X + A), and interveinal mosaic (X + F). The paper should make a material contribution to an international understanding of potato virus nomenclature. It should be read in conjunction with the American work upon the same subject (K. Koch and J. Johnson, *Ann. App. Biol.*, 22, 37; 1935). The potato virus known as aucuba mosaic has received detailed study from Dr. Phyllis Clinch, J. B. Loughnane and Prof. P. A. Murphy (*Sci. Proc. Roy. Dub. Soc.*, 21, No. 41; Sept. 1936). The aucuba virus produces a typical yellow mottle upon the leaves, but this type of symptom also appears with two other viruses, namely, the 'tuber-blotch' virus, and a virus latent in the Dutch potato *Monocraat*. These last two are probably identical, and it is proposed to designate them virus F, whilst virus G shall denote the active principle of aucuba mosaic.

Economic Effects of Sugar Cane Streak Disease

WHEREVER the effects of a virus disease upon a crop of economic importance have been investigated, some striking figures are brought to light. Messrs. A. P. D. McClean and R. H. Halse have made a large-scale survey of the sugar-cane districts of South Africa, which should leave no one in any doubt about the economic significance of the streak disease (*Proc. S. Afr. Sugar Technologists' Assoc.*, 1936). Approximately 241,220 tons of cane, with a value of £170,864, were lost in 1934-35, as a result of its

ravages. Zululand had the heaviest infection, more than ninety per cent, the Natal districts south of Durban had 62 per cent on ratoon cane, and 48 per cent on plant cane. North of Durban, the disease was less severe, with 26 per cent and 19 per cent on ratoon and plant cane, respectively. The paper also makes some constructive investigation of several of the new varieties which have recently found favour in commercial practice. Those designated Co 290 and POJ 2725 are moderately resistant, whilst the POJ varieties 2714, 2722, and 2878, with Co 281, are highly resistant. One is left with the impression that the streak disease may well be controlled in the near future.

Time Discharge of Condensers

EVERYONE who has experimented with electric condensers knows that some types absorb a certain amount of electricity which does not come back immediately when the condenser is discharged. It is gradually liberated and accumulates on the plates as a residual discharge. This 'oozing out' effect is sometimes explained by assuming that a process analogous to viscous action is taking place, and that this prevents the immediate return to the normal state. The amount of the residual charge and the relaxation rate at which it is freed are of importance to the telephone engineer owing to the large number of condensers used in telephone apparatus. The explanation of the effect usually given starts with the assumption that dielectric absorption is due to an action of the molecular structure which takes place uniformly throughout the material. In a paper on this subject by W. A. Yager in the *Bell Laboratories Record* of November, it is shown that the relaxation effect is much too complicated to be explained in this simple way. The results show that the residual current involves a combination of relaxation times. A successful explanation has been made by K. W. Wagner, who postulates that the number and magnitude of the relaxation times are determined by the laws of chance. For the simple theory we get fair agreement for dielectrics, like pure liquids, of relatively simple constitution. But for dielectrics of even moderate complexity the simple formula is practically worthless. Wagner's equations appear to be applicable to systems of all degrees of complexity and it is concluded that a helpful advance in the theory of dielectric action has been made.

High-Permeability "Furukawa Magnetic Alloy"

IN the September issue of the quarterly journal *Nippon Electrical Communication Engineering*, published in English by the Institute of Telegraph and Telephone Engineers of Japan, there is an important article on the new high-permeability magnetic alloy made by the Furukawa Electric Co., Ltd. In low magnetic fields it is known that this new alloy has a much higher permeability than the English mumetal. Its composition is now described, and we are told that its manufacture is protected by Japanese patents. It is manufactured in four grades called A, B, C and D respectively, each being suitable for specific purposes. These alloys are uniform and easy to work at any temperature. They can be rolled into transformer sheets as thin as 0.1 mm. or drawn into very fine wire. The time required for the heat treatment of these alloys is very short, and after taking the metal from the furnace it can be cooled

in the air. The *A* alloy is of very high electric resistance, and is specially suited for the magnetic core of high-frequency devices. The characteristics of the *B* and *C* alloys show that they would be very suitable for use with audio-frequency transformers. The alloy *D* has extraordinarily high permeability, and is highly recommended for the iron cores of very sensitive relays and ammeters for use in electric power lines. By using the alloys for the cores of the transformers employed in aeroplanes, their weight has been reduced to one fifth of the ordinary values. A photograph is shown of a transformer core made of stalloy having a weight of 1,010 gm. and of another made of the new magnetic alloy fulfilling the same functions and weighing only 75 gm.

Atomic Weight of Arsenic

IN 1933 Baxter and Shaefer carried out two series of estimations of the atomic weight of arsenic by analysis of the tribromide and obtained the values 74.919 and 74.901 respectively. This led to the acceptance of the value 74.91 for the atomic weight of arsenic. This is 0.02 units below that found by Křepelka in 1930, which was adopted at the time by the International Committee for Atomic Weights. Křepelka and Kočnar have now (*Coll. Czech. Chem. Comm.*, 8, 485; 1936) synthesized arsenic tribromide from specially pure bromine and arsenic, and from determinations of the ratios $\text{AsBr}_3 : 3\text{Ag}$ and $\text{AsBr}_3 : 3\text{AgBr}$ they arrive at the new value 74.923, which thus lies between what were hitherto regarded as the most trustworthy determinations. This new value agrees better with Aston's value derived from the mass spectrum ($\text{As} = 74.934$, or 74.925 according to Babcock and Naudé) than the value found by Baxter and his collaborators. Křepelka and Kočnar have taken every precaution to use highly purified materials throughout their work, and whilst the new value lessens the discrepancy between the earlier values of Křepelka and Baxter respectively, there is still a difference of 0.01 unit. The same journal contains a paper from Prof. Moles of the Madrid Instituto Nacional de Física y Química dealing with the atomic weight of iodine and advocating the value $I = 126.917$.

Locomotive Fuel Economy

INVESTIGATIONS into the problems of combustion in locomotive boilers and prevention of fuel wastage have in the past been hampered by lack of a method for determination of unburnt fuel loss. A suitable technique has, however, now been evolved on the basis of a suggestion put forward by A. C. G. Egerton, and this was described in a paper by Dr. P. Lewis-Dale at a meeting of the Institute of Fuel on November 25. The principle of the technique is to carry out experiments similar to those usually employed for stationary boilers on the locomotive boiler while it is actually in service. This involves analysis of the exhaust gas, measurements of rate of combustion, amount of unburnt carbon and temperature of exhaust gases. In addition, analyses of the coal used, weighing and analysis of the ashpan ashes and various temperature measurements are essential to accurate interpretation of results. The investigation is in every case designed to last throughout a complete journey of the engine, and thus varying conditions of gradient, curves and wind are taken into account. A number of valuable observations have been made

as a result of investigations of this description, the most valuable conclusion reached being that under certain working conditions the loss of heat due to unburnt carbon approximates 30 per cent of the heat which would have been generated by complete combustion of all coal fed to the furnace.

Automatic Starting Resistances

ON switching on electrical machines, very large currents may be obtained initially unless suitable starting 'resisters' are used. These resisters are varied by hand, being large resistance at the start when the counter electromotive force due to the rotating armature is zero and being all cut out when the machine is running at full speed. In the *Philips Technical Review* (Eindhoven) of July a description is given of new automatic starting resistances manufactured by the firm. The starting tubes, which have the trade name of 'starto' tubes, have a large negative resistance coefficient, that is, the higher their temperature the less their resistance. In this respect they are similar to the filament of an electric lamp or to a glass rod, which at ordinary temperatures has a very high resistance but when red hot has comparatively a very low one. These tubes work on the exactly opposite principle to the hydrogen-filled iron filament resisters, sometimes used as regulators, the resistance of which increases rapidly with the temperature. In starto tubes the semi-conductor used is a mixture of silicon and a ceramic 'binder'. The silicon itself does not possess a pronounced negative temperature coefficient, but on diluting with a suitable binder it has a large negative resistance coefficient. The resistance material is formed in the shape of a rod which is fixed inside a glass tube filled with argon. This filling is required because the silicon of the rod reacts with oxygen and hydrogen. The tubes are designed for different maximum currents of between one and a hundred amperes. On full load the rod is raised to red heat and its temperature is then about 800° C. Starting tubes can also be used to switch on lamps automatically when it is desired, as in theatres and cinemas, to light them up gradually. These starting tubes can be used for many other applications in electrical working.

The Galaxy

IN the issue of *Scientia* of December, Dr. J. S. Plaskett, of the Astrophysical Laboratory, Victoria, British Columbia, describes the progress made recently in our knowledge of the extent of, and the distribution of stars in, the Galaxy, and sums up the results obtained. In its main features it resembles the Andromeda Nebula—that is, a flat disk nearly circular 30,000 parsecs (each $3\frac{1}{2}$ light years) in diameter and 1,000–2,000 parsecs in thickness, in rotation about its axis and containing about ninety per cent of the total mass. Within this disk the star density decreases from centre to circumference and rapidly near the edge. Throughout the disk and for 5,000 parsecs beyond its edge and 10,000 parsecs on either side of it are scattered high-velocity stars and clusters, and near its central plane is a light-absorbing medium 500 parsecs in thickness. The sun is situated in the central plane 10,000 parsecs from the centre (in a direction away from Vega?) and has a velocity of 275 kilometres per second, which would give the period of rotation of the Galaxy as 224 million years.

The Bowl of Integers and the Hexlet*

By Prof. Frederick Soddy, F.R.S.

INTO a hollow sphere of unit radius, with a curvature or bend, therefore, -1 , put two solid spheres of radius $\frac{1}{2}$, or bend $+2$. The two solid spheres then kiss each other at the exact centre of

since it has the unique property that the bend of every sphere of the infinitely infinite number of spheres that theoretically can be packed into it, so that each is located by its neighbours, is an exact

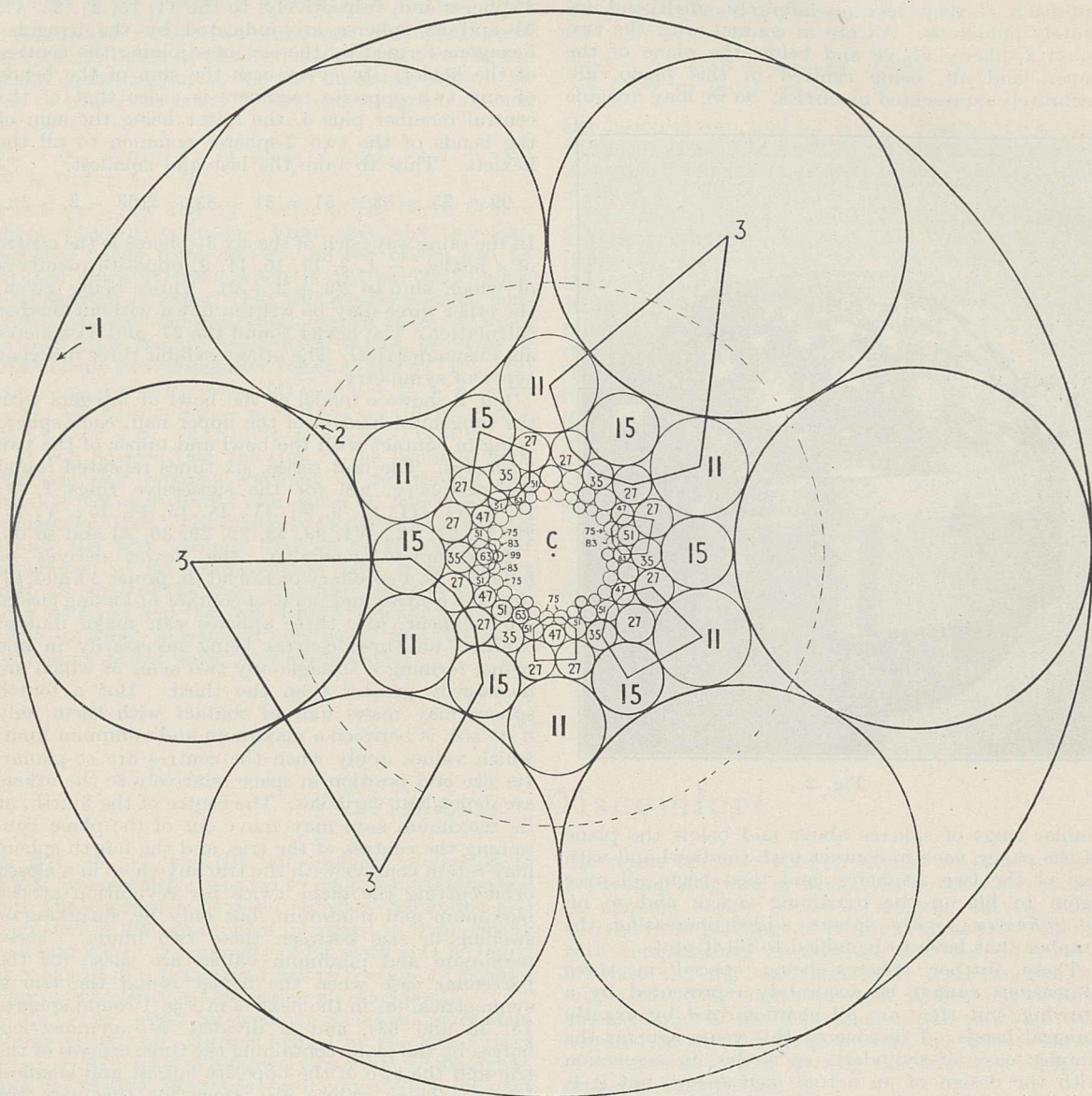


Fig. 1.

the bowl, and kiss the latter at the extremities of its diameter through all three centres, no other disposition being theoretically possible. This three-sphere assembly may be termed the 'bowl of integers',

integer which can be written down at once from those of its neighbours. It enables the nature of the 'hexlet' to be elucidated without either trigonometry or the algebra of irrationals.

Fig. 1 shows a section through the bowl of integers through its centre, *C*, in the plane of the paper,

* Vide "The Kiss Precise" and "The Hexlet" (NATURE, 137, 1021, June 20, and 138, 958, December 5, 1936).

which is also the point of contact of the two 2-spheres, one of which is above and one below it, the centres of the latter and their points of contact with the bowl being on the line through C vertical to the plane of the paper. The circle shown by a dotted line is the 2-sphere below the plane of the paper, and the figures labelling the circles are the bends, or reciprocals of the radii, of the spheres centred in the plane of the paper, of which they are sections. The space between the two 2-spheres and the bowl has been packed by successive rings of spheres, each ring in passing inwards consisting of ever larger and larger numbers of smaller and smaller spheres, until as we approach C they become infinitely small and infinitely numerous. All are in contact with the two equal 2-spheres above and below the plane of the paper, and all, being centred in this plane, are accurately represented by circles. So we may imagine

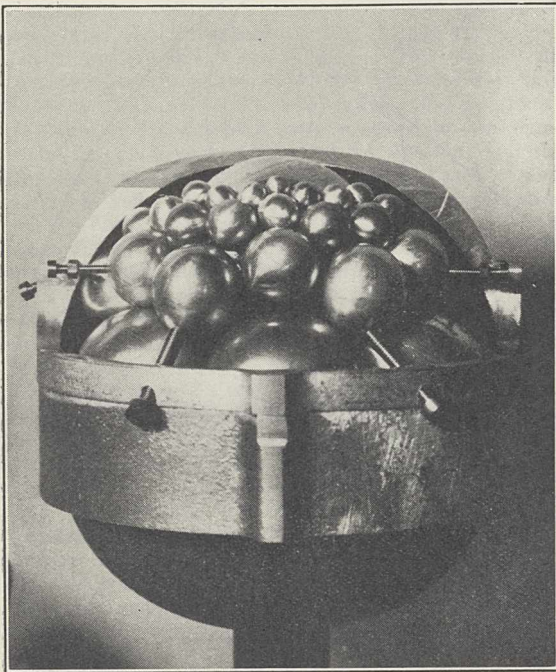


Fig. 2.

similar rings of spheres above and below the plane of the paper, each in contact with the bowl and with one of the two 2-spheres, and then begin all over again to fill up the remaining spaces and so on *ad infinitum*, every sphere added increasing the number that have to be added to fill it up!

These further spheres being spaced in three dimensions cannot be accurately represented by a drawing, but they are all characterized by exactly integral bends. I discovered this years ago for the simpler case of cylinders, or circles, in connexion with the design of an actual mechanism, but it is true also for the spherical analogue. So long as the sum of the two radii of the two largest equals that of the enclosure, the bends are always rational, and when the largest two are equal in radius, integral with respect to that of the enclosure as unit. So far as I am aware, this has not before been observed.

From the case illustrated, the principles of the hexlet are easily exhibited. The largest spheres that can be fitted in after the two of radius $1/2$ are a

ring of six of radius $1/3$, the centres of which are at the corners of a regular hexagon. It is the simplest case of the hexlet; all six spheres being equal, the bend, 3, is simply the sum of those of the common trio, namely, $2 + 2 - 1$. Going inward towards C the next ring has twelve spheres, six 11's alternating with six 15's; the next has 18, six contiguous pairs of 27's alternating with six single 35's; the next twenty-four, the series, 63, 51, 47, 51 being six times repeated round the periphery; and the last to be shown in the diagram has thirty, the unit series being 75, 83, 99, 83, 75.

Seven different hexlets belonging to the pair of 2-spheres and, respectively, to the 11, 15, 27, 35, 47, 51 and 63 spheres are indicated by the irregular hexagons formed by the six lines joining the centres of the hexlet. In every case the sum of the bends of any two opposite members is twice that of the central member plus 4, the latter being the sum of the bends of the two 2-spheres common to all the hexlets. Thus to take the last and smallest,

$$99 + 35 = 83 + 51 = 51 + 83 = 2(63 + 2 + 2).$$

In the same way each of the six 3-spheres is the centre of a hexlet, $-1, 3, 11, 15, 11, 3$, opposite members of which sum to $2(3 + 2 + 2)$. Three being given, the other three may be written down without further calculation. The hexlet round the 27- and 51-spheres are unsymmetrical. The others exhibit three different types of symmetry.

Fig. 2 shows a model of the bowl of integers with the tangential hexlets of the upper half, each sphere being in contact with the bowl and upper of the two 2-spheres. The unit series, six times repeated round the periphery, are for the successive rings I, 3; II, 6, 5; III, 11, 9, 9; IV, 18, 15, 14, 15; V, 27, 23, 21, 21, 23; VI, 38, 33, 30, 29, 30, 33 and so on.

In complete generality, the hexlet derives as follows. As a corollary of Euclid (ii, props. 11 and 12) that the centres and point of contact of kissing circles are collinear, *any* three spheres can make mutual contact, all three centres being necessarily in one plane, forming a triangle any two sides of which are necessarily greater than the third. But a fourth sphere may make mutual contact with them only if its size is between a maximum and minimum limit, which values apply when the centres are co-planar. Its size and position in space relatively to the others are dependent variables. The centre of the fourth, at its maximum say, may move out of the plane containing the centres of the trio, and the fourth sphere may retain contact with the trio anywhere in a closed orbit cutting the plane twice per revolution at the maximum and minimum, but only by shrinking or swelling in size between these two limits. These maximum and minimum values are those for the particular case when the hexlet round the trio is symmetrical (as in the hexlets in Fig. 1 round spheres 15, 35 and 63), and is divided into symmetrical halves by the plane containing the three centres of the trio and the two of the opposite largest and smallest beads. These values are, since for this case the centres are co-planar, the two roots of the quadratic equation for four circles in mutual contact ("The Kiss Precise", verse 2):

$$2(\varphi^2 + \alpha^2 + \beta^2 + \gamma^2) = (\varphi + \alpha + \beta + \gamma)^2, \\ \text{or } \varphi \pm = \alpha + \beta + \gamma \pm 2\sqrt{\alpha\beta + \alpha\gamma + \beta\gamma} \quad (1)$$

where φ stands for the bend of the fourth sphere and α, β and γ for those of the trio, the sum of which

will be termed σ . Equation (1) may be written $\varphi_{\pm} = \sigma \pm 2\rho$, where ρ is the bend of the circle inscribed in the triangle formed by joining the centres of the trio. $\varphi_+ + \varphi_- = 2\sigma$.

But if the fourth sphere has any other value, say δ , between the maximum and minimum, the centres are no longer co-planar, but four bends being fixed, the fifth is determined by and can be found from the quadratic equation for five spheres in mutual contact (*ibid.*, verse 3).

$$3(\varphi^2 + \alpha^2 + \beta^2 + \gamma^2 + \delta^2) = (\varphi + \alpha + \beta + \gamma + \delta)^2$$

$$\text{or } \varphi_{\pm} = \frac{1}{2}[\alpha + \beta + \gamma + \delta \pm \{6(\alpha\beta + \alpha\gamma + \alpha\delta + \beta\gamma + \beta\delta + \gamma\delta) - 3(\alpha^2 + \beta^2 + \gamma^2 + \delta^2)\}^{1/2}] \quad (2)$$

As always, we get two real roots, which refer, not to opposite beads of the hexlet as in the two-dimensional equation, but to the two on either side of the one to which the bend, δ , has been assigned. Hence we have

$$\varphi_+ + \varphi_- = \sigma + \delta; \text{ OR } \varphi_{N+1} + \varphi_{N-1} = \sigma + \varphi_N;$$

$$\text{OR } \varphi_3 = \sigma + \varphi_2 - \varphi_1,$$

where φ_{N+1} , φ_N and φ_{N-1} refer to the bends of any three consecutive beads. From this, any two consecutive beads being known, all the others can be written down at once, when it will be found, quite unexpectedly I think, that this simple relation conceals a periodic function, with a period of six, or $\varphi_{N+6} = \varphi_N$. Thus the six beads have values, in terms of those of any two consecutive beads, φ_1 and φ_2 , (1) φ_1 ; (2) φ_2 ; (3) $\varphi_3 = \sigma + \varphi_2 - \varphi_1$; (4) $\varphi_4 = \sigma + \varphi_3 - \varphi_2 = 2\sigma - \varphi_1$; (5) $\varphi_5 = \sigma + \varphi_4 - \varphi_3 = 2\sigma - \varphi_2$; (6) $\varphi_6 = \sigma + \varphi_5 - \varphi_4 = \sigma + \varphi_1 - \varphi_2$; (7) $\varphi_7 = \sigma + \varphi_6 - \varphi_5 = \varphi_1$.

It will be seen that the sum of the bends of each opposite pair remains constant at 2σ , though *any* value δ between limits was given to the one bend arbitrarily fixed. The hexlet in fact is free to revolve round the trio without loss of serial contact, or separation of its several beads each from contact with all three of the trio. Similarly any given hexlet may be fixed and the trio varied through a definite cycle in which σ remains unchanged but the three individual bends vary interdependently.

The primary hexlet of the bowl of integers is free to revolve in its tri-spherically sided annulus without change of grade, because exceptionally all its beads are identical, and this property is not due to two of the spheres of the trio being equal, but derives from the sum of their radii being equal to that of the bowl. Using Roman letters for radii, A and B may have any values so long as they sum to C , or using Greek letters for bends, so long as $1/\alpha + 1/\beta + 1/\gamma = 0$. When we introduce this value for γ into the surd of equation (1) for four circles in mutual contact $\alpha\beta + \alpha\gamma + \beta\gamma$, it vanishes and $\varphi_+ = \varphi_- = \sigma$. When we introduce these values for γ and δ , δ being the φ of equation (1) when $\varphi_+ = \varphi_-$, into equation (2), its surd

$$6(\alpha\beta + \alpha\gamma + \alpha\delta + \beta\gamma + \beta\delta + \gamma\delta) - 3(\alpha^2 + \beta^2 + \gamma^2 + \delta^2), \text{ or } (\varphi_+ - \varphi_-)^2,$$

also becomes zero, and $\varphi_+ = \varphi_-$. That involves that all the six spheres of the hexlet are identical, because the opposite members as well as those on each side of them are all equal.

In conclusion, one point of really fascinating historical interest emerges. The Greeks, in their study of the $\alpha\rho\beta\eta\lambda\omicron\varsigma$ or "shoemaker's knife", obtained by pure geometry the radius of the fourth circle that will make mutual contact with a mutually tangent trio for which $A + B = C$, whatever the ratio $A : B$. The proposition from the Arabic "Liber Assumptorum" will be found in full with notes in Sir Thomas Heath's "Works of Archimedes", p. 307 (Camb. Univ. Press, 1897). In the actual figure by which the proof was demonstrated A/B was $3/2$, which gives for the radius in question $6/19$, in terms of C as unity, when, therefore, A is $3/5$ and B is $2/5$. Since $\varphi = \sigma$,

$$\varphi = 5/3 + 5/2 - 1 = 19/6!$$

It is curious this should have remained unnoticed for thousands of years. Possibly when a mental arithmetic of reciprocals becomes as natural as that of number we may hope to learn the real secret of the circle and the sphere.

Climatic Discomfort

MR. W. F. TYLER, an engineer interested in meteorology, was led to make an investigation into the connexion between climatic discomfort and the state of the atmosphere in regard to temperature and humidity. A summary of his work is to be found in a reprint of a paper read before Section J (Psychology) of the British Association at Blackpool.

Mr. Tyler began his work at Shanghai more than thirty years ago. He was helped by the late Father Froc, then director of Siccawei Observatory, Shanghai, and by twelve observers—well-educated, intelligent men, one gathers—who during the month of August 1902 made an observation at every noon of their sensation of discomfort from the heat and dampness while sitting quietly in their offices, cooled by the punkah or fan to which they were accustomed. Their sensations were recorded on an arbitrary scale extending from 1 to 10; the numbers on the scale have been called hythers, hyther 10 being taken to represent an "unbearable condition". As

the result of these determinations we have a very interesting diagram in which the hythers are shown as sloping, nearly parallel, slightly curved lines derived from plottings of the individual observations with temperatures as abscissæ and the differences between the dry and wet bulb thermometers as ordinates. The course of each hyther shows how much change in the depression of the wet bulb was required on an average to prevent any given change of temperature from altering the discomfort appropriate to that hyther.

One is tempted to criticize this fundamental diagram, on which a number of climatic studies have been based, on the grounds that the data are too meagre, that one individual differs greatly from another in response to atmospheric conditions, and that each varies according to health, state of mind and other influences, but Mr. Tyler surely deserves credit for trying to bring more precision into the psychology of hot climates, and his work should be

of practical value in problems of air conditioning in such climates. Hythers suitable for temperate climates might be useful to European weather forecasters in more scientific times in the future, when air temperature and discomfort may be forecast separately. The general public does not know that in present-day forecasts the forecaster's references to temperature apply to temperature recorded in a screen designed to remove the vitally important effects of radiation. This fact results often in the anomaly of the forecaster knowing that he has made a technically correct forecast while even intelligent readers of the forecast imagine that it has gone utterly astray. But the hyther system would be more likely to give useful results in the near future in the comparison of different climates with very large contrasts of temperature and humidity.

The usefulness of a scale of discomfort of the type used by Mr. Tyler is apparent from a recent article entitled "Temperature Profiles in Toronto" by W. E. Knowles Middleton and F. Graham Millar (*J. Roy. Ast. Soc. Canada*, Sept. 1936). It is an account of observations of air temperature made with a nickel resistance thermometer of small lag, well shielded from radiation, which was mounted two feet from the front of a car 27 inches above the road. The observations were made in a street that runs north-north-west from the shore of Lake Ontario to the

northern limit of the town of Toronto and continues as a paved highway several miles farther in the same direction. Observations of this kind, it may be noted, were made by H. Tollner in Vienna in 1931 (*Sitz. Akad. Wiss. Wien, Math. Nat. Kl., Abt. IIa*, 141, 1-13; 1932). The results of a few selected sets of observations are discussed. They are shown as graphs with temperature as ordinates and distances from the lake as abscissæ. The elevation of the land is also plotted, so that temperature variations can be related at a glance to the changes of elevation. On a hot sunny day with light southerly wind, a very sharp rise of temperature was observed in the first 200 yards from the lake front and then an average increase of 1.3° F. in each mile for five miles, after which temperature fell a few degrees in the more countrified surroundings. At such times workers in offices near the lake have the advantage in temperature but experience a higher humidity and dew point as compared with their families in the residential parts higher up and farther from the lake. In the absence of a sensitive scale of climatic discomfort on the lines of the scale obtained by Tyler, it is difficult to form an idea as to which of the two is the better off. Another graph for a clear winter night showed a difference of no less than 27° F. between the bottom of a valley and its crest, for a difference of height of about 120 feet.

Chemistry of Essential Oils

IN the nineteenth Streatfeild Memorial Lecture, delivered at the Institute of Chemistry on November 20, Prof. John Read, of the University of St. Andrews, described a chapter in organic chemistry of extraordinary fascination. He showed how the discovery by Captain Cook of Australia opened a new field of research in the related sciences of botany and chemistry, which was soon appreciated by the early settlers in that continent.

Dr. John White, Surgeon-General to the first settlement at Botany Bay under Governor Phillip, and First Assistant Surgeon D. Considen, both referred in or about 1788 to a large peppermint tree growing around Port Jackson, the essential oil of which bore a close resemblance to that obtained from peppermint (*Mentha piperita*) long grown in England. This Australian tree, now known as *Eucalyptus piperita* or the Sydney peppermint, was supposed to contain the same odoriferous constituent, menthone, as the English tree. But in 1900 this peppermint odour of the genus *Eucalyptus* was shown by H. G. Smith to be a distinct ketone to which he gave the appropriate name of piperitone.

Prof. Read compared Smith with Streatfeild as regards his Kentish origin and his unselfish devotion to practical organic chemistry. Migrating to Sydney for reasons of health, Smith took up the study of chemistry and devoted himself especially to the chemistry of the Australian flora. His most remarkable work on the chemical nature of the essential oils of the genus *Eucalyptus*, which includes three hundred species, has an important bearing on the development of the natural resources of Australia. Certain oils were found to be rich in cineole, phellandrene, geraniol, citral, pinene and piperitone,

whereas others yielded new chemical constituents peculiar to the Australian flora. Some of these researches were carried out in collaboration with Profs. Read and J. C. Earl, both of whom were former pupils of Streatfeild.

Piperitone, which is a key to the stereochemistry of the menthones, menthols and related substances, is invariably levorotatory when obtained from eucalyptus, whereas from a Himalayan grass *Andropogon Jwarancusa* it was isolated by Simonsen in the dextrorotatory variety (1921).

Prof. Read then showed how the systematic study of the piperitones as pursued at St. Andrews has disclosed a new approach to the menthols and their congeners. These stereochemical researches offer a clue to the biogenetic relationships of the constituents of essential oils, some of which were traced by Smith and his co-workers. According to Baker and Smith, the open chain, geranyl acetate, passed into *Eucalyptus* through *Angophora* (an Australian genus of Myrtaceæ) and probably runs through the whole of the eucalypts although sometimes present only in small amounts.

In most species of eucalypts, geraniol may be presumed to function as the precursor of *l*-piperitol, *l*-piperitone, α -phellandrene and allied substances. The delicate control of molecular mechanism takes, however, a different turn in the Indian grasses, where geraniol becomes transformed into the enantiomeric *d*-piperitol, *d*-piperitone and into Δ^4 -carene. In the present stage of knowledge these subtle differentiations are beyond the powers of the chemical laboratory and appear to be inseparably bound up with vital processes. The systematic study of these biochemical phenomena is of wide scientific interest and also of considerable industrial significance. G. T. M.

Science News a Century Ago

A Visit to Mount Athos

AMONG the contributions read to the Royal Geographical Society on January 9, 1837, was "An Account of an Ascent of Mount Athos and a Visit to its Mountains, in June 1836" by Lieut. Webber Smith, of the 48th Regiment. On the south-east shore of the district of Saloniki, he said, three remarkable peninsulas, twenty-five miles in length by about five miles breadth, project nearly parallel to each other, in a south-easterly direction into the Archipelago. The easternmost of these three promontories, Mount Athos, is joined to the mainland by a low sandy isthmus, about 5 miles long and nearly $1\frac{1}{2}$ broad; and through which the famous canal was cut by Xerxes. The height of the central plateau of the peninsula is 250-500 feet, and from this rises a giant peak of white limestone about 6,350 feet high. The peninsula contains twenty monasteries, the whole containing about 1,500 men including 300 mendicants. At the village of Kares, a weekly fair or market is held, which presents the uncommon scene of a fair without noise, and a crowd without women; no female is on any account admitted within the precincts of the mount, nor indeed anything it is said of the feminine gender.

Darwin's Gifts to the Zoological Society

ON January 10, 1837, at a meeting of the Zoological Society, "Mr. Reid described several Mammalia, which were on the table, forming part of an extensive collection in Natural History, presented to the Society by Mr. Darwin, who accompanied the surveying ship *Beagle*, in the capacity of naturalist to the expedition. The whole contains upwards of 80 varieties, whilst the birds consist of nearly 450 specimens, including about 150 species, eleven of which from the Gallapagos Islands, were described by Mr. Gould, as being of entirely new forms to this country" (*Athenæum*).

An Epidemic of Influenza

UNDER the date January 12, the *Annual Register* for 1837 said that an influenza of a peculiar character had been raging throughout the country, and particularly in the metropolis. It was attended by inflammation of the throat and lungs, with violent spasms, sickness and headache. So general was its effects, that business in numerous instances was entirely suspended. The greater number of clerks at the War Office, Admiralty, Navy Pay Office, Stamp Office, Treasury, Post Office and other Government offices were prevented from attending to their daily avocations. Of the police force, there were upwards of 800 incapable of doing duty.

Death of Rev. William Farish

ON January 12, 1837, the Rev. William Farish died at Little Stonham, Suffolk, at the age of seventy-eight years. Born in 1759, he was the son of a clergyman of Carlisle, and after attending Carlisle Grammar School entered Magdalene College, Cambridge, as a sizar. He graduated in 1778, and was senior wrangler and Smith's prizeman. In 1794 he was appointed professor of chemistry at Cambridge, and as such he made a point of showing the application of chemical science to the arts and manufactures. In 1813 he

was appointed to the Jacksonian professorship of natural philosophy, being the successor of Francis John Hyde Wollaston (1762-1823) and the predecessor of Robert Willis (1800-75). In 1800, Farish became the incumbent of St. Giles's, Cambridge, and in 1836, rector of Little Stonham.

Dr. Roux on the Removal of Cataract

IN a note in the *Athenæum* of January 14, 1837, it is stated, "In making a report before the French Academy of Sciences, concerning the work of M. Maunoir, in favour of extraction of cataract from the eyes, M. Roux adduces the result of his own practice. Having registered all his operations during ten years, for the purpose of ascertaining which was the most efficacious method, he has been induced to give the preference to extraction. During this period he performed more than six hundred operations, as much as possible under similar circumstances, and the advantage gained by extraction was one-sixth".

Joseph Philibert Roux was born on April 26, 1780, and died on March 24, 1854, shortly after publishing "Quarante années de Pratique chirurgicale".

The British Medical Association

THE *Lancet* of January 14, 1837, contains the following notice. "The first public meeting of the members of the British Medical Association will be held at Exeter Hall in the Strand at six o'clock for seven precisely on Thursday evening next, the 19th inst. . . . This is essentially a NATIONAL association; it is open to the reception of all classes of medical practitioners; but it has been most prudently determined that the President shall always be a surgeon who is engaged in *general practice*, and that all the Councillors shall have been or shall be general practitioners. The thousands of our professional brethren have now only to unite in a spirit of cordial co-operation, under a governing body, thus qualified, constituted and interested in upholding their rights and within a very brief period the immense majority of surgeons in this country will find that they are enabled to take their proper station in Society. . . ."

Instances of Early Maturity

IN a lecture on forensic medicine delivered at the Aldersgate School of Medicine and published in the *London Medical Gazette* of January 14, 1837, Dr. William Cummin remarked that though it was only the infant produced at the ninth month of intra-uterine life that could be considered completely mature, there were numerous instances of children born at earlier periods sufficiently mature to run the normal course of human existence. Numerous old writers such as Avicenna, Schenck, Spigelius, Valesneri, Ammianus and Diemerbroeck among others had recorded examples of children having lived to adult age and even to the ordinary limits of human life though born after only five months of conception. Fortunio Luceti, according to Capuron, though born at the age of five months, lived to the age of seventy years. When born he was no bigger than a man's head. Belloc recorded the case of a female infant born about the sixth month who was only a foot long and looked like a little skinned rabbit, yet she was carefully fed and lived to woman's estate. Marshal Richelieu was recognized as viable by the parliament of Paris, although born only at five months.

Societies and Academies

Dublin

Royal Irish Academy, November 30.

L. M. INGOLD: Geology of the Currywongaun-Doughruagh Area, Co. Galway. The hills of Currywongaun and Doughruagh, north of Kylemore, are formed by an intrusion of basic plutonic rock of eueritic composition, which metamorphoses the schists and injection gneisses of the Connemara Series. This rock is particularly rich in rhombic pyroxene. On the coast west of these hills is a small intrusion of serpentine which also metamorphoses the schists. Evidence as to the age of both intrusions is inconclusive, but they are thought to be Pre-Cambrian.

W. B. MORTON: Centred vortex polygons. The stability of the steady motion is considered for the case of a ring of equal vortices with another vortex of any strength at the centre of the circle which they describe. It is found that the motion is stable when the strength of this last lies between an upper and a lower limit for each case.

Paris

Academy of Sciences, December 7 (*C.R.*, 203, 1193-1300).

LOUIS DE LAUNAY, CLÉMENT LIMB and CLAUDIUS ROUX: The rectification of any arc of a circle smaller than the half circumference, by André Marie Ampère, aged thirteen years. Hitherto unpublished, dated July 8, 1788.

LUCIEN CAYEUX: The existence of numerous bacteria in sedimentary phosphates of all ages. Consequences. Use was made in this work of photography with infra-red light. Previous conclusions were confirmed, and bacteria were found to exist in phosphates of all geological ages.

CHARLES ACHARD, AUGUSTIN BOUTARIC and MME. MADELEINE ROY: Study of the dilution of serums in weak solutions of different pH coefficients.

GEORGES CLAUDE: The production of white light by means of a single luminescent tube. A mercury neon tube is coated internally with a phosphorescent mixture, such as calcium tungstate with a little samarium: the mixture may be fused into the wall of the tube.

ANDRÉ WEIL: Remarks on the recent results of C. Chevalley.

WOLFGANG DEBLIN: The chains of Markoff.

J. NEYMAN: The law of limit probability of a system of aleatory variables.

PAUL DELENS: Generalities on the tetrahedron.

AUGUSTIN DELGLEIZE: The transformations of Ribaucour.

JEAN MIRGUET: A family of surfaces with tangent plane defined by the second paratingent.

ARNAUD DENJOY: Extensions of a continuum.

FERDINAND BEER: The study in complex space of the potential created by real bodies.

RENÉ LAGRANGE: The addition theorems of Legendre functions.

A. E. TAYLOR: The theory of analytical functions in abstract spaces.

LÉON REBUFFÉ: The measurement of the mean electrical resistance and the duration during the shock of two metallic bodies.

CHARLES CHARTIER: The hydrodynamic field around a marine three-bladed propeller.

JEAN LUNEAU: The influence of pressure on the resistance to motion of obstacles in air. From the experiments described, it is concluded that for fairly high Reynolds numbers, the law of proportionality between the resistance to motion and the density of the fluid is verified within one per cent (the accuracy of the experiments), provided that in calculating the density the deviations from Boyle's law are taken into account.

J. LE ROUX: The definition of distance in the theory of relativity.

TH. DE DONDER and J. GÉHÉNIAT: The electronic model of Dirac's wave theory.

ASSÈNE DATZEFF: The relativistic quantum mechanics of the electron.

GEORGES DEFLANDRE: A practical method of increasing the distance between the object and the objective of microscopes. A divergent achromatic lens of suitable focus is interposed immediately above the objective.

PIERRE BARCHEWITZ: The absorption spectrum of acyclic saturated alcohols in the near infra-red (6000 A.-9500 A.). Study of the OH band.

MARCEL SERVIGNE: Some phenomena of luminescence relating to the production of a sensibly white light. The light obtained from electrical discharge tubes containing mercury now used commercially in modern lighting can be modified by coating the walls with certain substances. A mixture of calcium tungstate containing samarium and synthetic willemite gives a photo-luminescent light with a spectrum approximating to that of sunlight.

JACQUES RABINOVITCH: The magnetic rotation and magnetic double refraction of some pure benzene derivatives in solution.

GABRIEL VALENSI: Introduction to the kinetics of the oxidation of metals giving two oxides. At fixed temperature and pressure, the oxidation of a metal possessing two valencies produces the two oxides simultaneously in a constant ratio. The square of the quantity of oxygen absorbed is proportional to the time, but the coefficients obtained at various temperatures do not satisfy the law of Arrhenius.

LOUIS GUITTON: The potential of iron in hydrochloric acid.

Mlle. JEANNE BOULANGER: The hydrates of the molecular combinations of zirconyl oxalate with oxalic acid and the alkaline oxalates.

CHRISTIAN AALL: The solubility of the impurities silica, alumina and magnesia in commercial calcium carbide.

LOUIS HACKSPILL: The thermal decomposition of the calcium carbonates.

PIERRE JOLIBOIS and GEORGES FOURETIER: The idea of basic salt in the hexavalent uranium series.

VICTOR LIVOVSKI: 5,7-Dimethyloxindol.

ROBERT FORRER: The intensity of the orbital interaction in metals.

A. FENAUX: The extension of the Tertiary sea in the regions of Provençal and Languedoc.

FERNAND JACQUET: The Eocene and the phosphates in the valley of the Senegal River.

PAUL QUENEY: The evolution of the rains in Algeria since the French colonization. Since 1898, there has been a change in the distribution of the rains; before that date, the spring rains predominated; but after 1898, the autumn rains have increased. Taken over the whole year, there is no marked change.

ROBERT BUREAU and J. MAIRE: Ionospheric anomalies with sudden commencement.

ROBERT DOUIN: The inversion of the geotropism of the peduncle of the carpophore of the Marchantiæ.

HENRI COLIN: Artificial inulogenesis in the Compositæ.

RAOUL COMBES: The glucidic nutrition of the corolla.

RENÉ VANDENDRIES: The sexuality of the Basidiomycetes.

ROBERT KÜHNER: The reaction to iodine of the walls of the hyphæ of the carpophore of *Mycena*.

A. and R. SARTORY and J. MEYER: The influences of a partial or high vacuum on the biochemical properties of some lower fungi.

PHILIPPE JOYET-LAVERGNE: Experimental demonstration of the role of the chondriome in respiration.

Mlle. CAMILLE CHATAGNON: Bromine in the gastric juice. Bromine is a normal and constant constituent of the gastric juice. The mean ratio found for 1,000 Br/Cl was 2.43.

MAURICE DOLADILHE: A physical property of one of the constituents of the non-dialysable fraction of a blood serum.

HENRI JACOTOT: Swine fever is transmissible to the sheep and goat.

Amsterdam

Royal Academy (*Proc.*, 39, No. 9, Nov. 1936).

H. J. JORDAN: Investigations on reaction retardation in the muscles of the snail, and their significance for the interaction between contraction and viscous tonus.

W. H. KEESOM and G. SCHMIDT: Researches on heat conduction by rarified gases. (2) The thermal accommodation coefficient of helium, neon, hydrogen and nitrogen on glass at 70°–90° K.

L. S. ORNSTEIN: Scattering of neutrons in matter (3).

J. G. VAN DER CORPUT: (1) Generalization of an inequality of Knopp. (2) On Kummer's solutions of the hypergeometric differential equation.

J. A. SCHOUTEN and J. HAANTJES: Conformal invariant form of the relativistic equations of motion.

G. VAN ITERSOU, jun.: Notes on the structure of the wall of Algae of the genus *Halicystis*.

A. H. BLAAUW, IDA LUYTEN and ANNIE M. HARTSEMA: The limit of flower formation and the growth of iris bulbs (2b).

L. S. ORNSTEIN and J. F. SCHOUTEN: Age and rate of decrease of red blood corpuscles before and after liver treatment of pernicious anæmia.

J. J. MEIUIZEN and C. A. CROMMELIN: Vapour pressures of liquid krypton.

D. VERMEULEN and J. G. HAGEDOORN: Visual intensity measurement with the aid of successive contrast.

A. ERDÉLYI: Development of an analytical function in terms of Whittaker functions.

J. GILLIS and J. EECKHOUT: Quantitative investigation of the ion exchange produced by the addition of the nitrates of thorium, hexol and cerium to the negative sol of silver iodide.

H. G. BUNGENBERG DE JONG and L. TEUNISSEN-VAN ZIJP: Further examples of unmixing in aqueous salt solutions.

L. ALGERA: Influence of temperature treatment on the carbohydrate metabolism, the respiration and the morphological development of the tulip (3).

J. KUYPER and L. K. WIERSUM: Occurrence and transport of a substance causing flowering in the soya bean (*Glycine Max L.*).

J. WESTERVELD: Geology of North Banka, Djeboes (Dutch East Indies).

A. A. THIADENS: Some caprinids and a monopleurid from southern Santa Clara, Cuba.

J. L. ADDENS and T. KUROTSU: The pyramidal tracts of *Echidna*.

F. J. NIEUWENHUYZEN: Chronic experimental catatonias produced by intermediate products of metabolism. Indolethylamine.

Cape Town

Royal Society of South Africa, September 16.

R. F. LAWRENCE: The external sexual characters of South African harvest spiders.

G. P. LESTRADE: Notes on the political organization of certain Xhosa-speaking tribes in the Transkeian Territories. The political organization of the Gcaleka, Mfengu and Thembu tribes in the Transkeian districts of Willowvale, Idutywa and Engcobo is described. An account is given of the territorial organization obtaining among these tribes; and the various political units into which they are divided—the kraal, the ward, the tribal division, and the tribe—are described.

R. S. ADAMSON: Anomalous secondary thickening in *Ostrospermum*.

Moscow

Academy of Sciences (*C.R.*, 3, No. 9; 1936).

M. M. GREENBLUM: Geometrical structure of the symmetric transformation in Hilbertian space.

P. I. LUKIRSKY and T. CAREVA: Slowing-down of neutrons by the nuclei of heavy elements.

D. A. ČERENKOV: Influence of a magnetic field on the visible luminosity of fluids produced by gamma-rays.

P. D. LAZAREV, E. M. KLINKOVSTEIN, Z. V. BULANOVA and S. S. KATZNELSON: Study of the visual adaptation in the normal and pathological state of the organism. (1) The influence of diabetes mellitus on adaptation in peripheral vision.

N. A. Slioskin: The problem of motion of a gas in two dimensions.

M. MICHAÏLOV and J. A. ARBUZOV: Thermal decomposition of olefinic hydrocarbons.

V. Š. BUTKEVIC: The formation of oxalic and citric acids by fungi.

R. A. RUBIN: The biose/monose ratio as a biochemical varietal character in the onion.

A. NIKIFOROVA: Boundary between the Permian and the Carboniferous in the reef limestones of the Urals established on the basis of the Bryozoa enclosed therein.

N. G. CHOLODNYJ: Hormonization of grains.

M. C. ČAILACHJAN: The hormonal theory of plant development.

L. M. ŠULPIN: The faunal features of the north-west Tian Shan.

Forthcoming Events

[Meetings marked with an asterisk are open to the public.]

Monday, January 11

VICTORIA INSTITUTE, at 4.30.—Sir Ambrose Fleming, F.R.S.: "On the Methods of Determining the Age of the Earth" (Presidential Address).

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—E. T. D. Lambert: "From the Brahmaputra to the Chindwin".

Tuesday, January 12

SOCIETY FOR THE STUDY OF INEBRIETY AND DRUG ADDICTION, at 4.—Dr. H. M. Vernon: "Alcohol and Motor Accidents".

WARBURG INSTITUTE, at 5.30.—Dr. Konrad Lorenz: "Biological Aspects of Play".*

PHARMACEUTICAL SOCIETY, at 8.30.—Dr. F. B. Parsons: "Anæsthetic Agents".

Wednesday, January 13

ROYAL SOCIETY OF ARTS, at 8.—Olaf F. Bloch: "Applications of Photography to Scientific and Technical Problems".

Thursday, January 14

ROYAL ASIATIC SOCIETY, at 4.30.—Prof. W. Perceval Yetts: "Chinese Bronze Mirrors".

Appointments Vacant

ASSISTANT (GRADE I, ENGINEERING OR PHYSICS), ref. 305 E., and ASSISTANT (GRADE III, ENGINEERING), ref. 307 E., in the Royal Aircraft Establishment, South Farnborough, Hants—The Chief Superintendent (January 15).

ASSISTANT CHEMIST in Somerset County Laboratory—The County Analyst, County Hall, Taunton (January 15).

ESTABLISHED CIVIL ENGINEERING ASSISTANTS in the Headquarters and Divisional Road Engineers' Offices of the Roads Department of the Ministry of Transport—The Establishment Officer, Ministry of Transport, Whitehall Gardens, London, S.W.1 (January 15).

INSPECTOR OF LIVE STOCK in the Department of Agriculture for Scotland—The Secretary (Establishment Branch), York Buildings, Queen Street, Edinburgh 2 (January 16).

TECHNICAL OFFICER (MATHEMATICS OR PHYSICS) in the Meteorological Office—The Secretary (S.2.E.), Air Ministry, Adastral House, Kingsway, W.C.2 (January 18).

ORGANIZER OF AGRICULTURAL EDUCATION to the Lindsey County Council Education Committee—The Director of Education, County Offices, Lincoln (January 23).

LECTURER IN ORGANIC CHEMISTRY in University College, Exeter—The Registrar (February 1).

CHEMIST in the A.I.D. Test House, Kidbrooke—The Secretary, Air Ministry, S.2.d., Adastral House, Kingsway, W.C.2.

HORTICULTURAL ADVISER to the Land Settlement Association, Broadway Buildings, Broadway, Westminster, S.W.1.

Official Publications Received

Great Britain and Ireland

Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1935. Part 1, with Report of the Geological Survey Board and Report of the Director. Pp. iii+98. (London: H.M. Stationery Office.) 1s. 6d. net. [1612]

Department of Scientific and Industrial Research. Forest Products Research Records No. 13 (Seasoning Series No. 3): Types of Timber Kilns. By R. G. Bateson. Pp. ii+9+5 plates. (London: H.M. Stationery Office.) 6d. net. [1712]

Scottish Development Council. Second Report of the "Oil from Coal" Committee. (Economic Series No. 13: Scottish Industry.) Pp. 27. (Glasgow: Scottish Development Council.) 6d. net. [1712]

Imperial Bureau of Plant Genetics (for Crops other than Herbage). The Experimental Production of Haploids and Polyploids. Pp. 28. 5s. The South American Potatoes and their Breeding Value. Pp. 15. 3s. 6d. (Cambridge: School of Agriculture.) [1812]

Lily Year-Book 1936. (No. 5.) Pp. iv+131+28 plates. (London: Royal Horticultural Society.) 5s. [1812]

Scottish Marine Biological Association. Annual Report, 1935-36. Pp. 24. (Glasgow: Scottish Marine Biological Association.) [2112]

Leeds University. Report to the Worshipful Company of Cloth-workers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing during the Session 1935-36. Pp. 20. (Leeds: The University.) [2112]

New Forest Association. Annual Report and Statement of Accounts. Pp. 18+6 plates. (Brockenhurst: Capt. Cecil Sutton, Hon. Sec., The Estate Offices.) [2312]

Scientific Proceedings of the Royal Dublin Society. Vol. 21 (N.S.), No. 42: On the Comparison of the Gamma Ray Intensities from Radium Preparations. By J. A. C. Teegan. Pp. 449-452. 6d. Vol. 21 (N.S.), No. 43: Award of the Boyle Medal to Dr. H. H. Poole. Pp. 453-456. 6d. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) [2412]

Other Countries

U.S. Department of the Interior: Office of Education. Bulletin, 1936, No. 5: Bibliography of Research Studies in Education, 1934-1935. Prepared by Ruth A. Gray. Pp. xv+287. (Washington, D.C.: Government Printing Office.) 25 cents. [2112]

New Zealand. Tenth Annual Report of the Department of Scientific and Industrial Research. Pp. 108. (Wellington: Government Printer.) 2s. 3d. [2112]

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 66: The Sheep Blowfly Problem in Australia; Results of some Recent Investigations. By I. M. Mackerras. Pp. 39. (Melbourne: Government Printer.) [2112]

U.S. Department of Agriculture. Miscellaneous Publication No. 253: Conservation Farming Practices and Flood Control. By H. H. Bennett. Pp. 16. (Washington, D.C.: Government Printing Office.) 10 cents. [2112]

Studies in West Indian Soils. 10: The Cacao and Forest Soils of Trinidad. B: South-Central District. By F. Hardy, D. W. Duthie and G. Rodriguez. Pp. 56. (Trinidad: Government Printing Office.) 2s. [2112]

Spisy vydávané Přírodovědeckou Fakultou Masarykovy University. Čís. 225: O některých barytech Moravských (Über einige Barytvorkommen in Mähren). Napsala Božena Bobková. Pp. 15. Čís. 226: Akustická měření Rayleighovou deskou (Les mesures de vitesses par le disque de Rayleigh), napsala Marta Chytilová; Měření radioaktivity torsními vázkami, elektrometrem a fotočlánkem (Mesures de la radioactivité par la balance de torsion, par l'électromètre et par la photocellule), napsal Josef Zahradníček; Klesající charakteristika pístalového jazýčku (Sur la caractéristique descendente de la languette d'un tuyau), napsal Josef Zahradníček. Pp. 27. Čís. 227: Über *Dorydrius (Piguetia) mirabilis* N. subg. n.sp. aus einem Sodbrunnen in der Umgebung von Basel sowie über *Dorydrius (Dorydrius) michelseni* Pig. und *Bichata sanguinea* Bret. (O žížalích *Dorydrius (Piguetia) mirabilis* N. subg. n.sp., *Dorydrius (Dorydrius) michelseni* Pig. a *Bichata sanguinea* Bret.). Napsal Sergej Hrabě. Pp. 18. Čís. 228: Remarque pour l'étude des tremblements de terre en Tcheco-slovaquie. Par F. Koláček. Pp. 5. Čís. 229: Energetické poměry v jazykových pístalách (Energieverhältnisse in den Zungenpfeifen). Napsal Josef Zahradníček. Pp. 9. (Brno: A. Piša.) [2112]

Sborník vysoké školy Zemědělské v Brně, Fakulta Hospodářská. Sign. C. 31: Pokusy se sladováním nahého ječmene pro lihovary. Napsal V. Almendinger. Pp. 60. (Brno: A. Piša.) [2112]

Field Experiments on Sugar-Cane in Trinidad. Annual Report for 1936. By P. E. Turner. Pp. 67. (Trinidad: Sugar-Cane Investigation Committee.) [2212]

Norges Svalbard- og Ishavs-Undersøkelser. Meddelelse Nr. 27: The Lichen-Genus *Acarospora* in Greenland and Spitsbergen. By A. H. Magnusson. Pp. 22. Meddelelse Nr. 32: Norges Svalbard- og Ishavs-Undersøkelser Ekspedisjoner i årene 1934 og 1935. Av Anders K. Orvin. Pp. 18. Meddelelse Nr. 33: Dagbøker av Nordmenn på Grenland for 1814. Ved H. Ostermann. Pp. iii+246. Meddelelse Nr. 34: Luftkartlegningen på Svalbard 1936. Av Bernhard Lumeke. Pp. 10. Skrifter om Svalbard og Ishavet, Nr. 67: Oceanographic Investigations in East Greenland Waters in the Summers of 1930-1932. By Anton Jakhelin. Pp. 79+2 plates. 7.00 kr. (Oslo: Jacob Dybwad.) [2212]

Smithsonian Miscellaneous Collections. Vol. 95, No. 16: A 17th Century Letter of Gabriel Diaz Vara Calderón, Bishop of Cuba, describing the Indians and Indian Missions of Florida. Transcribed and translated by Lucy L. Wenholt. (Publication 3398.) Pp. 14+12 plates. (Washington, D.C.: Smithsonian Institution.) [2312]

U.S. Department of Agriculture. Miscellaneous Publication No. 248: Peat Land in the Pacific Coast States in relation to Land and Water Resources. By A. P. Dachnowski-Stokes. Pp. 68. (Washington, D.C.: Government Printing Office.) 15 cents. [2312]

U.S. Department of the Interior: Office of Education. Bulletin, 1936, No. 7: Instruction in Hygiene in Institutions of Higher Education. By Dr. James Frederick Rogers. Pp. vi+47. (Washington, D.C.: Government Printing Office.) 10 cents. [2312]

University of Colorado Studies. Vol. 24, No. 1: Abstracts of Theses and Reports for Higher Degrees, 1936. (University of Colorado Bulletin, Vol. 36, No. 17.) Pp. 77. (Boulder, Colo.: University of Colorado.) 1 dollar. [2312]

Transactions of the San Diego Society of Natural History. Vol. 8, No. 20: A Key to the Rattlesnakes, with Summary of Characteristics. By Laurence M. Klauber. Pp. 185-276. Vol. 8, No. 21: New Porcellanids and Pinnotherids from Tropical North American Waters. By Steve A. Glassell. Pp. 277-304+plate 21. Vol. 8, No. 22: West American Species of the Genus *Phos*. By A. M. Strong and H. N. Lowe. Pp. 305-320+plate 22. (San Diego, Calif.: San Diego Society of Natural History.) [2312]

Catalogues, etc.

Catalogue of the Twenty-seventh Annual Exhibition of Scientific Instruments and Apparatus held at the Imperial College of Science and Technology, South Kensington, London, S.W.7, January 5th, 6th and 7th, 1937. Pp. 196+lxviii. (London: The Physical Society.)