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Science and the Community

Co-operation in Research

IN that impressive plea for closer co-operation between men of science and those concerned with the general affairs of the nation which formed a main theme of his presidential address to the Science Masters' Association, Sir William Bragg emphasised the need for much closer contact between workers in different branches of science as well as between the scientific worker and the everyday problems of industry or society. Science, he pointed out, loses its vitality if it turns in upon itself. No splendid isolation is possible for the scientific worker. On the contrary, it is one of the gravest dangers which besets the specialist, and specialists we must all be to-day.

The intense pursuit of knowledge in various directions is apt to carry us out of sight and touch of each other. Even in the world of science, it is becoming difficult for specialists in one field to understand the work of specialists in another, and divisions tend to form and deepen. If, however, the mathematician, the chemist, the physicist, the biologist, the engineer and others lose contact, their separate progress is likely soon to come to an end. Moreover, many of the gaps in the uneven front of research to-day are represented by unexplored fields which lie between the activities of two or more branches of science. Further progress depends upon filling in these gaps by co-operation between workers in the sciences concerned.

This is not all. Apart from the rich rewards which have often attended the exploration of these stretches of scientific no man's land by those who have taken their bearings from both sides, it is difficult to exaggerate the value of the stimulus to thought and resource which is gained within the bounds of the particular sciences concerned.

In fact it is remarkable, as Sir William Bragg reminded us, how often it happens that most interest is found where two phases meet.

Despite the easy talk about the breakdown of barriers between different branches of science and co-operation in the attack on common problems, it is doubtful whether real interpenetration of thought has taken place to anything like the extent required. Few sciences can find more ground in common than physics and chemistry, and yet the rapid development of physical chemistry may give us quite a misleading impression of the extent to which the ideas of the new physics, for example, have penetrated into those of chemistry.

In a lecture last year before the American Society of Mechanical Engineers, Dr. I. Langmuir suggested that the distinction between chemistry and physics, for example, is only disappearing in a narrow field that lies at the borderline between physics and chemistry. The chemist and physicist have essentially different habits of thought and different types of interest; and in support of this view he pointed out that of 2,700 chemists listed in "American Men of Science", only 2.5 per cent are members of the American Physical Society; similarly of 760 physicists, only 3.3 per cent are members of the American Chemical Society.

These facts suggest that physicists themselves are not likely to do much on their own ground to revolutionise the science of chemistry, and that the revolutionary influence of even the quantum theory on chemistry may well be a much slower process than is often assumed. There is accordingly all the greater opportunity for those who will take the trouble to train themselves in the methods of one science and then apply them to the study

of problems in these borderline fields which are commonly approached from some other angle.

Dr. Langmuir in his address had particularly in mind the application of the new physics to the study of the properties of matter, and voiced the opinion that many fields, such as surface tension, which have been neglected for many years, could very profitably be investigated by modern methods. The application even of the atomic theory might lead to an entirely new understanding of them. This is equally true of many industrial problems and also of many of these social and economic problems in which the application of the scientific method is now only beginning.

Probably the majority of such problems to-day depend for their solution upon an organised attack by a team of scientific workers representing several different sciences, from the clash of whose differing techniques and points of view not merely new techniques may be developed but also the new conceptions and new ideas which will make further progress possible. The difficulty is that, despite the unquestioned stimulus which such teamwork brings to the individual sciences and scientific workers who participate, in the absence of such an economic motive as is to be found in industry, the specialist is rarely sufficiently interested in fields outside his own sphere to initiate such work.

For example, the fundamental mechanical properties of matter do not sufficiently interest either the chemist or the physicist, although, as the correlation of the mechanical properties of rubber with its chemical and physical structure in recent years has shown, the development of our knowledge of these fundamental properties will come through the ideas of both chemistry and physics. The study of lubrication and adhesion, the investigation of plastics and highly polymerised substances generally are examples of fields in which equal success might be expected, and Dr. Langmuir stated that in Schenectady efforts were already being made to correlate the chemical, physical and mechanical properties of plastics and the like.

The prospect that Dr. Langmuir thus holds out of modern physical concepts of the quantum theory leading to a better understanding of phenomena in many fields of physical and chemical science, and thereby to the development of materials having new mechanical properties, is not more attractive than that which would attend the linking of the physical sciences with the biological or social sciences in the study of some of the wider economic and social issues of to-day.

Besides the lack of interest of the specialist in problems that lie outside his own immediate domain, there is the question of language, to which also Sir William Bragg referred. The demands of specialisation, and the tendency for the scientific worker to become detached not merely from the general affairs of the community but also from all but a small band of fellow workers in the same field, have engendered an indifference and carelessness in regard to the reporting and interpretation of scientific work which is often a fatal obstacle to its utilisation either by industry or by society in general.

It is possible indeed that we have reached a point when the continued advance of science itself depends not merely upon the specialised technique which has been developed, but upon the development also of a capacity to interpret to the non-specialist the results that have been obtained. The detached view of the problem under discussion, the capacity for logical presentation, for lucid statement and the sifting of essentials from details demanded in exposition may indeed be of immense value to science itself. Their practice forces the scientific worker to make at least some effort to comprehend the life and thought with which each of us is surrounded, to which the early fellows of the Royal Society were so well able to address themselves. It also helps him to escape from views of his problems which are circumscribed by tradition or by existing practice and, gaining a fresh point of view, to strike out into fresh fields or along original lines in which creative thought in due course will bear its fruit.

Mechanical-mindedness is a peril to which the scientific worker and above all the specialist is exposed as much as, if not more than, his fellow men. The team work and co-operation which are required to-day can do much to avoid this danger and encourage receptivity to new ideas. Such team work and co-operation are required, however, over a much wider front than has yet been seen. They demand indeed the planning of research over the whole realm of science on a scale and in directions commensurate with the national needs. That planning will only come as scientific men prove themselves able to participate in it and to convey to the leaders of the community some sense of the benefits with which science could endow the nation. Here is a task of exposition which brooks no delay. Equally pressing is the task of dealing with the training of the scientific worker so as to check the evils of excessive specialisation and encourage a

wider outlook, or of the ordinary citizen so as to give the scientific background which he needs for his everyday life in the modern world. Sir William Bragg's address should give a welcome impulse to such efforts if only by reminding scientific workers that the pursuit of their own special studies can

only achieve continued success if they themselves regain contact with the world's affairs and the stimulus, not merely of a wider point of view, but also of that vision of service to the community, from which the true spirit of science can never be divorced.

Archæological Expedition to Northern Syria

SINCE the passing of the new Antiquities Law in Iraq, that country has been regarded by British archæologists as virtually closed, and outside Palestine Britain has done little in the archæological exploration of the Near East. It is gratifying, therefore, to learn that an expedition under Sir Leonard Woolley, organised by the British Museum (Bloomsbury), has just left to excavate in Northern Syria.

The interruption of British archæological activities in Mesopotamia came at a peculiarly inopportune moment. While the work of exploration at Kish and Ur had either drawn or was drawing to a close, work on other sites seemed to be on the eve of discoveries of far-reaching import. This was especially to be noted in the excavation by the British School of Archæology in Iraq under Mr. M. E. L. Mallowan at Arpachiyah in the north. When considered in relation with the results obtained on sites under examination by the School of Oriental Studies of the University of Chicago, where work has continued, these investigations were not only adding to knowledge of the relation of the cultures of north and south within Mesopotamia itself in ever-increasing precision of detail, but also evidence was accumulating, which bade fair to enlarge the conception of the extent and character of international relation and influence from India to the Mediterranean in the early world.

The highly significant results achieved by French archæologists at Ras Shamra in Northern Syria point in a like direction at a later period. They confirm argument on general grounds that the Syrian sea-board, like the desert border towns of Damascus and Dura of later date, was an important point of convergence from hinterland and sea of peoples and trade from east and west—a point where races and creeds and cultures of diverse origin, Sumerian, Hittite, Syrian, Mediterranean and Egyptian, with Phœnicians later, all met to leave the record of their contact and association in buildings, sacred and profane, in

art and material equipment, and in tablets inscribed in the languages commonly used. Nor is it probable that Ras Shamra exhausts or even monopolises the archæological and historical interest of the region. As the result of a preliminary archæological reconnaissance made last year, Sir Flinders Petrie has arrived at the conclusion that the country affords a large number of sites which would richly repay investigation. This is no more than might be expected.

The exploration upon which the British Museum expedition is now about to enter is in a sense experimental and exploratory; but two sites have been selected for preliminary examination, which on topographical grounds alone might be expected to yield data of importance in their bearing upon the major objective of investigation which, it is stated, is "to throw light on the origin of civilisation in Europe by tracing possible connexions between the art of early Crete and that of the mainland".

Of the two sites, one is a harbour lying to the north of Ras Shamra—one of the very few on the coast of northern Syria serving inter-communication between the Mediterranean and the interior by easy passes through the Ammanus range. It lies at the mouth of the River Orontes. Here possibly evidence of direct relations with Crete may be obtained. The second is in the great Amu plain, between Antioch and Aleppo, and commands the caravan route to Aleppo and the Euphrates. It is thought that it should serve to illustrate better than the former site the development of native culture and its reaction to the Cretan, while the upper strata may produce Hittite sculpture and inscriptions and even possibly inscriptions in the early Phœnician script, such as were found at Ras Shamra, throwing new light on Semitic religion and Old Testament history.

The cost of the expedition will be met by contributions from friends of the British Museum and from the Ashmolean Museum, Oxford.

A History of German Pharmacy

Grundriss der Geschichte der deutschen Pharmazie

Von Dr. A. Adlung und Dr. G. Urogang. Herausgegeben auf Veranlassung der Gesellschaft für Geschichte der Pharmazie mit Unterstützung durch Die Deutsche Apothekerschaft. Pp. viii + 648. (Berlin: Julius Springer, 1935.) 28 gold marks (inland); 21 gold marks (abroad).

ON the Continent, pharmacy is more of a learned profession, less a matter of trade, than it is in Great Britain. Its prestige is perhaps greatest in France and in Spain, where a pharmaceutical training still often precedes an academic career in pure chemistry. Formerly it was also so in Germany; we need only mention Beckmann, Fehling, Fresenius, Poggendorff. Even to-day much valuable research in organic chemistry is done by professors of pharmacy in the German universities. There the academic nature of the profession dates from 1835, when a period of university study became necessary for the qualification; in 1904 the leaving examination of a complete secondary school (usually a *Gymnasium*) was made a prerequisite to professional studies; from April 1, 1935, the period of university study was extended to six semesters, which, with the preliminary practical apprenticeship of two years followed by an examination, makes a total course of five years. This long curriculum is scarcely necessary for acquiring the art of dispensing, or the capacity to sell proprietary preparations over the counter; its length seems rather due to economic factors, to a desire to restrict the entry to the profession, for in Germany it is not enough to be a qualified pharmacist before setting up in business. The number of *Apotheken* is limited; a concession has to be obtained, which is generally personal, and under the new regime depends to some extent on war service; the right to conduct certain specified pharmacies can even be inherited, or bought at a high price.

It is only this academic aspect of German pharmacy which will explain the production of the comprehensive history under review, published with the official support of the Deutsche Apothekerschaft (the guild of pharmacists under the new regime). The book is fittingly dedicated to the memory of Hermann Schelenz, but it is by no means as readable as the latter's general history of pharmacy, a pioneer work ("Geschichte der Pharmazie", 1904). The legal, economic and social history of the profession is dealt with in great detail. The extreme subdivision of Germany into

many States (in all some three hundred in the eighteenth century) and their characteristic particularism are well illustrated by a list of more than four hundred pharmaceutical and medical enactments between 1162 and 1933, which will not appeal greatly to the average reader. Nor can the thirty pages devoted to military pharmacy, most of them in the form of a chronicle, arouse general interest. Foreign readers are more likely to turn to the account of pharmaceutical industry in Germany, or to that of homœopathy. The theoretical views of Hahnemann were first published in 1796, and whilst there is no mention of support from scientific pharmacology, it would appear that the system has gained favour in the Third Reich, for since October 1934 every German pharmacy must have a book on homœopathic medicaments, and physicians are no longer allowed to dispense these; since April 1935, all candidates for the pharmaceutical profession must produce evidence of having attended a course of lectures with practical work on homœopathy for pharmacists. The book under review gives some account of even more mystic systems of therapy, including one masquerading under the name of *Biochemie*, but the authors evidently considered a full account of present-day quackery beyond their scope; nor are they greatly concerned with the numerous specialities of German chemical industry, except as regards the prices to be charged for them.

A considerable part of this book is in chronological or in tabular form, a method of treatment which facilitates reference but does not lead to continuous reading. Thus there is a chapter composed entirely of short biographical notes on individual pharmacists, mostly university teachers. The documents and literature of the past are collected in bibliographies which have the great merit of specifying one or two German libraries or archives where each item may be found. The list of herbals (pre-eminently German productions, as the authors point out), is not as comprehensive as other parts of the book; it does not include the regional floras of Thalius (1588), Schwenckfelt (1600) or M. Hoffmann (1662), which, although less ambitious than the larger works, have a merit of their own. Caspar Bauhin's herbal first appeared as "Phytopinax" (1596) and not in 1613 as is suggested. The list of editions of Adam Lonicer's "Kreuterbuch", although indicating completeness, does not include those of 1569, 1573 and 1582. The last named is rare, and is not mentioned in Pritzel's "Thesaurus" (which work the authors do not seem to have consulted); there is a copy

in the library of the Linnean Society of London. This 1582 edition is of interest since it contains the first mention of ergot, a drug which in the words of Tschirch "started its triumphal career from Germany". Yet in a subsequent appendix the two references to this pre-eminently German drug are both erroneous; in particular, the suggestion that the ergotin of Wiggers (1831) was the pure active principle gives the impression that the authors have paid more attention to history than to chemistry, that they are more concerned with the profession of pharmacy than with the sciences on which it is based.

The work is entirely up to date; from it we learn that Jews may no longer become pharmacists, although it is only in Bavaria that existing Jewish owners have been forced to sell out. We also learn that in the Nazi State there now exists a journal devoted entirely to the youth of the apothecaries' class (*Nachrichtenblatt der Standesjugend Deutscher Apotheker*). In its completeness this history is a monument of German diligence and most valuable as a book of reference; but it will scarcely provide general reading for the British pharmacist, even if he is not troubled by sentences extending over a quarter of a page (as on p. 114). G. BARGER.

Magnetism and Chemistry

Physical Principles and Applications of Magnetochemistry

By Prof. S. S. Bhatnagar and Dr. K. N. Mathur. Pp. xiv + 375. (London: Macmillan and Co., Ltd., 1935.) 21s. net.

BY his classical researches during the years 1908-13, Pascal was able to show that the magnetic susceptibility of any diamagnetic compound can be considered as the sum of the 'atomic susceptibilities' of the constituent atoms, plus constitutive constants depending on the structure of the molecule, the presence of double bonds and so on. In the determination of the susceptibility the chemist thus possesses a means of supplementing purely chemical evidence as to the nature of any substance. For example, the experimental value for anthraquinone agrees within one per cent with that calculated on the assumption that the substance is a derivative of anthracene, but there is a discrepancy of eleven per cent if the molecule is supposed to contain two benzene rings connected by aliphatic linkages. The β -ketonic esters exist as equilibrium mixtures of two forms of the molecule (keto and enol). Pascal's determinations show that ethyl acetoacetate consists mainly of the ketonic form while the opposite is the case with ethyl benzylacetate, in accordance with the chemical behaviour of these compounds.

The extensive group of co-ordination compounds provides another example of the value of magnetism in helping to unravel the problems of molecular structure. The magnetic properties of these compounds are frequently strikingly different from those of the simple salts of the same metals and can now be correlated with the spatial distribution of the groups attached to the central co-ordinated atom. The fourfold nickel compounds

may be taken as an example. From their chemical and optical properties, it has been concluded that such compounds can be of two kinds, in which the four bonds are directed from the nickel atom towards the corners of a tetrahedron or lie in a plane respectively. With four different groups attached to the nickel atom, the molecule will be optically active in the first case but not in the second. Pauling, by his simplified wave-mechanical treatment of the problem, has shown that this behaviour is to be expected for four bonds of the types sp^3 and dsp^2 respectively, and as a consequence that the former compounds should be paramagnetic with a magneton number of 2.83 Bohr magnetons, and the latter diamagnetic, in complete accord with the experimental observations.

In "Physical Principles and Applications of Magnetochemistry", Prof. S. S. Bhatnagar and Dr. K. N. Mathur have written the first account in English of magnetism from the point of view of the physical chemist. After a historical introduction and a description of the many and varied methods of determining the magnetic susceptibilities of solids, liquids and gases, a fairly detailed discussion is given of the magnetic properties of the elements and of diamagnetic compounds. Then follow chapters on paramagnetism, ferromagnetism, magnetism and valency, magneto-optical properties from the point of view of the chemist, various magnetic effects, crystal magnetism and the influence of magnetic fields on chemical reactions. The book closes with a table of the magnetic susceptibilities at 20° C. of some two hundred substances.

The book is written for the physical chemist, and is a plea for the wider use of the weapon which magnetism offers to attack chemical problems of all kinds. The necessary basis of physical

theory is, however, dealt with adequately but quite briefly. The work may be recommended to chemists wishing to employ magnetism as a tool in the investigation of molecular structure and to physics students requiring a book intermediate in scope between Stoner's small monograph, "Magnetism", and his comprehensive work "Magnetism and Matter".

It is, however, unfortunate that so great a delay has occurred between the writing and publication

of the book. The preface bears the date July 1933 and no work later than the early part of 1934 is discussed. It is thus inevitable that certain sections of such a rapidly growing subject are treated differently from what they would be in a more recent account. In particular, less space might be given to the early naïve attempts to explain the magnetic properties of complex salts, and more to the work of Pauling and its extension by Van Vleck.

L. C. J.

Woman's Position in Society

(1) Sex and Temperament in Three Primitive Societies

By Margaret Mead. Pp. xxii+335. (London: George Routledge and Sons, Ltd., 1935.) 10s. 6d. net.

(2) Woman's Mysteries: Ancient and Modern
By Dr. M. Esther Harding. Pp. xvi+342. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1935.) 10s. 6d. net.

IN these two books the factors which contribute to the determination of woman's position in modern society are considered from very different points of view, though both authors approach the question in the light of an analysis of more primitive custom and belief—in the one instance as found among modern peoples of the simpler cultures, in the other mainly relying on the evidence of the cults of antiquity.

(1) Dr. Margaret Mead's evidence is drawn from her observations of three communities living in adjacent areas on the Sepik River in Papua, the mountain-dwelling Arapesh, the cannibalistic Mundugumor, and the head-hunters of Tchambuli. These communities were visited by herself and Dr. R. Fortune in an expedition in 1931-33. Among them, Dr. Mead found some very striking differences in temperament and outlook as between the three communities. These are brought out very clearly in her interpretation of custom and institution, as well as in her observations of mentality, which are described with the lucidity and literary skill that readers of her earlier works on Samoa and New Guinea will have been led to expect. She makes out a convincing case, in these communities, at least, that qualities of temperament which it is customary to regard as sex-linked are to be regarded rather as socially determined, but that even in these primitive societies there are 'misfits'.

Applying conclusions drawn from these simpler societies to modern civilisation, Dr. Mead infers that the social dichotomy of sex, to which much of modern social unrest is here attributed, especially in so far as it affects the activities and position of women, is avoidable by a reshuffling which would allow scope for individual development without regard to the limitations of an assumed temperament imposed by convention.

Dr. Mead's volume is stimulating and provocative. While ethnographic evidence and modern experience lend some support to her views, nothing short of a much extended investigation on similar lines would warrant acceptance of her somewhat sweeping generalisations.

(2) While Dr. Mead by no means ignores emotion, and especially sexual emotion, Dr. Harding gives it what may seem an exaggerated importance. In the light of Dr. Jung's doctrine of the unconscious, she demonstrates the symbolism of cults and rituals which in the history of religion are shown to have had special reference to woman and her part in human life. She holds, for example, that the myths of the moon goddess reveal the inner subjective reality of feminine psychology, the moon being the characteristic feminine symbol. Dr. Harding finds support for her views in what is known of the mystic religions and the cults of Astarte and her counterparts in the early religions of the East, as well as in the cults of the Great Mother.

As Dr. Harding admits, such views as these are matters of interpretation, which are incapable of proof. They are to be accepted or rejected according as the psychological hypothesis, upon which they depend, is regarded as valid or not. Like other theories of the psychoanalytic school, the supporting evidence is drawn from a restricted field. When such views are tested in the light of ethnographic evidence at large, very considerable modification and adaptation are necessary.

Gmelins Handbuch der anorganischen Chemie

Achte völlig neu bearbeitete Auflage. Herausgegeben von der deutschen chemischen Gesellschaft. Bearbeitet von R. J. Meyer. System-Nummer 53: Molybdän. Pp. xviii+xi+393. (Berlin: Verlag Chemie G.m.b.H., 1935.) 64 gold marks.

MOLYBDENUM was first isolated in 1778 by Scheele, who converted the sulphide into molybdic anhydride, which was then reduced. Twenty years previously, Cronstedt had demonstrated the difference between the lustrous mineral molybdenite and graphite. It was left to Berzelius to explain the chemical character of the element by establishing the composition of molybdic acid.

In view of the wide variation in the valency of molybdenum, it is rather surprising to find that it gives rise to so few oxides. On the other hand, it yields an exceedingly rich assortment of co-ordination compounds, including the important heteropolybasic acids derived from phosphoric, arsenic, silicic and other acids. These occupy considerable space at the end of the present volume. Apart from the heteropolybasic acids, molybdic acid itself develops a high degree of complexity. The classification by Ullik in 1867 of the molybdates into groups according to the ratio of MoO_3 to R_2O , where R represents a univalent metal, was unsatisfactory since the paramolybdates interrupted the simple sequence. These were first formulated as $3\text{R}_2\text{O}\cdot 7\text{MoO}_3$ but later as $5\text{R}_2\text{O}\cdot 12\text{MoO}_3$ from analysis of the barium and thallium salts.

G. Jander and his colleagues have recently introduced a new system based upon a study of diffusion in acid solutions, which has enabled them to detect the transition from the simple MoO_3 to 6-, 12- and even 24-fold aggregates of MoO_3 in the presence of gradually increasing hydrogen ion concentration. They have also obtained confirmation of their results from measurements of the absorption of visible and ultra-violet light.

The section on alloys does not include the molybdenum steels, which are incorporated in another volume.

Exposés de biométrie et de statistique biologique

5: Les associations biologiques au point de vue mathématique. Par Vito Volterra et Umberto d'Ancona. (Actualités scientifiques et industrielles, 243.) Pp. 97. (Paris: Hermann et Cie, 1935.) 20 francs.

THIS book contains a systematic summary of a number of papers published mainly by Volterra. The problems treated may be exemplified by the following. Denote by N_1 , N_2 , N_3 the numbers of organisms of three different species, such that the first is feeding on the second and the second on the third. The authors assume simple intuitive hypotheses concerning the three species: (1) The natural death-rate of the two first of them is constant in time. (2) Besides the natural death-rate, there is for the second and third species a death-rate due to the encounters with individuals of the first or the second species respectively. These are assumed to be proportional to the products N_1N_2 and N_2N_3 respectively. (3) The

multiplication rate of the third species is proportional to $K - \lambda N_3$, where K and λ are positive constants, the negative term being due to the limitation in space occupied by the species. (4) Lastly, the total of the organisms of one species consumed by the others is transformed into flesh, so that the decrease in weight of one species is accompanied by an equal increase of the other. The above hypotheses lead to three linear differential equations in N 's, which are solved and discussed by the authors.

However crude some of the hypotheses may seem, it is extremely interesting to follow their consequences, which are found to be, on the whole, in agreement with observations, for example, of fish catch made by D'Ancona and others. Presumably, after some further test of the theory, the conclusions may find practical applications, for example, in fishing, etc. The book is brilliantly written, as is usual with the work of Volterra. J. N.

A Class Book of Magnetism and Electricity

By H. E. Hadley. Pp. x+512. (London: Macmillan and Co., Ltd., 1936.) 6s. 6d.

FROM the point of view of the teacher and the student, one can thoroughly recommend this book. It is impossible to proceed far in the study of electricity without clear conceptions of potential and potential difference. The author introduces these terms at an early stage and points out their analogy to the corresponding terms in a gravitational field of force. This is a distinct improvement on the unsatisfactory analogies to hydrostatic phenomena usually employed. The interposition of historical descriptions in the text, although they are of general interest, sometimes leads to considerable breaks in the continuity of the argument. They are therefore, at least in the chapters necessary for examination purposes, relegated to collected historical notes given at the ends of the chapters.

Although primarily intended for school certificate and matriculation examinations, this book will be found useful to all desirous of obtaining accurate knowledge about the extensive and ever increasing practical applications of electrical science. It is clearly printed and easy to read, and contains no less than 432 diagrams, many of which are novel and instructive.

Topographical Anatomy of the Dog

By Dr. O. Charnock Bradley. Third edition. Pp. xii+284. (Edinburgh and London: Oliver and Boyd, 1935.) 25s. net.

THE number of books dealing with the anatomy of the dog is strikingly small. This third edition of the topographical anatomy is a credit to the distinguished principal of the Royal Dick Veterinary College. The instructions for dissection together with the ninety-one illustrations make the book invaluable to the zoologist, physiologist and comparative anatomist.

It is to be hoped that the author will write a short book dealing with the growth of that animal which is the "friend of all our friendships and foeman of our foes".

The Evolution of Natural Fats

A General Survey

By Prof. T. P. Hilditch and Dr. J. A. Lovern

METABOLIC processes and products in living organisms are frequently specific, and it is interesting to consider what relation a classification of organisms according to their characteristic chemical products would bear to that based upon morphology. In a number of cases it has already been realised that chemical peculiarities in plants or animals are specific for a number of biologically related organisms and for no other species. The generalisations of Baker and Smith on the types of essential oils produced in different groups of eucalypts are a case in point. Similarly, it has been realised for some time that in the seed-fats of some plant families specific fatty acids are elaborated in quantity (for example, lauric in the *Palmæ*, myristic in *Myristicaceæ*, erucic in *Brassica*, etc.); while the recent observations of Heilbron and co-workers on the pigments and sterols of certain algæ disclose similar specific relationships.

Hitherto sufficient differentiation has not been defined, in any one group of related chemical compounds common to practically all organisms, to permit a comprehensive view of all forms of living matter from the metabolic or chemical standpoint. Of recent years, however, a very wide range of natural fats (triglycerides) has received detailed attention and, although there are still many lacunæ in the available data, it has become increasingly evident that many close parallelisms exist between the kind and proportions of fatty acids combined as triglycerides in living plant or animal organisms, their classification on morphological grounds, and their places in the evolutionary scale of development.

Of all the constituents of living organisms, the fats (triglycerides) are exceptionally suited to such comparisons because they contain in combination a number, often a considerable number, of individual acids which can be both qualitatively and, at least approximately, quantitatively determined. There is also considerable variation in the particular acids present, or in their proportions, in organisms of different types. These acids may be saturated (lauric, palmitic, stearic, etc.) or unsaturated (oleic, linoleic, erucic, etc.), and in the latter group the unsaturation may be restricted to one ethylenic union or may extend to as many as four, five or six. Taking the theory of evolution as a general background (as in biological correlations based upon morphology or anatomy), some

interesting relationships become apparent when we review progressive differences in fat types. From this point of view we commence with the fats of aquatic life, in the light of recent studies at the Torry Research Station.

All fats of aquatic origin are characterised by the presence in combination with glycerol of an exceptional variety of acids, mainly of the unsaturated series. The saturated acids usually form only 15–20 per cent of the whole, and of these palmitic acid, $C_{16}H_{32}O_2$, is the chief, the others (myristic and stearic) often only amounting to about 2–4 per cent and 1–2 per cent respectively of the total fatty acids. The unsaturated acids include, on the other hand, members containing 16, 18, 20, 22 and even 24 carbon atoms in the molecule (conveniently referred to as glycerides of unsaturated C_{16}^- , C_{18}^- , C_{20}^- , C_{22}^- , C_{24}^- acids) in varying proportions and degrees of unsaturation. In fats from all freshwater life, plant or animal, small or large, the type appears to be much the same, namely, that containing relatively high proportions of unsaturated acids of the C_{18}^- and C_{16}^- series, with low contents of those of the C_{20}^- and C_{22}^- series (the latter often being minimal). Again, both freshwater and marine algæ of the *Chlorophyceæ* have the same type of fat, and it appears that here both for fat type and morphology salinity has made no real difference. In the more specialised brown and red marine algæ the fat type is definitely altered, the component acids still being aquatic in range but with quantitative differences in the relative proportions of the various homologous unsaturated members. The diatoms resemble the green algæ alike in that many species can live in either fresh or salt water and that their fat is of the 'freshwater' type in all instances so far studied.

We pass on to a more general survey of aquatic animal fats. Throughout the whole animal life of fresh water we find one broad type of fat only—that already referred to as characteristic of freshwater flora. In other words, for the whole of freshwater life the relative proportions of the component acids are of the same order throughout (at the same time minor differences are to be observed, for example, higher degrees of unsaturation in the acids, and concurrent presence of small proportions of higher alcohols as well as glycerol, in the plankton *Crustacea* in contrast to

fishes, etc.). In the marine world, on the other hand, salinity or some other factor has led to a definite alteration in fat type. While, as has been said, marine diatom fat (so far as at present studied) is similar to the 'freshwater' type, the fat of marine plankton Crustacea (which feed on the diatoms) is considerably different in composition—unsaturated C_{16}^- and C_{18}^- acids are reduced in amount and C_{20}^- , and especially C_{22}^- , acids are correspondingly increased. This crustacean fat type persists as a general background throughout almost the whole range of marine fish and mammalia, although it may again be modified in certain families in various ways. In elasmobranch fish, for example, the triglycerides are often accompanied by abnormal proportions of non-fatty compounds, including especially the hydrocarbon squalene and sometimes the glycerol ether-esters known as batyl, etc., alcohols; when these substances are also produced in quantity it has invariably been found that the unsaturation of the acids in the triglycerides is almost wholly monoethenoid.

Similar specific features include the elaboration of esters of higher alcohols as well as triglycerides in depot fats of the Physteridæ (here, again, the unsaturation of the acids present is abnormally low), and that of mixed glycerides of the quite exceptional isovaleric acid in those of the Delphinidæ; such differences are as definitely characteristic as those in the anatomical features of the respective groups. Other interesting marine animal fats include those of the sturgeon, which are of the freshwater type; while salmon body fats alter progressively as the fish develop from purely freshwater to marine animals.

As we pass from depot fats of aquatic to those of land animals we find marked simplification in the mixed fatty acids, and in the higher land animals the important component acids are almost always the (monoethenoid) oleic, $C_{18}H_{34}O_2$, and the (saturated) palmitic, $C_{16}H_{32}O_2$, the latter occurring in much larger proportions than in aquatic animal fats, namely, about 25–30 per cent of the total fatty acids—a figure which is roughly the same for the depot fats of widely different animals such as the rat, rabbit, pig, sheep, ox, reindeer, horse and also, apparently, birds. Nevertheless, the disappearance of the characteristic 'aquatic' unsaturated acids of the C_{16}^- (mainly monoethenoid, palmitoleic), C_{18}^- , C_{20}^- and C_{22}^- (mono- and poly-ethenoid) series is by no means abrupt. Klenk has established the interesting fact that, in depot fats of amphibians and reptiles, unsaturated C_{16}^- , C_{20}^- and C_{22}^- acids are present, but in less amount than in fish depot fats: frog depot fat contained 15 per cent of palmitoleic and the same amount of unsaturated C_{20-22}^- acids, that of the lizard, 10 per cent of

the C_{16}^- , and 5 per cent of the C_{20-22}^- acids, while in the depot fat of the Greek tortoise the respective proportions were 9 and 7 per cent. The unsaturation of the C_{20-22}^- acids, though still high, was not so pronounced as in the fish oils. In these fats the proportion of saturated acids was not very different from that in 'aquatic' fats, and the drop in unsaturated C_{16}^- , C_{20}^- and C_{22}^- acids is balanced chiefly by increase in unsaturated C_{18}^- (mainly oleic) acid. Work at Liverpool had previously shown the presence of small quantities (6–8 per cent) of palmitoleic acid in the depot fats of rats and of the domestic fowl, together with minor amounts (0.5–1 per cent) of unsaturated C_{20}^- and C_{22}^- acids. The latter acids were already known, from the work of J. B. Brown and his colleagues, to be present in very small proportions in other animal depot fats (for example, pig) and in cow milk fat. In rats, rabbits and hens, in contrast to the frog, lizard and tortoise, the saturated acids of the depot fats form 30–35 per cent of the total acids (palmitic, 25–28 per cent).

Klenk has considered the connexion between body temperature and the amounts and degree of unsaturation of the C_{20}^- and C_{22}^- acids; we would point out here the progressive changes in depot fat component acids in conjunction with the position of the animals in the evolutionary scale. Perhaps the data we have quoted will be more clear if we tabulate the general range of values so far observed for the main component acids in some of the different groups of the larger animals:

	Component Acids (Percentage Wt.) in Depot Fat				
	Saturated Palmitic	Unsaturated			
		C_{16}^- (Palmitoleic)	C_{18}^-	C_{20}^-	C_{22}^-
Fish, freshwater	13–15	c. 20	40–45	c. 12	0–5
" marine	12–15	15–18	27–30	20–25	8–12
Whales	12–15	15–18	35–40	15–20	5–10
Frog	11	15	52	15	
Tortoise	14	9	65	7	
Lizard	18	10	56	5	
Domestic fowl	25–26	6–7	ca. 60	0.5–1	
Rat	24–28	7–8	ca. 60	0.3–0.5	
Pig	25–29	absent	50–65	0.3–1	
Ox	27–30	absent	40–50	absent (?)	

Almost all the acids other than palmitic (that is, about 70 per cent of the component fatty acids) in the depot fats of the land animals belong to the C_{18} series. In many cases, apparently (detailed analyses are, curiously, still somewhat scanty in this group except for a few common animals), these acids are largely unsaturated (oleic, with sometimes polyethenoid acids); but in the Ungulata, at all events, stearic glycerides occur, often to a marked degree, in place of oleic glycerides; and specific characteristics in the constitution of the mixed triglycerides in these depot fats, which place them apart from most other natural fats, suggest that the stearic compounds

are the result of hydrogenation of oleic derivatives. The milk fats of this group, which are, of course, also differentiated by the presence of a certain quantity of lower saturated acids (C_4 to C_{10}), share with the depot fats this particular type of glyceride structure; this feature has been the subject of many studies in our Liverpool laboratory. In contrast to elaboration of specific lower saturated acids in the milk fat of the larger land mammals, we may note in passing the observation of Schmidt-Nielsen and Frog that the component acids of whale milk fat are almost quantitatively the same as those of its depot (blubber) fat.

In the depot fats of the land animals, there occurs frequently (usually in not very large amounts) the linoleic acid, $C_{18}H_{32}O_2$, which is a component of many seed fats; but there is much reason for thinking that this is derived by assimilation from the latter. At this point it should perhaps also be said that the data quoted above refer to animals which have received their natural diet; it is well known, of course, that higher animals, at all events, are able to ingest fats from vegetable seeds, etc., and to lay down some of the specific acids of the latter in their depot fats, but this aspect of fat deposition has been excluded, so far as possible, in the observations on which this survey is based.

The parallelisms to be observed between fat types and evolution in the animal world, as outlined above, appear to possess a certain significance. It remains now to consider the corresponding sequence in the vegetable kingdom. Here, as in the fauna, the data are most abundant for depot (seed) fats of the more developed land plants; there is at present a great lack of detailed information on the characteristic fats of the lower forms of land flora and also on the glycerides present in the growing parts of the larger plants. Nevertheless, it is interesting that the unsaturated palmitoleic (C_{16}) acid, so characteristic of aquatic and lower land animal life, has been observed in quantity in the fats of a bacillus (diphtheria), of yeast (*Saccharomyces cerevisiae*), and of the spores of a cryptogam (*Lycopodium*), respectively by Chargaff, by Newman and Anderson, and by Riebsomer and Johnson.

There is some evidence that higher aquatic plants, including sub-aquatic grasses, have fat closely resembling freshwater algæ, while the work of Chibnall and others on the glycerides of forage grasses suggests the presence of unsaturated C_{18} -acids which are not identical with those typical of most seed fats. The component acids of the glycerides of the seeds (and, when present, of the pericarp or other fruit coat) of members of many plant families have, on the other hand, been widely studied in detail in recent years; especially,

perhaps, at Liverpool. The first thing which is apparent, in contrast to fats of aquatic flora, is considerable simplification in the component fatty acids. As in the land animals, palmitic and oleic become the most consistently prominent features; but a third acid, linoleic, must be added to these as a component which is of most frequent occurrence. The latter acid is either absent, or only present in small quantities, in most fats of aquatic origin, but it, and the related still more unsaturated linolenic acid, are amongst the most familiar constituents of the widely distributed class of 'drying' seed oils.

Fruit coat fats so far examined include (with at present only one exception) palmitic and oleic acids as sole major components, irrespective of the plant family in which they occur; linoleic acid is also frequently present, but usually only in minor quantities. In many seed fats, also, the bulk of the component acids is palmitic, oleic and linoleic in varying proportions; and, in general, seed fats of the same family have a certain resemblance in the relative proportions of these component acids. Malvaceæ and Bombacaceæ seed-fats, for example, are usually high in their content of palmitic acid (20-25 per cent) and also contain about 50 per cent of linoleic acid. The latter acid is prominent in many seed-fats of the conifers, of the larger dicotyledonous trees and shrubs, and in Rosaceæ, Compositæ, Labiatae, Linaceæ and other families, and also in those of Gramineæ, the component acids of most of which include about 10-15 per cent of palmitic, 30-60 per cent of oleic and 60-30 per cent of linoleic.

Land plants differ, however, from all other natural sources of fats in that, in many other families, their seed fats include as major components a fatty acid (or acids) different from any of those previously mentioned; in such cases the occurrence of the specific acid is almost wholly confined to one, or at the most to only a few, of the natural plant families. Thus the unsaturated erucic acid, $C_{22}H_{42}O_2$, is present in quantity in all Cruciferous seed fats; a structural isomeride of oleic acid, 'petroselinic acid', is similarly found in seeds of the Umbelliferae and the closely related ivy; and the cyclic unsaturated chaulmoogric and hydrocarpic acids in some of the Flacourtiaceæ. Of saturated acids, arachidic (C_{20}) and lignoceric (C_{24}), which occur in minute amounts in many seed fats, only attain major proportions in members of the Sapindaceæ and some of the Leguminosæ, whilst stearic acid (by no means so common a major component of fats as is usually supposed) is present in quantity only in the seed fats of a few tropical families. Saturated acids of lower molecular weight (lauric, C_{12} , myristic, C_{14}) are similarly characteristic of other, mainly tropical,

families; the composition of all Palmæ seed fats yet studied is remarkable for close quantitative similarity, with lauric (45-48 per cent) and myristic (16-20 per cent) as main components.

Ivanow and others have pointed to climatic temperature as the factor mainly operative in determining the relative saturation of seed fats. Production, in plants of cooler latitudes, of fats solid at the prevailing temperatures of the atmosphere is in any case not very probable; but this is not evidence that the tropical temperature *per se* causes or favours development of the more saturated fats. Actually, many of the most unsaturated fats (those of *Aleurites*, *Hevea*, *Perilla*, *Licania* species, to quote only a few) are synthesised in the fruits of plants which can only live in tropical or subtropical conditions. On the other hand, in those plants which thrive both in either hot or cold climates, the investigators quoted have demonstrated a greater production of the characteristic unsaturated acids in seeds from plants grown in the cooler regions.

In a few cases, as in *Ricinus communis*, *Picramnia* sp. or *Aleurites montana* and *Fordi*, the seed fats of one or two species of a genus elaborate quite distinct fatty acids—in the cases mentioned,

respectively, ricinoleic (hydroxy-oleic), tariric (acetylenic) and elaeostearic (conjugated triethenoid). The last-named is at present quite exceptional, since it is quite an unusual plant fatty acid, and has yet been observed (in each case in isolated species only) in the three distinct families Euphorbiaceæ, Rosaceæ and Cucurbitaceæ.

Although the biosynthesis of these specific fatty components places many of the higher land plant families apart from the rest of Nature as regards their fat types, we are left with the circumstance that the occurrence of these unusual features runs on the whole remarkably parallel with the groups into which morphologists have placed them. Apart from the widespread occurrence of specific component acids in certain plant families, there is observed a (probably gradual) simplification in fatty acid composition, commencing from the aquatic flora and proceeding in the direction of the fruit fats of the more highly developed land plants, similar to that which may be traced in the animal world. The facts to which attention is here directed illustrate that consistent and well-defined changes in biochemical as well as in biological conditions have accompanied evolutionary development in Nature.

Flora of the Sahara Mountains

By Dr. J. Hutchinson

UNTIL a few years ago, the flora of the mountains in the Sahara desert was practically unknown. Modern means of transport, however, have rendered access to these remote masses comparatively easy, and their vegetation has been fairly well investigated during the last ten years or so.

There are two main ranges in the middle Sahara (Fig. 1), the Hoggar or Ahaggar Mountains, half-way between Tunis and Nigeria, and in a direct line between them, and the Tibesti Mountains, on the western border of the Libyan desert, about five hundred miles north-north-east of Lake Chad. Due mainly to the work of French explorers and Prof. René Maire, of the University of Algiers, botanical science is now furnished for the first time with lists of the species known from these two mountain masses, which, so far as their plant-life is concerned, are like islands in a wide ocean, the 'ocean' in this case being the barren sands of the Sahara Desert. To the north of this desert is the rich Mediterranean flora and that of the Great Atlas Mountains, and to the south the vast tropical flora of Central Africa.

Prof. Maire, in a paper entitled "Études sur la Flore et la Végétation du Sahara central" (*Mém. Soc. Hist. Nat. Afr. Nord.*, No. 3; 1933), gives an account of the Hoggar Mountains flora, and last year there appeared his "Contribution à l'Étude de la Flore du Tibesti" (*Mém. Acad. Sci. France*, 62). The purpose of these notes is to compare the floras of the two mountain masses with each other and with the Mediterranean and tropical African floras to the north and south of them respectively.

Maire's contribution to our knowledge of the Central Sahara is an important one and is the result of a personal visit to the Hoggar Mountains in 1928 with a special mission organised by the governor of the territory. His account occupies 272 pages, and is illustrated by 36 photographs and 2 sketch maps. The coloured frontispiece of a lilac-flowered crucifer, *Moricandia arvensis*, DC., var. *garamantum*, Maire, shows how beautiful a flower-garden this arid region may become after rain, for it is the dominant plant of the 'acheb' on the Atakor plateau in the Hoggar Mountains. A white-flowered form occurs here and there. The

typical species is native of the Mediterranean; but this variety is endemic to the Hoggar region. From this sea of lilac rises the culminating Ilaman peak, about 9,000 ft. altitude.

Growing in association with this crucifer is a highly interesting Composite, *Pentzia Monodiana*, Maire, a representative of a genus only known previously from South Africa. Maire says of this plant: "Le *P. Monodiana* est la première espèce trouvée dans l'hémisphère boréal d'un genre jusqu'ici exclusivement austro-africain; il appartient certainement à l'élément orophile ancien de la flore africaine". I should interpret the presence

is an endemic cypress, *Cupressus Dupreziana*, A. Camus, known as 'tarout', a tree which was made known to botanists only a few years ago. But so early as 1864, Duveyrier noted the occurrence of a great forest of conifers on the southern slopes of Tassili, part of the Hoggar massif, and mistook it for the North African *Tetraclinis articulata*, Mast. (*Thuya articulata*, Desf.). It was not until 1925, however, during the expedition from Tunis to Lake Chad and Dahomey, that M. Lavauden, inspector of forests, collected portions of this conifer, which proved to be a new species of *Cupressus*. Unfortunately, he found it on the

point of extinction, but he learned from the natives that it had at one time covered the slopes of Tassili. Now only a very few living examples remain among many dead stumps, some of which reach as much as twelve feet in diameter a few feet above the ground. To the layman the possibility of an evergreen forest in the middle of the Sahara seems somewhat fantastic; nevertheless, there it was a little more than seventy years ago, and but for the ravages of the Touaregs it would be there still. It furnished timber for building the habitations at Djanet and Rhât.

There are also three species of *Ephedra*, a genus typical of such regions. Besides the edible fig, *Ficus carica*, L., there are varieties of another species, *F. salicifolia*, Vahl, which occurs in Arabia and tropical Africa, and a third species, *F. ingens*, Miq., also very common in tropical

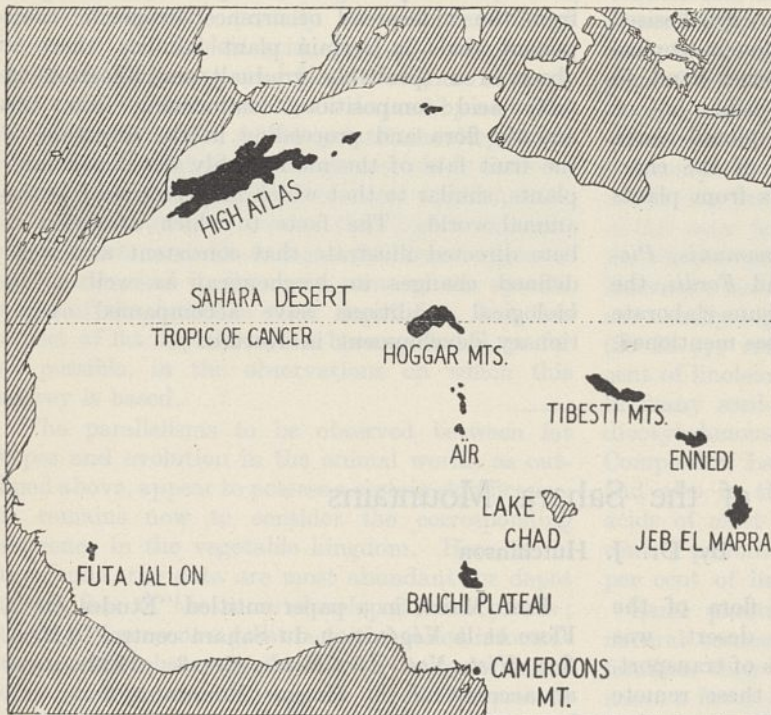


FIG. 1. Sketch map of north-west Africa showing the chief mountainous regions.

of this plant somewhat differently, however, for a study of the phylogeny and relationships of the South African species of *Pentzia* suggests that *Pentzia* has probably been derived from *Matricaria* (Chamomile), lacking only the ray-flowers of the latter genus and being usually more woody. In consequence, I would prefer to regard this newly described species of *Pentzia*, not as a relic, but as a parallel development in the northern hemisphere and derived from boreal species of *Matricaria*, just as is probably the case of the genus in South Africa, for true *Matricaria* also occurs in the latter region. Species of *Pentzia* are dominant in some parts of the South African karoo, and provide valuable fodder in that arid region.

Among the more interesting woody plants of this supposed 'desert' region in the Sahara, there

Africa. A woody parasite is *Osyris alba*, Linn. (Santalaceae), a Mediterranean species which imposes itself on a wonderful variety of hosts, for example, on such diverse plants as *Olea*, *Tamarix*, *Myrtus*, and even on *Scripus* (Cyperaceae) and *Artemisia* (Compositae). An interesting discovery is that of the Mediterranean *Clematis Flammula*, L., which is recorded for the first time at the foot of volcanic rocks in the Hoggar Mountains. There are a few woody Capparidaceae, and as many as four species of *Acacia*, which provide food for camels and other animals, a species of *Retama* (*R. raetam*, Webb), and even a *Genista* (*G. uniflora*, Briq.). *Pistacia atlantica*, Desf. (Anacardiaceae) is recorded from the Hoggar for the first time, very rare, and Prof. Maire regards it as a remarkable relict from the Mediterranean flora.

There is a variable and widespread species of *Gymnosporia* (*G. senegalensis*), and the usual species of Christ's thorn (*Ziziphus*), a species of *Grewia* (*G. populifolia*, Vahl), common farther south and extending eastward to India, seven species of *Tamarix*, and a few rock-roses (*Helianthemum*). The myrtle family is represented by an endemic species, *Myrtus Nivelii*, Batt. and Trab., and there is also a native olive, *Olea Laperrini*, Batt. et Trab., about twelve feet high with a trunk eighteen inches in diameter, very closely related to the European olive, *Olea europea*.

It may be said, therefore, that the ligneous plants of the Hoggar region show affinities with both the Mediterranean and tropical African floras.

The herbaceous vegetation is composed mainly of the most advanced families or of advanced genera which are widely spread from Morocco to Arabia and Sind. The dominant families are the Compositæ (about 60 species), Cruciferae (35 species), Papilionaceæ (31 species), Chenopodiaceæ (22 species), Caryophyllaceæ (18 species), Boraginaceæ (13 species), Umbelliferae (10 species), Labiatae (10 species).

There are as many as ten species of Asclepiadaceæ, several of them widely spread from North Africa to as far as India; but there are two endemics, *Glossonema Garitieri*, Batt. and Trab. and *Caralluma venenosa*, Maire.

The family Malvaceæ, so common in the savannah region farther south, is very poorly represented, and Acanthaceæ not at all.

The flora of the Tibesti Mountain mass, so far as known, is poorer than that of the Hoggar. Four botanical collections have been made, by Nachtigal, General Tilho, Dalloni and Tarrieux.

The range is volcanic and reaches an altitude of more than 10,000 ft., culminating in the peak called Emi Koussi. The best collection so far made is that of Dalloni, who reached an altitude of 7,700 ft., but in a poor season after prolonged drought. It is possible, therefore, that during a good season many more flowering plants would be discovered. The number of ferns and flowering plants recorded by Maire is 159.

Ephedra is represented by an endemic species (*E. Tilhoana*, Maire), and an endemic variety of *E. altissima*, Desf. (var. *tibestica*, Maire). The typical form of the latter is found also in the Hoggar and in North Africa. The Hoggar cypress has so far not been observed; but the interesting *Pentzia*, *P. Monodiana*, mentioned above, was collected by Tilho at about 9,000 ft. altitude. It is browsed by goats and donkeys.

A shrub common in tropical Africa, *Phyllanthus reticulatus*, Poir. (Euphorbiaceæ), is rare in Tibesti. The beautiful crucifer of the Hoggar, *Moricandia arvensis* var. *garamantum*, is absent; but there are two rock roses common to both mountain groups. Another interesting composite has been discovered in the Tibesti, besides the *Pentzia*, namely *Tibestina*, Maire, a new genus of the thistle tribe, and two interesting new Papilionaceæ, *Dichilus Dallonianus*, Maire, and *Lotus tibesticus*, Maire, the former claimed by its author to be of South African affinity, the latter allied to species from the Atlantic Islands.

Prof. Maire's two papers are notable contributions to our knowledge of the flora of the Sahara, and botanists will await with keen anticipation his third paper dealing with its phyto-geography and a study of its vegetation.

Obituary

Prof. I. P. Pavlov, For.Mem.R.S.

PROF. IVAN P. PAVLOV, who died on February 27, was by common consent the doyen of physiologists. This position he achieved by reason of his great age, his great distinction, and his great vitality. His age was such—he celebrated his eighty-fifth birthday in 1934—that few living workers in Great Britain even came within measurable distance of being his contemporaries, whilst to most, Pavlov's early working years appeared to go back into a distant past. Yet even apart from that, Pavlov was to English workers a somewhat remote figure until within the post-War period*. This perhaps was because he was not a particularly good linguist: he spoke German and had worked in Germany, but he was never at home in English.

* Notwithstanding that Pavlov visited Cambridge in 1912 to receive an honorary degree.

Nevertheless, though not well known personally in England, Pavlov's name became one with which to conjure in the early nineties of last century as the result of his work on digestion. His book "The Physiology of the Digestive Glands" produced a profound impression throughout the scientific world, and at once placed Pavlov not only in the first rank of physiologists, but also of scientific men of whatever kind. So far as the technical side of Pavlov's work on digestion was concerned, the great progress which he made was due to his recognition of two principles: first, that the deductions from his experiments would be misleading if the animals on which those experiments were made were in pain or even in a disturbed mental condition; and secondly, that no better results could be obtained if the animals were under a general anæsthetic. Thus Pavlov set himself, by ingenious surgical methods, so to dispose the parts

of his experimental animals that, while the relevant organs were accessible, the animals were happy and in their usual health. In this way he observed the properties of the principal digestive secretions, the conditions under which those secretions took place, and their interrelation.

Much of the ground has been covered since on man; but the whole of it never can be on a single patient or at a single time, because the repetition on man of some one observation of Pavlov's depends upon the chance of a patient at the same time being the victim of some unusual accident and falling into the hands of a doctor with the scientific ability to profit by the occasion. Pavlov's work on dogs, the items of which form a continuous whole, can be checked on man—one item on one patient say in Chicago, another on a different patient in Boston, a third in London, and so on—everything being referred to the original work as to a builder's line. Sometimes complete identity is found between the human findings and the canine and sometimes a species-difference; but though there is nothing very new in the evils accidents involve, the knowledge to be derived from them is duly threaded together on the basis of Pavlov's work.

Another and entirely novel aspect of Pavlov's work on the digestive glands must be mentioned, and one entirely in keeping with his own character; it had a very human side. Not only was there close and correct thinking; not only tables of concentrations of this and that; but at the end there appeared a reasoned basis for age-old human customs: for why the menu was as it was; for why the *hors d'oeuvres* should precede the soup and the soup the joint. Perhaps most important of all, a new light was shed upon dietetics, no less than that—other things being equal—a condiment was likely to be digestible in proportion as it appealed to the palate. This, at the end of the Victorian era, amounted almost to a revolution. It was on the basis of his work on the digestive glands that Pavlov, shortly after the establishment of the Nobel Foundation, was the recipient of the Nobel Prize for Physiology and Medicine (1904).

Since the Great War, Pavlov has visited English-speaking countries on a number of occasions, the most recent of which was the Neurological Congress in London last summer. In 1928, he gave the Croonian Lecture at the Royal Society. Naturally, to those who knew him only as a researcher of great eminence, it was a matter of no small interest to discover what manner of personality this distinguished visitor possessed. At once the appeal which Pavlov had already made to the intellect spread no less powerfully to the heart. Pavlov became an object of affection to all with whom he came in contact. He came, of course, in very unusual circumstances: his country had passed through perhaps the most searching revolution of all time, and it had emerged the champion of simplicity; its creed that the figure of a man was to be measured by his personality and not by the circumstances of his birth. Pavlov was in a sense cast for this role: on great occasions, when others were adorned with

the panoply of circumstance, Pavlov, the greatest of them all, stood up in the simple suit of rough blue serge enjoined by the canons of the Soviet, and elevated that dress to a uniform more dignified than all the rest. He was a soldierly figure, rather spare, but vibrant with energy, the embodiment of dignity; but ere long the dignity expanded into benignity.

An incident may be recalled which at once illustrates Pavlov's concentration and his sense of humour. In the year 1928, Pavlov gave a lecture to a packed audience of Cambridge undergraduates. The scheme was as follows: Pavlov was to lecture in Russian for half a minute at a time and Dr. G. Anrep then to translate. After perhaps three such cycles, Pavlov got so engrossed in his subject as quite to forget that his audience did not understand what he was saying. On and on he went for perhaps five minutes—then it dawned upon him. He wrung his hands, he burst into peals of laughter, the whole audience rocked—Pavlov had completely won the undergraduate heart.

Little need be said of the second phase of Pavlov's work, that on conditioned reflexes: it is well known and has been fully dealt with in *NATURE* (Jan. 3, 1925) by the late Prof. Starling, which was accompanied by a photogravure portrait of Pavlov. Among the main conceptions of his work on the higher nervous centres are: that behaviour depends largely upon the balancing of excitatory and inhibitory activities—'do's' and 'don'ts'; that both may be 'conditioned', that is, associated by habit with some stimulus which appears to have little connexion with the action (as, for example, if a light is always turned out three minutes before a dog is given food, the dog will ultimately secrete saliva three minutes after the illumination whether the food be given or no); that owing to temperamental differences, some creatures will react more readily to the positive and others of the inhibitory stimuli; that sleep is a form of conditioned inhibition; that the even balancing of conditioned reflexes urging action in opposite directions may produce a conflict and ultimately a violent neurosis.

Perhaps the most arresting fact about Pavlov's later years was the enormous prestige which he possessed in his own country. Any such crude statement as that Pavlov was in an exalted position because the mechanistic trend of his work on conditioned reflexes furnished a prop for irreligion, seems to do less than justice both to Pavlov and to the Soviet. In proportion as a culture writes off the supernatural, it will regard the highest study of mankind as man, and the highest phases of human study as those of the nature and products of his intellect. Such studies are treated with the greatest emphasis in the Soviet Union. The marvellous collections in the Hermitage Museum at Leningrad of Scythian and Iranian art would not be cherished as they are except as manifestations of the development of the human mind. By a stroke of fate, it happened that the man who had done more than any other to analyse experimentally the workings of the intellect coincided in time and place with a culture which elevated that mind to a place accorded elsewhere to the supernatural.

Scientific distinction alone would not have given Pavlov the influence which he possessed. To distinction was added a fervent love for Russia and complete loyalty to her institutions. Not that Pavlov was a propagandist. So far as I know he took no part in politics, and that coupled with the fact that he was without guile probably contributed in no small degree to the trust which his Government placed in him.

The impression with which to end this slight tribute is that of Pavlov's home life. As he loved his country, so he loved his family. His tastes were simple; he loved digging the soil and spent his leisure largely in gardening. The prospect of, say, some new seeds filled him with enthusiasm, but they would be the seeds of some simple colourful species—for example, a new kind of poppy.

No better example than Pavlov could be quoted to illustrate the kinship between simplicity and greatness.

JOSEPH BARCROFT.

Dr. G. T. Prior, F.R.S.

GEORGE THURLAND PRIOR, keeper of minerals in the British Museum from 1909 until 1927, died on March 7 at the age of seventy-three years. He went to the Department of Minerals at the Museum at the close of a successful career at Magdalen College, Oxford, where he had gained a demyship in natural science in 1881, and a first class in the Honour School in Chemistry (1885) and Physics (1886). He studied for a short time in Germany, and entered the British Museum in 1887 a few years after the opening of the new building for the Natural History Departments.

Prior's first duties at the Museum were concerned entirely with the chemical analyses of minerals, work which had hitherto been done almost entirely by Dr. Walter Flight. He was a born chemist, and excelled in the careful manipulation of small quantities of material and in the patience with which he selected and prepared his materials for analysis.

The value of Prior's work was soon recognised, and in 1900 he was awarded the Wollaston Fund by the Geological Society of London. At that time, he had begun to be interested in petrography, and in his thanks to the president of the Geological Society he spoke of his intention to make his mineralogy more geological in its character. This promise was speedily carried out, and there followed a series of papers on the petrography of the volcanic rocks of British East Africa and the antarctic continent, based on the collection of J. W. Gregory in Kenya Colony, and on those made on numerous expeditions to the Antarctic. His account of the rocks collected by H. T. Ferrar during Scott's *Discovery* expedition of 1901-4, being printed only in a British Museum publication, is less widely known than his numerous papers in the *Mineralogical Magazine*.

Prior's work in petrography is distinguished by the skill with which from among the masses of material in the rock collections at the British Museum he selected the important and interesting specimens, and clearly and briefly described their characters. His

pioneer work on rocks from remote regions suggested to later workers many lines of fruitful study.

On the appointment of Sir Lazarus Fletcher to the directorship of the Natural History Museum, Prior became Keeper of Minerals. Almost at once he took up the work on meteorites begun in the Museum by Story-Maskelyne and continued by Fletcher. Here again his complete mastery of inorganic analysis led to the production of a series of chemical studies of meteorites, on which he based a classification of the greatest importance. He showed that there is a very definite and significant relation between the ratio of iron to nickel in the nickel-iron and the ratio of magnesia to ferrous oxide in the ferromagnesian silicates in a meteorite, a relation possibly accounted for by progressive oxidation acting on a common magma from which meteorites are derived.

During his keepership, Prior revised Fletcher's "Introduction to the Study of Rocks", rewrote the British Museum "Guide to the Collection of Meteorites" and completed a comprehensive catalogue of the meteorites in the British Museum collection, perhaps the finest in the world. The conclusion of this work was fittingly acknowledged by the award of the Murchison Medal of the Geological Society in 1927.

Prior's lovable, gentle character endeared him alike to friends and colleagues, and his published papers, numerous though they are, form only a part of his work, so much of which was devoted to the help of others who came constantly to seek his advice and assistance. He was general secretary from 1909 until 1927 and president in 1927-30 of the Mineralogical Society, and a vice-president of the Geological Society of London from 1921 until 1923. He was elected a fellow of the Royal Society in 1912. He married in 1914 Esther Louisa Alberta, daughter of the late Mr. Henry Cole of Cork, who survives him together with two daughters.

W. C. S.

ACCORDING to a note in the *Chinese Journal of Physiology*, 1935, Eric Reid, of the Henry Lester Institute of Medical Research, Shanghai, died there on November 24, 1935. Reid was born on October 3, 1906, at Gamrie, in Banffshire, Scotland. In 1929-32 he worked at the Rowett Research Institute, Aberdeen, upon the absorption of foodstuffs, chiefly carbohydrates and phosphates, from the alimentary canal. Going to Shanghai in 1933, he undertook a study of basic facts regarding the composition of local foodstuffs, general dietaries and infant feeding and much of this programme was accomplished.

WE regret to announce the following deaths:

Mr. Harold Brown, O.B.E., for the past ten years principal of the Plant and Animal Products Department of the Imperial Institute.

Prof. J. S. Haldane, C.H., F.R.S., director of the Mining Research Laboratory and honorary professor in the University of Birmingham, at midnight on March 14-15, aged seventy-five years.

News and Views

Mr. H. N. Ridley, C.M.G., F.R.S.

MR. H. N. RIDLEY, the well-known Malayan botanist and director of the Gardens, Straits Settlements, 1888-1911, was eighty years of age on December 10, 1935, and Part 1 of vol. 9 of *The Gardens' Bulletin* (Govt. Printing Office, Singapore, Dec. 20, 1935) has been dedicated to him. Mr. Ridley did more than any other individual to add to the knowledge of the flora of the Malay Peninsula: his "Flora" is the foundation for all later work. It was in rubber that perhaps his greatest economic work was done. He strongly advocated the plantation of Para rubber, and it is said that his pioneer tapping experiments were largely responsible for the foundation of that industry, upon which so large a share of the wealth of Malaya has rested. He also took up the study of minor products, both agricultural and forest, and reported on timbers, rattans and other products about which there was little original information extant. According to the *Bulletin*, Mr. Ridley during sixty-three years of activity published more than five hundred books, papers and notes.

BETWEEN 1888 and 1894, in addition to being director of the Gardens, Mr. Ridley was also director of forests, Straits Settlements. It was to Ridley's initiative and knowledge during the last dozen years of the century that the country was not in many important parts deprived entirely of its forests through the practice of shifting cultivation, coupled with ignorant exploitation. With the progress made in the political management of the States, the development of agriculture was a necessity, and towards this Ridley lent an invaluable hand. But outside, or between agriculture and forestry, came the new industry of rubber. The whole growth of this industry corresponded with Ridley's period of service from its earliest infancy to the great boom in 1910-11. On the economic side of his activities Ridley was a prodigious worker; but on the other side he turned out, as is well known, an enormous amount of purely botanical work. It was due to his work that the Malayan Forest Department was able to start off with immeasurably more knowledge of the composition of the forests than is the common lot of tropical foresters generally. His "Flora of the Malaya Peninsula" and "Malay Plant Names" were invaluable aids. The *Bulletin* also contains an appreciative note on Ridley's work on the flora of the Netherlands Indies.

Refugee Scientific Workers and other Scholars

AN appeal over Lord Rutherford's name appeared on March 18 for support for the formation of a Society for the Protection of Science and Learning, to act as a permanent successor to the Academic Assistance

Council. In the past three years, the Council has given extremely valuable assistance to university teachers displaced in Germany for political or 'racial' reasons, and has also been able to help refugee scholars from other countries. Of the 700 German refugee scholars, 363 are already permanently re-established, and a further 324 are still being temporarily maintained as research guests. Recent developments in Germany, especially since the publication of the Nuremberg legislation, have convinced Lord Rutherford that there is a continuing need for an assistance organisation, and the Council can no longer regard its work as purely of a temporary emergency character. Membership of the Society for the Protection of Science and Learning, which will take over the duties of the Council, is open to all who pay an annual subscription of a guinea or more, or covenant for a seven-year contribution, or make a capital donation or bequest. Lord Rutherford hopes that the Society will build up an 'academic assistance fund' from which research fellowships and studentships can be awarded to scholars displaced from any country on grounds of race, religion or political opinion. This fund will be administered under the auspices of His Grace the Archbishop of Canterbury, the president of the Royal Society, the president of the British Academy, Lord Horder, Lord Rutherford and the Hon. R. H. Brand. We hope that Lord Rutherford's appeal will meet with a generous response. It would be a magnificent demonstration of the widespread desire to defend the freedom of learning if the new Society had a large membership drawn from outside as well as from within the academic world. Contributions should be sent to Lord Rutherford of Nelson, O.M., F.R.S., President, Academic Assistance Council, 12 Clement's Inn Passage, Clare Market, W.C.2, made payable to the "Academic Assistance Council".

Australia and the Mandates

ALTHOUGH there has been a tendency, owing to the course of events, to focus attention on Africa in discussing the future of mandated territories, the uncompromising attitude of the Commonwealth ministers in reply to questions in the Federal Parliament on March 13 serves as a reminder that in Australia this question is regarded as a vital issue. Not only did Mr. Lyons, the Prime Minister, affirm the Commonwealth's whole-hearted support of the British Government's declaration on the matter of the return of the colonies to Germany, but also Sir George Pearce, Minister for External Affairs, in the Senate, as reported in *The Times* of March 14, recapitulated the strategic arguments, which make the retention of German New Guinea by Australia and the Japanese mandate essential conditions of the

security of Australia and of stability in the Pacific. He struck to the root of the matter, however, when he reminded his hearers that Australia in her administrative policy in New Guinea has been actuated by the British conception that colonial possessions are trusts to be administered in the best interests of the native populations. In support of this contention, Sir George pointed out that in present conditions the natives of the territory formerly German New Guinea are better protected, and that the development of roads, shipping, air transport and medical and educational services have contributed to their well-being and contentment. It is perhaps worth while to add, for the benefit of those who have not followed closely the extension of the administrative services of Papua to German New Guinea since the latter became a mandated territory, that this successful result is not fortuitous. It arises out of the efforts which have been made on behalf of the Australian Government to add to scientific knowledge of the country and people, and the administration's far-sighted adaptation of that knowledge to the needs of the situation.

Flying Boats for North Atlantic Air-Routes

IN addition to the specially fitted Short flying boats, and the Mayo composite aircraft mentioned in NATURE of March 7, p. 390, an order has now been placed for two four-engined De Havilland monoplanes for experimental Atlantic flights. It is understood that a regular North Atlantic air mail service is first visualised, which will be thoroughly tried out before passenger services are attempted. The new De Havilland machines are based, in design, on the 'Comet' type, that won the recent England to Melbourne air race, and bear a strong resemblance to them in general appearance. They are monoplanes, with the four 'Gipsy' engines partially buried in the wings, and are fitted with retractable undercarriages. The bodies of the machines are constructed so as to float in the event of a forced landing on the water, and additional buoyancy is given by a watertight construction of the wings. Messrs. De Havilland's method of fabrication, as used on the 'Comet', lends itself very well to this requirement. It is estimated that the cruising speed of the machines will be more than two hundred miles an hour, with an air endurance of three thousand miles. This same type should also be suitable for long-range high-speed naval reconnaissance. It is anticipated that these machines will be ready for delivery by November or December next.

New Fruit Products

FOR the past few years the Fruit Products Department of the University of Bristol Research Station at Long Ashton has been engaged in the experimental production of various wines, syrups, squashes, liqueurs, etc., prepared from the common varieties of fruits grown commercially in Great Britain. The work has now reached a stage where many of the products are capable of commercial manufacture, and on March 11 a demonstration was held at which

an opportunity was provided for representatives of food and beverage manufacturers and others interested in the industry to sample the various new preparations. Several fruit syrups were available which retained the natural flavour of the fruit after being stored for a number of years. These were particularly attractive in conjunction with cream ice in the American fashion, strawberry and loganberry syrups being outstanding examples. The juices of these two fruits were also successfully made into pleasing wines, whilst a spirit distilled from strawberry juice and flavoured with loganberry syrup made an attractive liqueur. Fruit squashes were also represented, that from black currant being of particularly pleasing quality. A number of non-alcoholic apple juices were displayed, and methods of storing these beverages without fermentation were demonstrated. In view of the probable rapid development of milk bars, much interest was shown in the 'milk shakes' prepared from a wide variety of pure fruit syrups, and data were presented to show that curdling of the milk does not normally occur at ordinary temperatures. The ultimate object of this work is to provide new outlets for fruit, in addition to those already existing through the fresh-fruit markets and the canning and jam industries. It is anticipated that this will lead to a considerable increase in fruit growing in Great Britain, whilst at the same time the grower will be assured of disposing of the bulk of his crop, and the serious wastage hitherto associated with glut crops will be considerably reduced.

Bibliography of Natural History

ON March 14, a meeting was held at the Royal Entomological Society of London to consider the foundation of a society for the study of the bibliography of natural history. Dr. C. Davies Sherborn, in opening the meeting, gave a brief statement as to the reason for the summoning of the meeting, and invited those present to express their views as to the desirability of establishing a society. In the discussion which ensued, warm approval was expressed with the proposal to found a society, especially in view of the suggestion that such a society should undertake the publication of a journal to which interested persons could turn for information on matters concerning the bibliography of natural history. At the conclusion of the discussion, Mr. W. L. Selater moved "that a Society for the study of the bibliography of natural history be founded, those persons here present, together with those who had signified their agreement with the aims of the Society and were unable to be present, being constituted Original Members". This proposal, seconded by Dr. Karl Jordan, was carried unanimously. It was then decided to appoint the following committee to deal with the preliminary details, and the committee was instructed to call a general meeting in three months' time: Dr. C. Davies Sherborn, Prof. W. A. F. Balfour-Browne, Francis Hemming, J. Ramsbottom, Dr. T. A. Sprague, A. Cockburn Townsend, Francis J. Griffin. All inquiries should be addressed to Mr. F. J. Griffin at 41 Queen's Gate, South Kensington, S.W.7.

Galileo and Scientific History

A LETTER has been received from Prof. Lane Cooper with reference to the article by Prof. A. S. Eve which appeared in *NATURE* of January 4 (p. 8). Prof. Lane Cooper suggests that physicists should find much to interest them in Aristotle's "Dynamics" (pp. 26-33) and in Aristotle's "Physics", edited by W. D. Ross (Oxford, 1936). There is a further suggestion that Salviati may have referred to the Tower of Pisa (178 ft.), while Sagredi might have considered the Campanile of Venice (323 ft.). Prof. Lane Cooper directs attention to the curious mistake of Galileo, namely, that "in free fall, wood starts off faster than lead". Moreover, Galileo, about 1590, claims that he had "often tested this". It must be remembered that Prof. Lane Cooper's main interest is in language and literature, and that his personal interest lay in the growth of a myth. He further questions whether those who suppose that a theatrical Galileo ascended the Tower, after due advertisement, to perform modern experiments with free fall before the mob, are really honouring that great and good man. "If Stokes and Rayleigh had lived in Galileo's day, would either of them have lent himself to a display of the sort?"

Control of Power Networks

THE problem of nation-wide electricity supply has undergone considerable changes in recent years. Electric power has been applied to many services, with the result that continuity of supply has now become almost essential to the life of the community. Economy in capital costs entails the reduction of spare plant to a minimum by creating a common pool. Economy in running costs necessitates the placing of the generating stations in such positions that fuel and water costs are reduced to a minimum. This has led to the linking up of distributing networks and power stations, and it is essential that the controlling engineer should be immediately informed of any appreciable change in the load on the networks. This subject was discussed in a paper read to the Institution of Electrical Engineers on February 7 by G. A. Burns and T. R. Rayner. They describe the automatic methods by means of which the engineer is at once informed of the state of the load at a distribution substation, and the methods by means of which the apparatus is started and circuits opened and closed without using any manual labour. There are already in service on various sections of the British grid 150 installations of the apparatus the authors described. It embodies automatic telephone apparatus spread over very wide areas. The components employed are the same as those incorporated in about eleven million lines of automatic telephones spread over practically every country in the world. This proves the robustness of construction and the stability of the apparatus components used in the system described in the paper. It is interesting to notice that the problems arising in connexion with the control, distribution and protection of power networks have been practically solved by the adaptation of methods and apparatus used in automatic telephony.

Mathematics in Engineering

THE scholastic method of dividing mathematics into various branches called geometry, algebra, trigonometry, calculus, etc., has advantages from the point of view of the teacher, but according to Dr. A. Russell, in the *Faraday House Journal* for the Lent term 1936, there is no need for the engineering student to handicap himself by solving a problem by some particular method. This custom was fostered in Great Britain some fifty years ago by the old-fashioned syllabus for the Cambridge Mathematical Tripos. In the old days, the Tripos used to last for nine days, and was divided into two periods of four and five days each, separated by an interval of ten days. Four of the papers were marked in the syllabus 'easy problems'; but few of them were easy. The problem papers sometimes had between twenty and thirty questions, and so the time of most of the candidates was largely expended on reading them. The candidates were also harassed by hearing quill pens scratching and squeaking all round them, as fountain pens were not then used. During the first three days of the examination, the use of the calculus was taboo. In the Euclid paper, the use of algebra or trigonometry was not permitted. In another paper the candidates were examined on the first three sections of Newton's "Principia". This was not difficult, but the riders were, as it was imperative to prove them by Newton's methods. These were the days in which there was a 'senior wrangler', and the mathematical coaches coveted the honour of having trained one almost as much as the owner of a racing colt covets winning the Derby. Dr. Russell illustrates the 'all-in' methods by applying them to geometrical problems.

Bathymetry of the Oceans

THE nomenclature of ocean deeps is still in some confusion, and this is largely due to the use of fathoms in Great Britain and metres in most other countries in the record of depths. In the *Challenger* reports, Sir John Murray named the areas over 3,000 fathoms as 'deeps'. This figure was arbitrary and when converted into metres (5,486 metres) has even less significance as a criterion of depth, although the Prince of Monaco in his "Carte générale bathymétrique" of 1912 adopted the near equivalent of 6,000 metres and many of the *Challenger* names. In *Petermann's Mitteilungen* of February, Dr. G. Wüst proposes a new system of nomenclature for the ocean features of the world which incorporates a good deal already in use by G. Schott. He chooses 4,000 metres (2,187 fathoms) as his standard. In depths of less the bottom figures as ridges: in depths of more as basins. The 'deeps' in the older sense of the term disappear from Dr. Wüst's map. Each feature receives a geographical name derived from its location, and the personal names commemorating oceanographers are not used. The figure of 4,000 metres is of course arbitrary except in so far as it approximates to the depths at which the average ocean floor lies. The map shows both Atlantic and Indian Oceans divided into east and west troughs,

each in turn divided into basins, and the Pacific Ocean divided into a wide central trough and narrow western and (south) eastern troughs. A second map divides the surface waters on the same basis and gives a name to the sea overlying each basin. This is of more doubtful value, and some of the names are unlikely to gain general acceptance.

Bathymetric Charts of the Oceans

At the Seventh International Oceanographical Congress held in Berlin in 1899 it was decided to draw up a general bathymetric chart of the oceans. Through the generosity of H.S.H. Prince Albert I of Monaco, it was possible to produce the first edition in 1904 and a second edition which was begun in 1912 but not completed until 1930. After the death of the Prince of Monaco, it was decided that a new edition should be prepared by the International Hydrographic Bureau at Monte Carlo. The first sheet of this third edition, Sheet A.1 (North Atlantic from Equator to lat. 47° N.), is now on sale at a price of 35 French francs. Since the publication of the last edition, echo-sounding has come into general practice, and in the construction of Sheet A.1 some 70,000 soundings were examined. As a result, the many inequalities of the bottom of the sea are now being disclosed in areas previously thought to be more or less smooth. The sheet (1 ft. 11 in. by 3 ft. 3 in., chart dimensions) is coloured to show the depth contours of the ocean and the principal mountain ranges of the continents.

Forty-Six Years of Phenology

MR. J. EDMUND CLARK'S important paper on "The History of British Phenology" (*Quart. J. Roy. Meteorol. Soc.*, 62, January 1936) comes at a time when the six hundred or so phenological observers organised in Britain by the Royal Meteorological Society are beginning their annual observations on the dates of flowering of plants, song of birds, appearance of migrants, butterflies, etc. In Great Britain organised phenology dates from Gilbert White's classic eighteenth century observations. The Royal Meteorological Society's phenological reports were begun in 1875 by the Rev. Thomas A. Preston, of Marlborough School, who made about 20,000,000 calculations. From 1889 until 1910 Edward Mawley organised them with 22-23 observing stations watching 50 plants, 14 birds, 6 insects and frog spawn. From 1911 until 1913, Messrs. J. E. Clark and R. H. Hooker were responsible, in 1914 Mr. Clark, and from 1915 until 1920 (during which year 5,000 reports were tabulated) by Messrs. J. E. Clark and H. B. Adames. For the last five years, Messrs. J. E. Clark, I. D. Margary and C. J. P. Cave have been responsible for them, and in 1930 as many as 18,000 records were tabulated. Critics of the exhaustive series of statistics and maps published annually in the Phenological Report will probably, after the half century of work is reached, appreciate their value in that the deductions are already proving useful for farm and garden crops.

Central Agricultural and Scientific Bibliography

MODERN mass-production of scientific and technical literature led first to the growth of comprehensive abstract services, which, as literary proliferation increased, have tended to bury the references to articles on specific subjects in the mass of abstracts on all subjects. Thus has developed the present-day demand for specialised bibliographies—lists of references classified according to the titles of the articles noticed, and informing about the quantity rather than the quality of scientific literature. A comprehensive bibliography on all branches of agriculture and allied subjects is now being organised at the Science Library, South Kensington, London, S.W.7. As the Library takes most of the four thousand or so agricultural journals published throughout the world, it offers unusually good facilities for the preparation of such a bibliography. Subscribers, paying 10s. per annum as individuals, or £5 5s. as institutions, will have full access to the bibliography and special facilities for reference to books in the Library. Translations and abstracts will also be made. The service commenced on March 1.

The Applications of Fluorescence

In a paper read to the Illuminating Engineering Society on January 14, Mr. F. E. Lamplough pointed out some useful applications of fluorescence. The work is carried out both by visual and photographic methods, and as the fluorescence colours as a rule bear little relation to the natural colours of substances, it often happens that colourless materials and those of identical natural colours can readily be distinguished by their fluorescence. This method is used by detectives, experts and collectors. It has been used for deciphering ancient manuscripts from which the writing had been erased, for detecting alterations in pictures, for distinguishing between old and new marble, cut ivory or bone. Repairs to pottery, glass and woodwork are at once evident. It is of equal value in the examination of foodstuffs, textiles and paper. It has been used to yield pictures of fossils otherwise almost invisible. Some use of it has been made in display and advertising as well as in stage and film work. Extensive use was made of fluorescence in the film production of H. G. Wells's "Invisible Man". If the skin of the actor is made non-fluorescent and his suit strongly fluorescent, then in ultra-violet light the suit appears to walk about in the most amazing manner without visible means of support. The use of fluorescence to vary the colour of a source of light was demonstrated by means of a series of discharge tubes, in which the light given by the discharge was changed by coating the interior of the tube with different fluorescent powders.

Biochemical Research in India

THE annual report of the Indian Society of Biological Chemists gives as usual a comprehensive summary of the work carried out during the past year (Society of Biological Chemists, India. Biochemical and Allied Research in India in 1934.

Pp. ii+107. Bangalore: Indian Institute of Science). The subject matter is divided into nine sections ranging from enzymes and plant and animal nutrition to chemistry in relation to pharmacology. Reference is made to more than three hundred papers, and there is a name index. The publication indicates the variety of the researches carried out by chemists in India, and provides a useful means of obtaining summaries of work published in detail in many different journals, including NATURE.

Third World Power Conference

THE Third World Power Conference and the Second Congress of the International Commission on Large Dams of the World Power Conference are to be held in Washington concurrently on September 7-12. Arrangements are in course of completion for the preparation of a thoroughly authoritative collection of British papers. The British Committee on Large Dams has arranged for the preparation of several papers for presentation at the Second International Congress. The meetings will be both preceded and followed by 'study tours', an essential feature of which will be 'round-table discussions' which will be linked up with the places of technical interest visited. It has been felt that as the questions to be dealt with at the plenary meeting are largely economic and administrative in character, a due balance will be preserved by emphasising the technical character of the study tours and of the round-table discussions between specialists which will be associated with them. There will also be a post-Conference trans-Continental tour of about three weeks' duration, the cost of which will be remarkably low since—thanks to the generosity of the American hosts—a substantial subsidy will be devoted to reduce what would otherwise be the very considerable expenditure involved. Intending participants in the Conference or Congress are requested to apply as soon as possible for full particulars to the office of the British National Committee of the World Power Conference, 36 Kingsway, London, W.C.2.

Announcements

PROF. A. C. SEWARD has been appointed a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

SIR ROBERT ROBERTSON, who has just retired from the post of Government chemist, and Mr. John Smith, formerly director of animal health in Northern Rhodesia, and since 1933 a member of the Colonial Advisory Council of Agriculture and Animal Health, have been appointed members of the Agricultural Research Council.

At the annual general meeting of the Microchemical Club held at the Imperial College of Science and Technology on March 14, the following officers were elected: *Hon. Secretary*, S. J. Folley; *Hon. Treasurer*, L. H. N. Cooper; *Hon. Librarian*, Isobel H. Hadfield. N. G. Heatley and C. H. Price were elected to the Committee.

UNDER the auspices of the Society of Glass Technology, the second International Congress on Glass will be held in London and Sheffield on July 2-11. Full particulars of arrangements will be issued later; but further information can be obtained from Prof. W. E. S. Turner, The Society of Glass Technology, Darnall Road, Sheffield, 9.

WE have received from the Safety in Mines Research Board a full Subject Index for the first eight volumes of its publications (1927-34) including the title page and table of contents of vol. 9 of that publication, comprising its Twelfth Annual Report together with a full list of papers Nos. 82-88, giving the results of its work in 1934. There is also a page containing instructions for binding, which advises users of the Index to re-number the publications of the Board.

THE Royal Scottish Geographical Society has recently issued an appeal for the proposed Dr. Marion Newbigin Memorial Fund. Dr. Newbigin, who died on July 10, 1934 (see NATURE, 134, 206; 1934), was editor of the *Scottish Geographical Magazine* from 1902 until her death. This, and her textbooks, of which there were more than a dozen, brought wide training and distinction in natural science to the service of geography. The memorial will probably take the form of an annual reward for a prize essay, a memorial medal or a memorial prize. Donations should be forwarded to Sir T. B. Whitson, Royal Geographical Society, Synod Hall, Castle Terrace, Edinburgh, 1.

ERRATUM. In the obituary notice of Prof. J. H. Ashworth which appeared in NATURE of February 22, p. 304, it is stated that he was brought up in Bolton. This is incorrect; he was brought up in Burnley.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

A technical assistant in agricultural economics in the University of Leeds—The Registrar (March 30).

Civilian technical assistants (engineering and physical) in the Admiralty Technical Pool—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (April 3).

An investigator on the cold-working of metals in the Department of Metallurgy of the University of Sheffield—The Registrar (April 11).

A University demonstrator in geodesy in the University of Cambridge—Dr. F. C. Phillips, Department of Mineralogy and Petrology, The University, Cambridge (April 15).

An assistant director and secretary of the Manx Museum, Douglas—The Director (April 18).

An abstractor of scientific and technical literature at the Shirley Institute, Didsbury, Manchester—The Director.

A professor of engineering in the University of Melbourne—The Universities Bureau of the British Empire, 88A Gower Street, W.C.1.

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. 498.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Lightning-Stroke Discharges in the Laboratory

DURING the past decade, investigators have made many attempts towards producing effects in the laboratory simulating in a measure the lightning discharges observed in the field. The natural outcome of high-impulse voltage and heavy impulse current generators has been the combination of the two into a lightning-stroke generator. This combination has been accomplished at the Sharon High Voltage Laboratory.

The lightning-stroke generator was briefly described, in principle, by me in the *Electric Journal* of June 1935, pp. 239-240. Since then, extensive tests have fully confirmed that the lightning-stroke generator, now developed, can produce the full lightning-stroke discharge observed in Nature. Fig. 1 shows a lightning-stroke flashover of a five-unit pedestal insulator column (25 cm. diameter disks, height of column 140 cm.). The voltage breakdown of the column is initiated with a steep-fronted impulse by means of a 3,000,000-volt impulse voltage generator. Upon flashover of the column and by means of a 'microsecond switch', a heavy current is connected to the test piece and it feeds into the arc a current of lightning-stroke intensity

and duration, that is, a current of approximately 100,000 amperes and 50-100 microsecond duration.

The 'microsecond switch' may take several forms. A very effective form consists of a fuse link of proper

resistance and fusion characteristics connecting the heavy current generator to the test piece. The link, depending on the flashover distance of the test piece, varies from about 100 ohms to 1,000 ohms. In length, it varies from a few centimetres to two metres and even more. The voltage generator initiates the breakdown even of high-voltage apparatus (insulator strings, full-sized wood poles, pillar insulator column (Fig. 1), etc.), that the current generator alone could not break down on account of its inherently low voltage. The resistance of the link prevents the voltage generator from discharging through the low-impedance circuit of the current generator. The action is as follows: first,

the test piece is flashed over with a steep-fronted impulse in about a microsecond or less. In the next few microseconds the high-resistance link is fused into a low-impedance arc, thus enabling the full discharge of the current generator to follow the voltage breakdown across the piece tested.

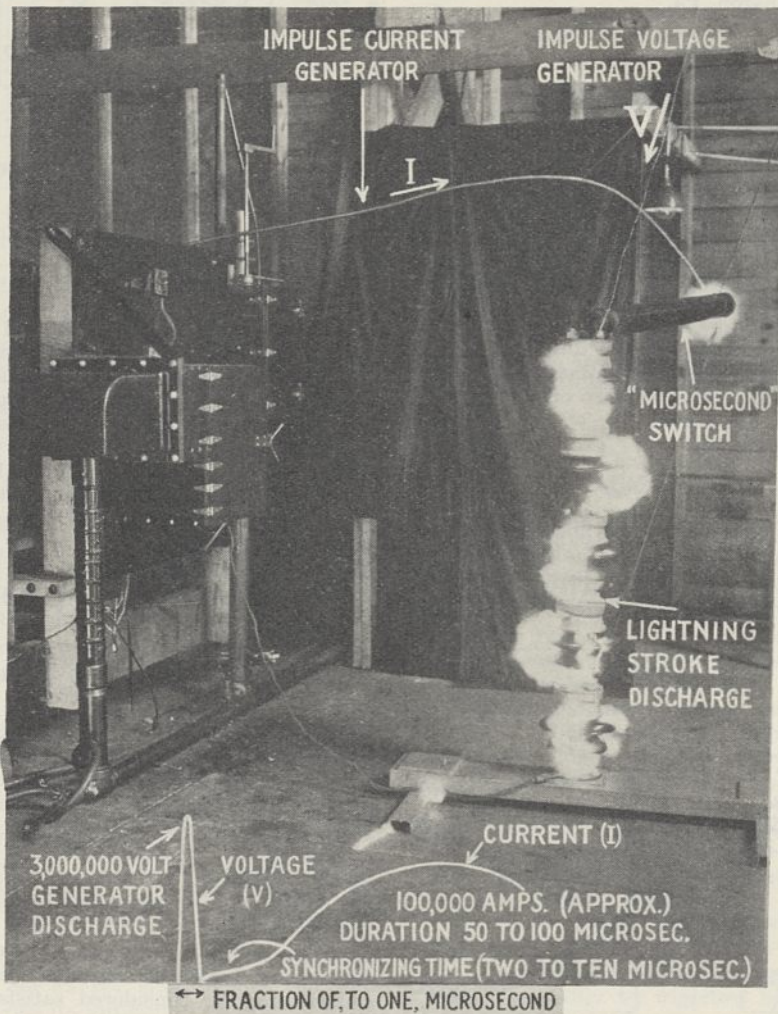


FIG. 1.

This combined impulse voltage and current generator or lightning-stroke generator simulates in effect the dielectric and dynamic stresses imposed on wood poles, insulator strings, electrical apparatus, etc., much the same as these occur from natural lightning. As an example of the destructive effect of the laboratory tests, full-sized wood poles—exactly identical with the poles employed in the distribution of electricity—have been split lengthwise by one or two discharges of the lightning-stroke generator. The resemblance of the poles split in the laboratory to those split by natural lightning is markedly close. Other interesting tests with the lightning-stroke generator will appear in due course in the technical literature.

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An Atomic Theory of the Magneto-Caloric Effect

As a result of an investigation on the change of temperature with magnetisation, Mr. T. Okamura has succeeded in separating the reversible and irreversible thermal effects. He has shown that the irreversible temperature variation agrees satisfactorily with the Honda-Okubo theory of ferromagnetism¹.

An explanation of the reversible effect may be given on the basis of the same theory. It is concluded that there are two factors contributing to this effect, the first being the volume change due to magnetostriction. According to the Honda-Masumoto theory² of latent heat of fusion, the increase of energy, δW_1 , due to the volume expansion, δv , of the substance during fusion is given by

$$\delta W_1 = p|\delta v| = (c|\delta v|)/(6v_s\alpha) \quad (1)$$

where c , v_s and α are the specific heat, the specific volume and the coefficient of thermal expansion at the melting point; p is the effective 'dynamical pressure'. The observed latent heats of fusion of a

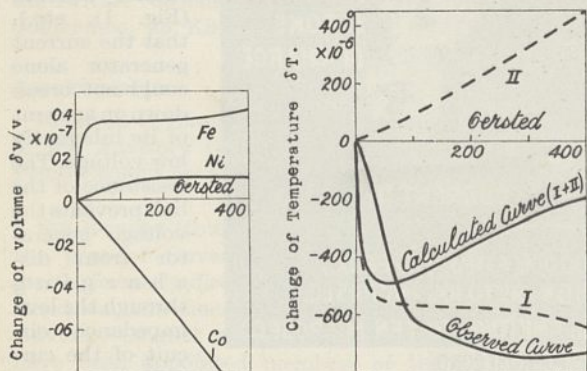


FIG. 1. Change of volume due to magnetostriction.

FIG. 2. Magneto-caloric effect for iron.

large number of elements agree fairly well with the theory. Taking for δv the volume change due to magnetostriction, and using the room temperature values of c , α and v_s , the heat absorption associated with the magnetostriction volume change may be obtained.

According to the Honda-Okubo theory of ferromagnetism, as the magnetic field increases, there is an increase in the kinetic energy of the magnetic atoms associated with their rotational vibration about their mean positions. This contributes a second factor to the reversible thermal effect. Near saturation the

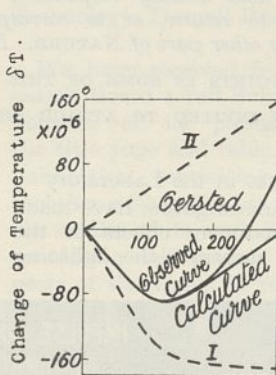


FIG. 3. Magneto-caloric effect for nickel.

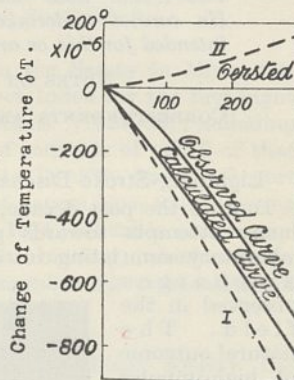


FIG. 4. Magneto-caloric effect for cobalt.

calculation of δW_2 is very simple and leads to the following relation:

$$\delta W_2 = 2MN [1 - \{E(\beta_0/2)\}/\{K(\beta_0/2)\}] \delta H \quad (2)$$

Here M is the magnetic moment of one atom, N the number of atoms per unit volume, K and E complete elliptic integrals of the first and second kind, and β_0 the initial amplitude of vibration, which is a function of temperature. In the initial stages of magnetisation, however, many of the atomic magnets are directed oppositely to the field. The effect of magnetisation on such magnets is to reduce their kinetic energy by an amount which can be calculated from (2). For weak magnetisation, therefore, an approximate value of δW_2 may be obtained by substituting NI/I_0 for N , where I and I_0 are the intensity in the given field and the saturation intensity. The total change of temperature due to the two effects considered is then given by

$$\delta T = -\frac{1}{6\alpha} \cdot \frac{1}{v} \cdot \left| \frac{\partial v}{\partial H} \right| \delta H + \frac{2MNI}{c\rho I_0} \left\{ 1 - \frac{E(\beta_0/2)}{K(\beta_0/2)} \right\} \delta H \quad (3)$$

where ρ is the density. In Fig. 1 the magnetostriction data³ used in the calculations are given; the curve for nickel is based on a provisional estimate, as the available experimental values do not agree even in sign. Figs. 2, 3 and 4 show the theoretical curves for δT together with the experimental curves of Mr. Okamura. In these figures (I) and (II) refer to the first and second terms respectively in equation (3). In view of the experimental difficulties, and of the approximations made in the calculations, the agreement between the observed and theoretical values may be considered satisfactory.

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¹ K. Honda and J. Okubo, *Sci. Rep. Tôhoku Univ.*, **5**, 153 (1916).
² K. Honda and H. Masumoto, *ibid.*, **20**, 342 (1931).
³ Fe: new measurements by Y. Masiyama, Co: M. Kornetzki, *Z. Phys.*, **87**, 560 (1934). The effective field corresponding to the applied field in Kornetzki's experiments was deduced from a magnetisation curve for cobalt.

On the 'Permalloy Problem'

SINCE the discovery of permalloy in 1923¹ the problem of explaining the very high permeability observed with 78 per cent nickel and the special heat treatment ('permalloy heat treatment') leading to these high values, has raised a good deal of discussion² and many *ad hoc* hypotheses have been put forward^{3,4,5}.

F. Lichtenberger⁶, basing his explanation on Becker's theory, assumes that permalloy owes its unique properties to the neighbourhood of three singular points in the nickel iron system: 71 per cent, where the crystal anisotropy vanishes, 82 per cent where the absolute value of the magnetostriction passes through a minimum, and 85.5 per cent where the anisotropy of the latter vanishes.

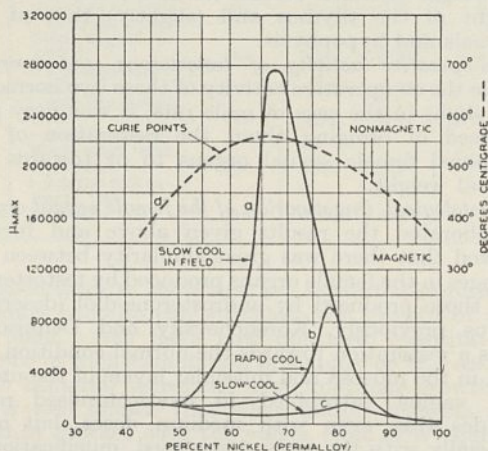


Fig. 1. Maximum permeabilities of iron-nickel alloys cooled in different ways after annealing at 1,000° C. Curie points of the same alloys are shown by the broken line.

It seems to me that recent experiments of Dillinger and Bozorth⁷ on the influence of a magnetic field applied during cooling, combined with the work of Yenssen and Ziegler⁸ and Ruder⁹ on the influence of grain size and crystal orientation on the permeability of iron and silicon iron, together with a renewed estimation I have made of the exact situation of the first mentioned singular point, definitely make it clear that Lichtenberger's explanation is essentially the right one.

Fig. 1 of Dillinger and Bozorth's paper (page 280), where the result of three different heat treatments is given, is reproduced here (Fig. 1) in order to facilitate the explanation. Slowly cooling in zero field brings the disturbing influence of magnetostriction on the permeability into full action due to the different positions of the magnetisation being 'frozen in'. This results in a low permeability, especially where the Curie point lies well above 500° (the flowing limit). The first thing to be noted now is that in this case the maximum permeability is found exactly at 82 per cent, where the mean magnetostriction has its minimum value (not zero!).

By the permalloy heat treatment (rapid cooling from 600°) the 'freezing' process is eliminated, and the permeabilities are accordingly much higher. The maximum shifts to lower nickel concentrations, while the crystal anisotropy, the other disturbing factor, is lower there.

Heat treating in a magnetic field results in a further radical elimination of the disturbing magnetostriction effects (only in one direction this time).

This has two consequences: first, the permeability is again increased enormously in the region where the Curie temperature is high enough. At the same time, however, the remaining influence of the crystal anisotropy clearly establishes itself by the circumstance that a pronounced maximum appears this time *just at the concentration where the crystal anisotropy vanishes* (66 per cent according to a renewed estimation I have made¹⁰).

Dillinger and Bozorth explain the same maximum by a corresponding maximum in the Curie point; the above explanation, however, seems to me to be the more probable one.

A direct influence of crystal anisotropy on the permeability has been established in pure samples of iron and silicon iron of varying grain size^{8, 9}. The fact mentioned by Dillinger and Bozorth that heat treating pure iron in a magnetic field has little or no influence on its permeability finds its explanation in the same way, the crystal anisotropy of iron being rather strong.

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¹ H. D. Arnold and G. W. Elmen, *J. Franklin Inst.*, **195**, 621 (1923).
² L. M. McKeehan and P. P. Cloib, *Phys. Rev.*, **28**, 146 (1926).
M. Kersten, *Z. Phys.*, **71**, 553, 572 (1932).
³ G. W. Elmen, *J. Franklin Inst.*, **207**, 583 (1929).
⁴ O. Dahl, *Z. Metallkunde*, **24**, 107 (1932).
⁵ A. Kussmann, B. Scharnow and W. Steinhaus, *Festschrift der Heraeus Vacuumschmelze*, 310 (1923-1933).
⁶ F. Lichtenberger, *Ann. Physik*, **15**, 45 (1935).
⁷ J. F. Dillinger and R. M. Bozorth, *Physica*, **6**, 279 (1935).
⁸ T. D. Yenssen and N. A. Ziegler, *Trans. Amer. Soc. Met.*, **23**, 556 (1935).
⁹ W. E. Ruder, *Trans. Amer. Soc. Met.*, **22**, 1120 (1934).
¹⁰ W. G. Burgers and J. L. Snoek, *Z. Metallkunde*, **27**, 158 (1935).

Electrical Conductivity of Thin Films of Rubidium on Glass Surfaces

THE electrical conductivity of films of the order of a few atomic diameters in thickness has been investigated for rubidium on pyrex glass surfaces. The work, carried out under rigid conditions of purity and high vacua, has yielded results differing so markedly from those of previous investigators that a preliminary note of the results seems worth while.

A defined beam of rubidium atoms is condensed on a flat pyrex glass surface at temperatures of 90° K. or lower. Contacts to the film are made by thin layers of colloidal graphite baked on to the surface. Owing to a discrepancy in the published data of the vapour pressure of rubidium, the film thicknesses quoted below may all be too small by a factor of 2, but this doubt should shortly be removed by an independent calibration of the apparatus by the hot tungsten filament method.

The influence of the surface condition on the resistivities has been thoroughly investigated, and it has been found possible to reproduce a standard surface infallibly by vigorous heat treatment. The accompanying table gives a brief summary of the

Film thickness (No. of atomic layers)	Resistivity (ohm cm.)		
	90° K.	77° K.	64° K.
1	2×10^2	8×10^1	2×10^{-3}
5	8×10^{-3}	3×10^{-4}	3×10^{-5}
10	8×10^{-4}	3×10^{-5}	1×10^{-5}

Resistivity of the bulk metal, 1.13×10^{-4} ohm cm. at 273° K.; 2.6×10^{-6} at 90° K. (Hackspill).

resistivities of the films in ohm cm., as a function of the temperature of deposition and film thickness, obtained on this reproducible surface.

If the deposition is stopped, the films normally show a decay of conductivity with time, even though the surface is maintained at the temperature of deposition. The magnitude of this decay depends critically on the condition of the surface on which the film is laid down, but becomes consistent after very vigorous heat treatment of the surface. It then decreases as the temperature of deposition is lowered and, provided the temperature is low enough, may be completely arrested. For example, a film of 10 atomic layers thickness deposited at 64° K. is quite stable, and a temperature/resistance curve can be obtained over the range from 64° K. to 90° K. Although this stable film of 10 atomic layers is quite invisible, the resistance has fallen so low as 30 ohms between opposite edges of a patch about 1 cm. sq., giving a resistivity only four times greater than that of the bulk metal at the same temperature.

At this temperature of deposition the conductivity first becomes appreciable with only $\frac{1}{2}$ an atomic layer on the surface. Apart from Reinders and Hamburger², previous investigators have been unable to detect conductivity in films of thickness less than about 40 layers. Also even for thicknesses of several hundred atomic layers, the resistivity of the film has not approached that of the bulk metal. For example, Reinders and Hamburger (*loc. cit.*), using evaporated silver films, only attained resistivities within ten times that of the bulk metal at about 400 layers. The improved vacuum conditions of the present work probably account for the marked difference in the results now obtained.

It seems possible to explain these resistivities by allowing for the modification in the mean free path of the electrons when the film thickness is less than the normal mean free path in the bulk metal.

A full account of this work will be published shortly, including a discussion of the complex phenomena of decay in terms of a tearing up of the film under surface tension forces.

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¹ *C.R. Acad. Sci.*, **151**, 305 (1910).

² *Rec. d. Trav. Chim. Pays Bas*, **50**, 441 (1931).

Biological Properties of Testosterone

THIS male sex hormone was extracted from testes by Laqueur and his co-workers¹ and prepared artificially by Ruzicka and Wettstein² and also by Butenandt and Hanisch³. In our experiments with testosterone (Ruzicka's artificial hormone, prepared and kindly supplied by Messrs. Ciba, Ltd.), the following results were obtained:

Castrated male rats. One rat unit (author's method of assay) was found to be contained in about 8 γ ; that is, of the male hormones or their derivatives which have so far been obtained, the minimal dose, which shows a definite effect of the hormone, is least in the case of testosterone.

However, even a daily dose of 1410 γ (= 176 rat units), injected for 23 days, failed to bring about a complete restoration to the normal weight of the atrophied prostate and seminal vesicles of rats

castrated about fifty days before starting the injections ('recovery test').

In contrast to this, a return to the normal condition after the injection of testosterone was obtained in the case of the adrenals (which are enlarged in castrated rats), liver, kidneys, heart and probably thyroid (all of which are decreased in weight by castration). The gain in body weight increases after injections without any definite changes in the deposition of fat, which indicates a favourable stimulating effect on the anabolic processes in the general metabolism of the tissues and organs.

Ovariectomised rats. Testosterone injected alone brought about hypertrophy of all the atrophied sexual organs towards but not to the normal weight (except in the case of the female preputial glands, the weight of which became normal); decreased the weight of the thymus and (slightly) that of the adrenals and hypophysis.

Co-operative activity of testosterone and oestrone. While the co-operative activity of these two hormones was slight in the case of male rats, it was very pronounced in bringing about the restoration of the atrophied female sexual organs to or towards the normal weight.

Histological investigation of the female sexual organs corroborated the results given above and further showed that there was great similarity between the changes in the female organs produced by testosterone and those produced by androsterone-diol (described by us previously, Korenchevsky and Dennison⁴). Thus a restoration towards the normal condition was seen in the mucosa and muscular layers of the uterus and vagina (atrophied in ovariectomised rats). Besides this, even with medium doses, but more especially with the large doses used, mucification of the vaginal epithelium was obtained to a degree (with large doses) which was similar to that observed during pregnancy.

Therefore, both our previous results, obtained with androsterone and androsterone-diol, and the present results with testosterone, show that the 'male' hormones have some of the important properties of 'female' hormones. Since the urine of females has been proved to contain 'male' hormones (not identified up to the present), there should be a co-operative activity in the female organisms between these hormones and oestrone, which, together, should control the structure and function of the sexual and some other organs.

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¹ Laqueur, David, Dingemans and Freud, *Acta Brev. Neerland.*, **5**, 84 (1935). David, *Acta Brev. Neerland.*, **5**, 85 (1935).

² Ruzicka and Wettstein, *Helvet. Chim. Acta*, **18**, 1264 (1935). Wettstein, *Schweiz. Med. Woch.*, **65**, 912 (1935).

³ Butenandt and Hanisch, *Ber. deut. chem. Gesellschaft.*, **68**, 1859 (1935).

⁴ Korenchevsky and Dennison, *Biochem. J.*, **29**, 2534 (1935). *J. Path. and Bact.*, **42**, 91 (1936).

Stimulation of Root-Hair Growth in Legumes by Sterile Secretions of Nodule Bacteria

WHEN a legume root is infected by the nodule organism, the formation of the young nodule is brought about by the multiplication and growth in size of the root-cells, principally in the cortex. In lucerne and clover, the bacteria are at first enclosed in 'infection threads', and it can be seen in young

nodules that the stimulation to growth and division of the host cells extends beyond the cells actually entered by the bacteria. Stimulation must be due, therefore, to diffusible secretions of the bacteria. Nevertheless, scarcely any evidence appears in

can be related to other growth-stimulating substances, such as the auxins, and 'pantothenic acid', which is claimed by McBurney, Bollen and Williams⁴ to be synthesised by nodule bacteria.

Evidence is still needed as to whether the same substance stimulates growth of cells within the root. Molliard⁵ claimed that sterile bacterial secretions caused the growth in thickness of pea roots, but evidence in support of this claim has not yet been obtained in the present work.

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Effect of the Secretions of Nodule Bacteria upon the Deformation and Mean Length of Lucerne Root-Hairs.

(The standard errors are based on replicate cultures.)

Set	Treatment	Root-hair deformation			Mean root-hair lengths in μ (20 root-hairs per culture)	Number of replicate cultures
		Number of root-hairs examined	Per cent deformed	Number of replicate cultures		
A	Control; no secretions	2,616	6.16 \pm 0.79	8	140.8 \pm 13.3	4
B	+ fresh secretions of nodule bacteria	901	30.04 \pm 7.11	4	304.4 \pm 40.4	4
C	+ bacterial secretions heated to 120° C.	893	49.0 \pm 6.97	4	295.8 \pm 11.5	4
D	+ reprecipitated gum	894	15.8 \pm 2.93	4	208.7 \pm 37.9	4
E	+ gum-free secretions	747	42.5 \pm 8.44	4	281.1 \pm 47.1	4
F	+ gum-free secretions after acid treatment	806	27.3 \pm 8.2	4	231.7 \pm 39.7	4
G	+ lucerne root extract; no secretions	345	5.06 \pm 3.0	2	150.0 \pm 13.4	2

published work to show that the separated secretions of nodule bacteria can stimulate cell growth of the host plant. We have now obtained quantitative evidence of such stimulation in a study of the action of the bacterial secretions upon root-hair growth.

It is well known that when nodule bacteria are placed in contact with the young roots of a legume, they produce a typical deformation of the root-hairs, which is a necessary prelude to infection. Deformation of the hairs can be produced by a sterile filtrate containing the secretions of the bacteria (Hiltner¹, McCoy²). In experiments in which lucerne seedlings were grown in an agar medium to which was added a sterile filtrate containing the secretions of nodule bacteria, it was found that these secretions, besides deforming the root-hairs, also increased their number and their mean length (Thornton³).

The accompanying table shows data obtained in an experiment using the general technique adopted by Thornton³. The results reveal some of the properties of the active substance. The growth-stimulation and the increased deformation of the root-hairs were roughly proportionate. Heating to 120° C. for fifteen minutes in neutral solution did not affect activity (set C). Treatment of filtered secretions with acetone precipitated a gum. This gum, washed in absolute alcohol, and redissolved in water, was less active than the whole secretions (set D). The gum-free secretions, after boiling off the acetone, maintained an unimpaired activity (set E). This activity seemed less after boiling for four hours with 0.5 per cent aqueous sulphuric acid, afterwards neutralised with barium carbonate (set F); but owing to the rather large standard errors, this difference was statistically insignificant. Since the bacteria, from which the filtered secretions were obtained, had been grown on lucerne root-extract agar slopes, the effect of this root-extract upon the root-hairs was tested (set G): it was found to be inactive.

Further data are needed before the component of the bacterial secretions that is active upon root-hairs

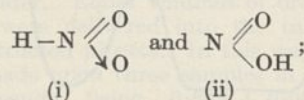
¹ Hiltner, L., *Arb. Gesundheitsamt.*, 1, 177 (1900).
² McCoy, Elizabeth, *Proc. Roy. Soc.*, B, 110, 514 (1932).
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⁴ McBurney, C. H., Bollen, W. B., and Williams, R. J., *Proc. Nat. Acad. Sci.*, 21, 301 (1935).
⁵ Molliard, M., *C.R. Acad. Sci.*, 155, 1531 (1912).

Constitution of Formic Acid and Formates

IN a previous communication¹, one of us put forward the idea of the difference in constitution of formic acid and formates.

E. V. Zappi² has shown that formic acid and its esters are without action on mercurous nitrate solution—the general reagent proposed by him for the detection of enols. Formates, on the other hand, we have found, immediately reduce mercurous nitrate. That the reducing property is due to formate ion is also shown by plotting the degree of dissociation of formic acid and the corresponding percentage of mercuric chloride reduced—the curve being linear.

The isomorphism of nitrites with formates was also observed (l.c.). Nitrous acid has two tautomeric structures:



owing to the presence of a co-ordinate linkage between N and O the prototropic change takes place readily in alkaline solution, giving rise to nitrites of constitution (ii), the pentavalent nitrogen in (i) becoming trivalent in (ii).

True formate ion, $\text{H}-\text{C} \begin{array}{l} \nearrow \text{O} \\ \searrow \text{O} \end{array}$ is isosteric with

$\text{H}-\text{N} \begin{array}{l} \nearrow \text{O} \\ \searrow \text{O} \end{array}$ and likewise undergoes prototropic change in water giving rise to a tautomeric ion $\text{C} \begin{array}{l} \nearrow \text{O} \\ \searrow \text{OH} \end{array}$. Abnormal behaviour of formates is due to this change.

Raman spectra of equimolar solutions of formic

acid and formates reproduced in Fig. 1 indicate distinctly the correctness of the above assumption, namely, that formic acid is *normal* in constitution, that is to say, the $-\text{CH}-$ oscillation ($2,963 \text{ cm.}^{-1}$) exists in its aqueous solution (Fig. 1, *a*) while in formate solution it is non-existent (Fig. 1, *b*).

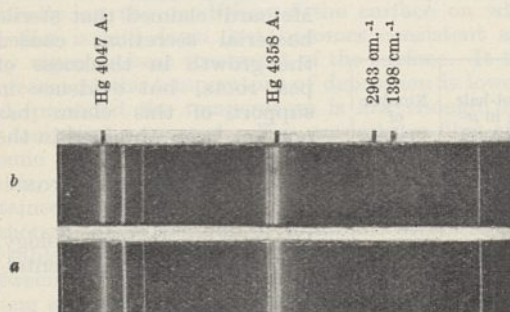


FIG. 1.

We have also examined the infra-red absorption curve for a number of formates (barium, cadmium, sodium, etc.) in the *solid* state. Fig. 2 indicates the infra-red absorption curve of sodium formate in the solid state and also in aqueous solution. The absorption maximum corresponding to 3.46μ , characteristic of all aliphatic $-\text{CH}-$ linkage, is present in the solid formate but absent from its aqueous solution.

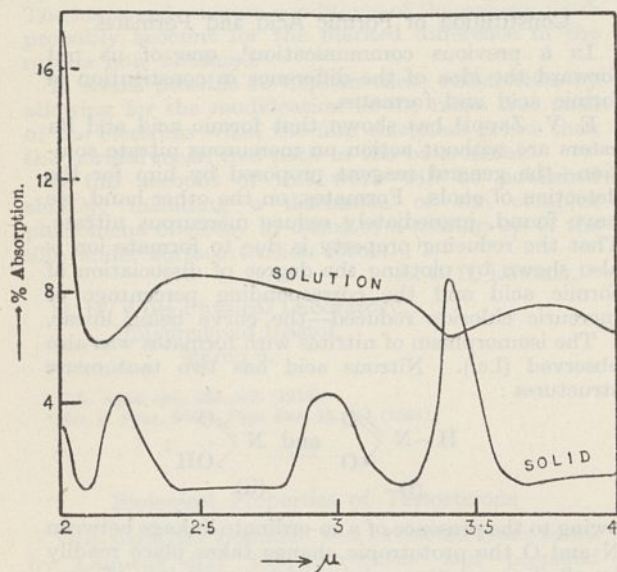
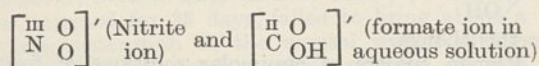


FIG. 2. Infra-red absorption curves of sodium formate (solid and in solution).

Hence we conclude that formic acid, formic ester and solid formates are *normal* in structure; abnormality appears in the aqueous solution of formates due to prototropy.

Comparison of CO_3^{2-} and NO_3^- ions reveals the fact that they are isosteric and iso-structural but not iso-electric, carbon being a tetrad and nitrogen a pentad.



are isosteric as well as iso-electric, nitrogen being a triad and carbon a diad.

The formate ion in aqueous solution should be logically called 'carbonite', from analogy with nitrite.

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¹ NATURE, 133, 646 (1934).

² Bull. Soc. Chim., 51, 57 (1932).

Absorption Spectra of Nitrates in the Vapour State

THE experiments of Franck and his collaborators¹ on the absorption spectra of alkali and silver halides made it desirable to extend such investigations to more complex inorganic molecules. Nitrates appear to be highly suitable for this purpose, since they invariably liberate NO_2 as a product of decomposition on heating, which can be easily recognised by its two characteristic sets of bands. Furthermore, the nitrate ion exhibits selective absorption with a sharp maximum at about $300\text{--}290 \mu$, as shown by alkali nitrates in solution and by solutions of dilute aqueous nitric acid. On the other hand, in nitric acid in the vapour state and in hexane solutions, and also in ethyl nitrate in the vapour state; this maximum disappears and is replaced by a very diffuse and flat one between about² 270μ and 260μ . This evidently gives a simple criterion for the existence of electrovalent and covalent forms.

The absorption spectra of a number of inorganic nitrates have been measured by heating in vacuum, to about 100° above the melting point of the anhydrous salt, in a porcelain tube of 80 cm. length placed in an electric stove and closed by water-cooled quartz windows. Some, such as cadmium nitrate, decompose too rapidly for measurement, but most of the compounds exhibit a flat and diffuse maximum of selective absorption between about 270μ and 260μ . The figures in μ are as follows: KNO_3 , 267; AgNO_3 , 263; $\text{Mg}(\text{NO}_3)_2$, 270; $\text{Pb}(\text{NO}_3)_2$, 268.

It is therefore concluded that the nitrates are covalently bound in the vapour state and constitute another example of the facile transition from covalent to electrovalent linkage. The absorption spectra of some nitrites and sulphates indicate a similar phenomenon.

A detailed report will be given in the *Proceedings of the Indian Academy of Sciences* (Bangalore).

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¹ Z. Phys., 43, 155 (1927); 56, 548 (1929); 63, 724 (1931), etc.
² Cf., for example, V. Halban and Eisenbrand, Z. phys. Chem. 132, 433 (1928). J. W. Goodeve, Trans. Farad. Soc., 30, 504 (1934).

Kinetics of Formation and Decomposition of Dicyclopentadiene

THE reaction *cyclopentadiene* + *cyclopentadiene* \rightleftharpoons *dicyclopentadiene* is reversible, and is bimolecular in the direct and monomolecular in the reverse directions. No observation indicates that a chain mechanism is involved. The association was measured in benzene solution between 15° and 55° , and the

decomposition in paraffin solution between 135° and 175°. The Arrhenius equation $k = Ze^{-E/RT}$ proved to be valid.

	Z	E
Bimolecular Association	1.2×10^6 1/gm.-mol. sec.	16.4 kgm. cal.
Monomolecular Decomposition	6×10^{12} sec. ⁻¹	34 kgm. cal.

The association is 'slow' because the value of Z is much smaller than the collision frequency in the gas phase (about 10^{11}). This cannot be connected with a restricted probability of electron transition because the Z value of the decomposition reaction is almost normal¹. This indicates that the slowness of the formation of *dicyclopentadiene* is best explained by a statistical mechanical treatment of entropy change².

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Feb. 8.

¹ Wigner and Polanyi, *Z. phys. Chem.*, **139**, 439 (1928).

² Eyring, *J. Chem. Physics*, **3**, 107 (1935) and subsequent publications. Evans and Polanyi, *Trans. Farad. Soc.*, **31**, 875 (1935). Cf. also Rodebush, *J. chem. Phys.*, **1**, 440 (1933); Rice and Gershinowitz, *ibid.*, **2**, 853 (1934).

Collision Frequency in Solution; Kinetics of Diene Syntheses in Solution and in the Gaseous State

In the Arrhenius equation

$$k = Ze^{-E/RT} = PCe^{-E/RT},$$

C is the collision frequency and P the 'steric factor'. For gas reactions the kinetic theory gives $C \sim 10^{11}$. Bimolecular reactions in solution can be divided into two main types¹: (a) reactions involving simple ions where $Z \sim 10^{11}$; (b) reactions involving molecules with many internal degrees of freedom, where $Z \ll 10^{11}$ ('slow reactions'). For reactions (a) a statistical mechanical treatment shows² that P should be of order unity and here it can be concluded that C is of order 10^{11} . For reactions (b) a statistical mechanical calculation of P is difficult and thus it is possible a priori that C falls below the gas value by several powers of ten.

This possibility can be tested by comparison of the kinetics of the following diene syntheses: (1) benzoquinone + *cyclopentadiene*; (2) *cyclopentadiene*-benzoquinone + *cyclopentadiene*; (3) *cyclopentadiene* + *cyclopentadiene*; (4) α -naphthoquinone + *cyclopentadiene*; (5) acrolein + *cyclopentadiene*; (6) acrolein + isoprene; (7) acrolein + butadiene; (8) crotonic aldehyde + butadiene. 1-4 were examined in solution³ and 5-8 in the gaseous state⁴. All are homogeneous bimolecular associations of the type $a + b \rightarrow c$, and all obey the Arrhenius equation. The values for Z and E are given in the accompanying table. It will be observed that for all the eight reactions Z is of the order 10^6 , whether in the gas phase or in solution.

Reaction	Formula of Reactants	$Z \times 10^{-6}$ (1/gm.-mol. sec.)	E (kgm. cal.)
1	$C_6H_4O_2 + C_5H_6$	2.5 ⁵	11.6 ⁵
2	$C_{11}H_{10}O_2 + C_5H_6$	0.33	13.2
3	$C_5H_6 + C_5H_6$	1.2	16.4
4	$C_{10}H_8O_2 + C_5H_6$	0.06	10.0
5	$C_2H_3O + C_5H_6$	1.5	15.2
6	$C_2H_3O + C_5H_6$	1.0	18.7
7	$C_2H_3O + C_5H_6$	1.5	19.7
8	$C_2H_3O + C_5H_6$	0.9	22.0

For the bimolecular associations in the gaseous state (5-8), C must be $\sim 10^{11}$ and therefore $P \sim 10^{-5}$. This small steric factor is explicable by reference to the passage of translational and rotational degrees of freedom of the reactants into vibrational degrees of freedom of the 'intermediate configuration'.

The molecules involved in the diene syntheses in solution are more complex than those involved in the gaseous reactions. For the associations here considered a larger number of degrees of freedom of the reactants will have the effect of either decreasing the steric factor P or leaving it unchanged. It follows that for 1-4 the upper limit of P is $\sim 10^{-5}$, and C at least 10^{11} . Hence for 'slow' reactions (type b) the collision frequency is not lower than that obtaining in the gas phase.

The author is indebted to Prof. C. K. Ingold for his interest in this work.

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¹ Moelwyn-Hughes and Hinshelwood, *J. Chem. Soc.*, 230 (1932); Moelwyn-Hughes, *Chem. Rev.*, **10**, 241 (1932); "Kinetics of Reaction in Solution", Oxford (1933).

² Cf. papers mentioned in the footnote of the preceding letter.

³ Wassermann, *Ber.*, **66**, 1392 (1933); *NATURE*, **134**, 101 (1934); *J. Chem. Soc.*, 828, 1511 (1935); *Trans. Farad. Soc.*, **62**, 69 (1936) and preceding letter.

⁴ Kistiakowsky and Lacher, *J. Amer. Chem. Soc.*, **58**, 123 (1936).

⁵ These figures have been calculated from measurements over a larger temperature interval than those in *Ber.* and *J. Chem. Soc.*, *loc. cit.*

Diamagnetic Susceptibility of Heavy Water

THE diamagnetic susceptibility of heavy water has been measured by Selwood and Frost¹ using a specimen only 92 per cent pure, and by Cabrera and Fahlenbrach² with a 99 per cent pure specimen. A specimen of 99.2 per cent purity having recently become available, it was thought worth while to measure the susceptibility by Gouy's method, using apparatus already set up for other investigations of which details have appeared elsewhere³. Two specimen tubes were used containing approximately 1.32 gm. and 1.01 gm. of ordinary water to their respective filling marks. The procedure was to take a reading with ordinary water in the tube and then with heavy water. Equal volumes of ordinary and heavy water were delivered into the tube from a specially constructed pipette. In this way measurements were made upon three samples in each tube, the mean results being $0.649 \pm 0.001(3)$ and $0.649 \pm 0.001(0)$ in units of 10^{-6} , for the two tubes, obtained by taking the susceptibility of ordinary water to be 0.720 at 20° C. The final mean value, corrected for the presence of ordinary water, is $0.648 \pm 0.001(2)$ at 20° C.; the average deviation from the mean is given in each case.

This result is higher than that of Cabrera and Fahlenbrach, 0.637 at 20° C., and also that obtained by Selwood and Frost, whose result of 0.65 for a specimen 92 per cent pure, if extrapolated to a 100 per cent purity assuming a linear variation with percentage composition, corresponds to a susceptibility of 0.644.

Taking the molecular weight of heavy water to be 20.027, we have 12.96 for its molecular susceptibility from the results of the present investigation; the molecular susceptibility of ordinary water at the same temperature is 12.97.

The estimated accuracy of the present measurements is rather better than 0.5 per cent. The difference between my result and that given by Cabrera and Fahlenbrach for 20° C. is 1.7 per cent. The causes of this relatively large difference in the values are not apparent.

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¹ Selwood and Frost, *J. Amer. Chem. Soc.*, **55**, 4335 (1933).

² Cabrera and Fahlenbrach, *Naturwiss.*, **22**, 417 (1934).

³ Hoare, *Proc. Roy. Soc., A*, **147**, 88 (1934).

Origin of the Broad Bands in Selenium and Tellurium Vapours

In recent papers, we have investigated a series of broad bands appearing on the long wave-length side of the main system $^1\Sigma - ^1\Sigma$ of Se_2 . These bands were observed under electrical¹ and optical excitation^{2,3} as well as in thermoluminescence³.

According to the suggested interpretation¹, this series of bands corresponds to transitions between a quasi-stable excited state (with a vibrational frequency of about 50 cm^{-1}) and high vibrational levels of the normal $^1\Sigma$ state of Se_2 . Similar bands appear also in tellurium vapour; the first results of our investigation of Te_2 show that the interpretation of these bands is essentially the same as in the case of

selenium. From the position of the potential energy curves of several electronic states investigated in Se_2 , it appears that absorption from the lowest vibrational levels of the ground state leads probably to the part of the quasi-stable energy curve situated above the limit of dissociation. This will accordingly give only a continuous absorption background superposed on the intense absorption bands of the main system and therefore not easily observable. If our interpretation is correct, the broad bands ought to appear in absorption when the temperature of the vapour is sufficiently high.

We have investigated the absorption spectra of Se_2 and Te_2 for temperatures as high as 1,000° C. and we have succeeded in observing the broad bands discussed above. This confirms the interpretation of these bands which we have given above and previously.

Details concerning the structure of these absorption bands and consequent data concerning the dissociation energy of Se_2 (probably 1.9 v.) will be published later elsewhere.

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¹ B. Rosen and M. Désirant, *Bull. Acad. Roy. Belgique, Cl. d. Sciences*, No. 7, 723 (1935).

² M. Désirant and A. Minne, *Bull. Soc. Roy. Sci. Liège*, Nos. 6-7, 229 (1935).

³ B. Rosen, *Z. Phys.*, **43**, 69 (1927).

Points from Foregoing Letters

AN apparatus which produces in the laboratory a lightning-stroke closely resembling in its effects the natural phenomenon (for example, lengthwise splitting of full-sized wooden poles) is described by P. L. Bellaschi. The test piece is 'flashed over' with a steep fronted impulse from a three million volt generator. A heavy current generator is immediately afterwards connected to the test piece by means of a micro-second switch, thus enabling the full low-voltage discharge to follow the high-voltage breakdown across the piece tested.

The temperature change of iron, nickel and cobalt with magnetisation has been calculated by means of the Honda-Okubo theory of ferromagnetism by Prof. K. Honda and T. Hirone. They find the theoretically deduced values in fair agreement with those obtained experimentally by Okamura.

Dr. J. L. Snoek considers that Lichtenberger's explanation of the high magnetic permeability possessed by the specially heat-treated 78 per cent nickel alloy (permalloy) is supported by recent experiments on the influence of a magnetic field applied during cooling, and by the influence of grain size and crystal orientation on the permeability of iron and of silicon iron.

The electrical resistance of films of rubidium metal a few atoms in thickness deposited, in a vacuum on glass cooled by liquid oxygen, has been determined by A. C. B. Lovell. He finds the resistivity of the films to be a few times greater than that of the metal in bulk, and not so large as found by previous investigators.

From experiments upon ovariectomised rats, Dr. V. Korenchevsky concludes that testosterone, like the other two known male sex hormones, androsterone and androsterone-diol, has some of the properties of the female hormones.

The typical nitrogen-fixing bacteria which form nodules on many leguminous plants secrete substances able to produce a characteristic curling of the host's root-hairs, without which infection of the plant does not occur. Dr. H. G. Thornton and Dr. Hugh Nicol have studied some properties of these secretions, and have found that they increase the number and length of the root-hairs.

Photographs of Raman spectra of solutions of formic acid and formates, and also infra-red absorption curves of sodium formate (solid and in solution) are submitted by P. B. Sarkar and B. C. Rây in support of their theory that formic acid and solid formates are normal in structure; abnormality appears in the aqueous solution of formates, due to prototropy (isomeric change depending on the displacement of a hydrogen atom, accompanied by a rearrangement of valence bonds).

The absorption spectra of the vapours of potassium, silver, magnesium and leadnitrates, examined by Md. I. Haq and Prof. R. Samuel, show a flat and diffused maximum of selective absorption in the ultra-violet (2700-2600 Å.) indicating that these compounds possess a co-valent bond in the vapour state.

From the rate of combination of certain organic compounds (bi-molecular diene syntheses), A. Wassermann deduces that in the case of slow reactions in solution, the collision frequency of molecules is not lower than in the gas phase. The slowness of reactions involving certain complex molecules may be due to the passage of translational and rotational degrees of freedom of the reactants into vibrational degrees of freedom in the 'intermediate configuration'. Working with B. S. Khambata, the author finds that the rate of formation and decomposition of dicyclopentadiene follows the Arrhenius equation.

Research Items

Late Bronze Age Site in West Suffolk

FURTHER exploration of the fenland area carried out by the Fenland Research Committee in March, 1935, throws light on the character of the invasive movements associated with the 'Deverell Rimbury' pottery during the Late Bronze Age in Britain. The site examined, upon which a report has been drawn up by the secretary, Mr. J. G. D. Clark (*Antiquaries J.*, 16, 1), is situated in the north-east corner of a field in Mildenhall Fen, West Suffolk, about a mile from the chalk. This field, recovered for agriculture not long before 1829, was ploughed for the first time for many years in 1935, when quantities of bones, flints and sherds appeared on the surface. A section of a sand-hillock, fifteen feet wide, was opened up. A circular hole 1 ft. deep found in undisturbed sand near the top of the hillock contained an interesting group of pottery, a few bone fragments and a mass of whitish material. The majority of the finds was recovered from the lower slopes of the sand ridge, where there was a well-defined culture stratum with masses of wild and domesticated animal bones, flints and sherds, as well as charcoal. It overlay dirty grey sand and was sealed by peat. The pollen and charcoal identifications show a marked predominance of alder, pointing to the wet conditions which had necessitated settlement on the higher ground at the edge of the fen. The pottery falls into seven groups, with affinities to the 'Deverell-Rimbury' types, and belongs unquestionably to the invasive element of the Late Bronze Age, though certain features illustrate contact with native people, presumably of the Middle Bronze Age, thus eliminating the interval postulated by Sir Cyril Fox. One group, the 'Mildenhall Ware', has no immediate parallels, but its general similarity in decoration to many late beakers from south-east Britain may, it is suggested, point to a belated beaker influence, which possibly will prove quite local in distribution. The site also yielded the first really extensive flint industry of the period.

Calendrical Correlation in Central America

THE evidence relating to the names of the months and days and the corresponding hieroglyphic signs in use among the ancient inhabitants of Central America has been reconsidered by Dr. O. D. E. Bunge (*J. Soc. Americanistes*, N.S., 27, Fasc. 1). The point of departure of his argument is that the calendar was the invention not of the Maya or the Quichua, but of the third element in the population, the Tzental people. Although these people have left behind them neither monuments nor important documents, archæologico-geographical considerations, legends and linguistic evidence point in this direction. The late E. Selser, who also investigated the Tzental calendar, endeavoured to explain it by the Mayan calendar, instead of vice versa, and overlooked the fact that there had been a shifting of the date of the winter solstice, with which the year begins, as between the records of the two systems, owing to the lack of intercalation. Hence his correlations fail. On the evidence of etymology and the hieroglyphic signs, the names of the twenty days in the Tzental system

are identified as signifying a primitive god, who is the origin of all things; five celestial gods—the sun, the new moon, the morning star (Venus), the evening star (Venus), the constellation of the polar star; two gods of death; four gods of the elements—wind, water, rain and the god of thunder and earthquake; two gods of Nature—one of the months and living things, the other of inorganic Nature; the god of war; the god of drunkenness; and three oracles. The order suggested does not agree with that of Nuñez de la Vega. The identification of the months is based on the sequence of the operations in the Tzental agricultural year, beginning with the winter solstice and ending with in order the month of harvest, the month of the first cold weather, and the month of the annual ritual ceremonial.

Sodium Chloride Deficiency in Man

IN some experiments described by R. A. McCance (*Proc. Roy. Soc.*, B, 119, 245; 1935) more than twenty per cent of the total sodium chloride was removed from the bodies of three living subjects, by exposing them to radiant heat and so inducing sweating. The water lost in this way was immediately replaced by drinking. This deprivation led to aberrations of flavour, cramps, weakness and severe distress on exertion. The concentration of sodium chloride in the blood was diminished but the concentrations of hæmoglobin and serum protein were increased. The blood-urea was increased. (See also NATURE of February 8, p. 246.)

Marine Fishes of West Africa

IN "The Marine Fishes of West Africa" (*Bull. Amer. Mus. Nat. Hist.*, 70, Pt. 1, 1936), Dr. Henry Fowler has attempted a comprehensive account of the fishes and fish-like vertebrates from the coast of western tropical Africa, based on material collected by the American Museum Congo Expedition, 1909–1915. According to this author, "the great homogeneity of this vast faunal region makes it evident that its influence extends somewhat beyond the confines of Africa proper", and he has found it desirable to include in his survey the outlying islands of the Madeiras, Canaries, Ascension Island and St. Helena. This very extensive work gives evidence of having been, in places, somewhat hastily compiled or inadequately checked. The illustration of *Scylliorhinus caniculus*, for example, suggests either that the drawing of another fish has been inadvertently inserted over this name or that the members of this species inhabiting West African waters are so different from typical specimens of *S. caniculus* as to justify their being placed in another genus.

Sperm Differences in Rodents

IN the course of an investigation of the sperm structure in the different rodents of the family Muridæ, G. F. Friend (*Quart. J. Micro. Sci.*, 78, Pt. III; 1936) has shown that those of the Murinæ differ from those of the Microtinæ. Both sub-families have sperms with a hooked head—a highly specialised type—with a striking exception in each, namely,

Micromys agrarius, the harvest mouse, and *Ondatra zibethica*, the musk-rat. These both have a simpler non-hooked type which is possibly more primitive since it is similar to that in less specialised groups of rodents. The nucleus within the head is of a curious hook-shape in the Murinae whereas that in the Microtinae is recessed. The sperm of the long-tailed field mouse, *Apodemus sylvaticus*, is different from that of De Winton's field mouse, *A. flavicollis*, which certainly supports the modern view of regarding them as distant species and not merely varieties as was formerly done. Since the sperms are specifically distinct and exhibit also generic types, it is possible that their examination may prove of value in detailed systematic studies. A clear account of the detailed structure of the head of the muride sperm with a suggested nomenclature is provided.

Insects of the Dutch East Indies

Two fascicules have recently come to hand dealing with certain groups of insects collected during the expedition of His Royal Highness Prince Leopold of Belgium to the Dutch East Indies. The publication of the scientific results of this expedition is being undertaken, in the form of a series of sumptuously executed memoirs, by the Royal Natural History Museum of Belgium. Fascicule 11 is concerned with the Coleopterous families Chrysomelidae (by Mr. S. Maulik), curculionidae (by Sir Guy Marshall) and Tenebrionidae (by Herr H. Gebien). The contents of Fascicule 12 form accounts of those moths grouped under the Pyralidae (by Prof. A. J. T. Janse) and the Heterocera (by Mr. W. H. T. Tams). In the last-mentioned contribution a number of miscellaneous families are dealt with. In view of the new species described, these memoirs are important for systematists as well as students of geographical distribution.

Bubbles from Water Plants as a Measure of Photosynthesis

F. GÓRSKI has recently given a valuable discussion of a very old method of measuring photosynthesis (*Bull. International de l'Acad. Polonaise des Sci. et des Lettres, Classe des Sci. Math. et Nat.*, Sér. B.: Sc. Nat. 1, No. 4-7 BI, 1935). The bubbles released from green water plants in sunlight, and especially from *Elodea*, have long been utilised for this purpose, though of recent years more and more critical examinations have been made of these methods, of which the value remains in their simplicity. Dr. Górski examines the extent to which the oxygen released in photosynthesis is present in the bubbles emitted. The conclusion is a little startling; of the oxygen emitted in photosynthesis, 70 per cent usually diffuses in water (this result is shown to be naturally explained by leaf anatomy, when most of the chloroplasts face a wall away from an intercellular space), but when assimilation is more intense, comparatively more oxygen escapes in the bubbles. One surprising result of this investigation is to support the view that the volume of the bubbles is a more accurate index of the amount of assimilation than is the measurement of the oxygen released. Only some thirty per cent of the oxygen released in photosynthesis is present in the bubbles; but as the gaseous nitrogen released compensates to some extent for the photosynthetic oxygen released in solution, the volume of the bubbles usually represents an equivalent of seventy per cent of the total oxygen. This compensation theory of the bubble method was

advanced to justify it many years ago by Godlewski, but as the result of some 260 analyses in the course of the present work, the bubble-counting method can only be granted a strictly limited utility. Many teachers will find in this paper some justification of their inability to do as the text-books usually suggest and "ignite a glowing splinter" in the gas collected from the bubbles rising from *Elodea*.

Serological Studies of Plant Viruses

THE highly specific immunological reactions of the mammalian body have been used by Jorgen M. Birkeland to differentiate the plant viruses known as cucumber mosaic, tobacco ringspot and tobacco mosaic ("Further Serological Studies of Plant Viruses", *Ann. App. Biol.*, 22, No. 4, 719-727, Nov. 1935). It was not, however, possible to distinguish serologically the viruses of tobacco mosaic, aucuba mosaic and tomato streak. The paper offers further evidence that viruses are themselves antigenic, and the effects of the host plant antigen have been eliminated so far as possible by estimating the precipitin reactions of the several viruses from serologically unrelated plants. A determined attempt to isolate a soluble specific substance has not been successful; but the methods used are very interesting, and are set forth in the paper.

Natural Decomposition of Lignin

A VERY useful critical summary of recent work upon this subject has been prepared by Dr. A. G. Norman of Rothamsted Experimental Station (*Sci. Prog.*, 30, No. 119, Jan. 1936). He points out that there is general agreement that lignin is one of the most resistant of all plant materials to natural processes of decay; but that it is attacked particularly by the mycelium of various basidiomycete fungi. At the same time, most divergent statements as to its rate of decomposition under both aerobic and anaerobic conditions are probably to be traced to the different methods used to isolate and estimate the residual lignin. Most methods rely upon the removal of other carbohydrates by comparatively strong acid reagents, and suffer from the fact that pentoses, which are practically always associated with the material containing lignin, tend to condense to insoluble black precipitates in contact with these strong acids and thus may add materially to the residue estimated as lignin. This difficulty may be avoided by previous removal of the pentose constituents by digestion with dilute acids, although it remains a matter of speculation how such predigestion processes affect the lignin. A more difficult problem is probably presented by the fact that most decomposing plant materials will also contain proteins and, when the lignin residues are obtained by digestion with strong acids, nitrogen undoubtedly links on to the lignin nucleus from the protein compounds. No calculation, by an arbitrary figure, based on the nitrogen in the lignin, can allow for this, as the size of the molecule introduced with the nitrogen is quite unknown although it is undoubtedly not a protein. Dr. Norman's paper thus makes clear the many difficulties in the way of interpretation in a field that interests those concerned with decay in the soil, with timber preservation and with the more remote results of those processes which are linked with the problems of the nature of the plant remains preserved as fossils in the older rock strata.

The Archæan Complex of Mysore

THIS was the subject of the presidential address by Dr. B. Rama Rao to the Geological Section of the twenty-third Indian Science Congress held at Indore on January 2-8 (Calcutta: Asiatic Society of Bengal). The Dharwar System and the associated granites have long been a source of controversy, and many rocks formerly thought to be igneous are now definitely known to be of sedimentary origin. According to the new classification the sequence is interpreted as follows: *Lower Dharwar*—Greenstone, keratophyre and quartz-porphyre schists, intercalated with mica-chlorite schists, ferruginous cherts and granitic limestones, with contact metamorphosed equivalents including hornblende schists, eclogites and amphibole-iron-ore-quartzites. *Middle Dharwar*—Conglomerates, quartzites, pelitic schists, limestones, dolomites and banded hæmatite-quartzites, with contact metamorphosed equivalents including kyanite-staurolite schists and pyroxene-granulites. These are followed by intrusions of granite, granite-porphyre and granodiorite, many of which are gneissose. *Upper Dharwar*—Crumpled shales, sandstones and brecciated hæmatite-quartzite and other ferruginous sediments. The Closepet granites follow, consisting of slightly foliated pink and grey types which are only rarely hornblende. Correlations with North American Pre-Cambrian formations from Keewatin to Upper Huronian are suggested tentatively, the two periods of granitic intrusion being paralleled with the Laurentian and Algonian granites respectively. In the absence of confirmation by lead-ratios, however, such long-range correlations are not practicable, especially as it is already known that in Canada and Russian Karelia there are intrusions dating back to 1,800 million years ago, far beyond the 1,000-1,100 million years usually assigned to the Laurentian granite-pegmatites.

Pulsation of Climate

A. H. R. GOLDIE has recently discussed a pulsation of climate that has been in evidence over the northern parts of the British Isles during the past thirty years (*Quart. J. Roy. Meteor. Soc.*, Jan. 1936). This pulsation came to light through a study of the variations of the differences of atmospheric pressure between certain pairs of observing stations in the north. These differences, when averaged for any period, are rough measures of the average strength of the component of the wind at right angles to the line joining the two stations. It was observed that when the stations lay nearly along a line of longitude, that is, when the difference of pressure measured the westerly component of the wind, maxima occurred with fair regularity about every four years. This discovery led to an examination of the weather associated with different stages of the cycle. Charts were prepared showing the mean deviation of atmospheric pressure from normal throughout the British Isles for the years of maximum westerly component of wind and also for years midway between two such maxima. It was found that in the former case pressure was above the average in all parts of the British Isles but especially from the south-west across to eastern England, an arrangement suggestive of a prolongation of the normal Azores anticyclone towards and over the British Isles. In the latter case (weak westerly component) mean pressure was everywhere low; there was a belt of maximum negative deviation across Scotland and a slight trough extending from

it towards south-east England. As regards temperature, sunshine and rainfall, calling those years of strong westerly component and high pressure *H* years and those of weak westerly component and low pressure *L* years, it was found that the *H* years were very consistently warmer, sunnier and drier than the *L* years. The duration of winds of gale force was greater in the *L* years, as was the exchange of air between low and high latitudes in the neighbourhood of the British Isles. Mr. Goldie stresses the point that he was not trying to establish the existence of a regular permanent periodicity of nearly four years in our climate, although he had occasion to refer to a periodicity of 3.8 years in atmospheric pressure found more than thirty years ago by Lockyer for India, Australia and South America.

Studies in Spark Formation

AN account of experiments by U. Nakaya and F. Yamasaki on the initial stages of spark formation in a Wilson cloud chamber has recently appeared (*Proc. Roy. Soc., A*, February). A potential was applied to the gap, the chamber was expanded, the spark was initiated by a flash of ultra-violet light, and the chamber was then illuminated. Clouds showing the characteristic formations were obtained for a number of gases. It was found that traces of certain organic vapours were very effective in changing the branched positive streamers, characteristic of the discharge in air, into a smooth track.

Road Vehicle Performance

THE latest of the publications issued by the Association of Engineering and Shipbuilding Draughtsmen ("Road Vehicle Performance", by R. W. Collins. The Draughtsman Publishing Co., Ltd. 2s. net) deals with the simple mechanics of the movement of motor vehicles—the connexion between the engine power, the speed, and the various resistances of motor-cars, and the influence of dimensions, road condition, etc., on their operation. The book can be read with understanding by anyone able to appreciate the simplest mechanics. Motorists have recently been particularly interested in stream-lining, and will here find a section dealing with air resistances in which values are given of the coefficients for several types of vehicle, and an appropriate set of curves. From these it is possible to judge how much or how little is to be gained by stream-lining in the case of familiar types of car at ordinary speeds. Unfortunately the author is not always scrupulously careful in the statement of his formulæ and in the use of the most direct form of expression, and thus involves himself and his reader in some difficulty. The first formula which appears is misstated and a symbol *R*, which has no right to a place there, is ultimately eliminated by a kind of mathematical legerdemain. The reader will recognise that such faults are due to insufficient checking and criticism, for the author in the end makes the meaning of each section quite clear. The subjects he deals with are transmission efficiency, tractive effort and the several resistances met with, horse-power required, acceleration and accelerating force, and the advantages of the oil engine. The paper concludes with a note on adhesion, the understanding of which would greatly help drivers to appreciate different road conditions, and a typical form of analysis of the performance of one particular vehicle—an analysis which could without difficulty be applied to any other.

Recent Advances in the Study of Monolayers

THE most significant feature of the discussion on "Surface Phenomena—Films" held at the Royal Society on March 12 was the evidence it gave of the very considerable advance which has been made during the last decade in the direction of a synthesis of the biological and the more exact sciences. The opening address by Prof. E. K. Rideal was an illuminating summary of the present state of knowledge of molecular phenomena at interfaces. He emphasised the two fundamental aspects of the wide range of physical, chemical and biological work discussed, namely, the reality and far-reaching importance of molecular orientation at interfaces, and the great wealth of information which can be gained from studying the properties of complex organic molecules, particularly those of biological importance, when spread in monolayers at the surface of aqueous substrates.

In 1912, Sir William Hardy introduced the conception of molecular orientation in the boundary state, and his picture was strengthened and extended in 1916 by Langmuir's association of the asymmetrical parts of the molecular fields with the polar groups. From the evidence gained by the surface pressure method with the Langmuir-Adam trough, it is universally accepted that a film of an insoluble organic compound, such as stearic acid, on a water surface, consists of a two-dimensional monomolecular array or monolayer, of molecules oriented with their polar hydrophilic groups immersed in the water and the nonpolar hydrophobic portions (in this case the hydrocarbon chains) extended above the surface. The classical work of N. K. Adam has elucidated the essential physical factors responsible for film formation and the general properties of the various states of matter in monolayers—gaseous, vaporous, liquid-expanded, liquid-condensed and solid. The liquid-expanded state is of interest because it has no three-dimensional analogue. Its nature has been explained by Langmuir by his bold assumption of a duplex film, composed of a sheet of oil above and a layer of polar groups below. There can be little doubt that this conception is essentially true; but there is evidence that it may require extension by interposition between the two layers of a non-homogeneous oil phase containing entangled water molecules, thus imparting a triplex structure to the expanded monolayer. In 1931, Rideal and Schulman supplemented the force-area method of investigating monolayers by measurement of the change in phase boundary potential produced by the film molecules. This method gives detailed information about the vertical component of the resultant molecular electric dipole moment, and in addition, very considerable insight into the molecular orientation.

The value of the surface pressure and phase boundary potential methods, in conjunction with the X-ray crystallographic data, in elucidating the structure of large organic molecules of biological interest, is shown by the recent work of Dr. Adam and his collaborators on monolayers of sterols. Of singular interest is their finding that the surface potentials of cholestane-3-ol and its epimer are of opposite sign.

The general problem of chemical reactions in

monolayers is of great importance. A number of these reactions have now been studied, chiefly by Prof. Rideal and his collaborators, and include:

(1) Reactions between film molecules and ions or molecules in the substrate, for example, hydrolysis of esters by acids, lactones by alkalis, proteins by proteinases and polypeptidases, fats by lipases, lecithin by snake venom; oxidation of double bonds by permanganate ions.

(2) Oxidation of film molecules by atmospheric oxygen, for example, oxidation of double bonds, of $-SH$ groups.

(3) Reactions between the film molecules themselves. The only known example is the polymerisation of the unstable peroxide produced by autoxidation of the maleic anhydride compound of β -elaeosterin. This reaction has been shown to have a typical chain mechanism.

(4) Photochemical decomposition of film molecules, for example, photochemical hydrolysis of the CO-NH linkage in proteins and in stearic anilide; photochemical splitting of carbon dioxide from organic acids.

In most of the cases studied, the apparent energy of activation is the same for the reaction at the interface as in bulk, but the molecular orientation present often controls the rate of reaction by controlling the steric factor. In the oxidation, by permanganate ions in the substrate, of the double bonds of molecules of oleic acid or petroselenic acid in the monolayer a rapid and striking decrease of reaction velocity is found when the films are compressed to the stage at which it is known that the double bonds are removed from the water surface. A similar reduction of reaction velocity is found in the hydrolysis of lecithin to lysolecithin by snake venom, when the double bond of the oleyl group is raised from the water surface.

In the drying of monolayers of the maleic anhydride compound of β -elaeosterin, it was shown by G. Gee that in the polymerisation stage, which is a chain reaction, steric hindrance is responsible for stopping the growth of the polymer.

Photochemical reactions in monolayers were described by J. S. Mitchell. Photochemical hydrolysis of the CO-NH linkage in stearic anilide was found to occur in light of wave-lengths 2350–2483 Å. with a quantum efficiency of unity; the reaction velocity varies rapidly with molecular orientation in agreement with the theory given. Experimental evidence was brought forward suggesting that one of the most important actions of ultra-violet light of wave-length 2500 Å. on protein monolayers is to produce photochemical hydrolysis of those CO-NH linkages adjacent to the aromatic side chains, which are the only regions of the molecule where light absorption can occur.

Optical evidence of molecular orientation was found by Tronstad and Feachem in 1934 by investigating monolayers of myristic acid by measurement of the coefficient of ellipticity of plane polarised light reflected from the surface covered with film. The scattering index in the plane of the film is of the same order as in bulk, but is very much smaller in the direction normal to the surface.

An interesting related observation was described by A. H. Hughes. He has found that monolayers of the green dye, magnesium naphthalocyanine, were visible, and in conjunction with C. B. Allsopp, he showed that the molecular extinction coefficient in the film is of the same order as that in solution.

The recent work on protein monolayers is of great biological interest. F. A. Askew described the preliminary results obtained by surface pressure measurements on protein films at the liquid-liquid interface between water and bromobenzene. Evidence on two very important issues was brought forward by Prof. E. Gorter. By an ingenious experiment with pepsin and trypsin monolayers, he has shown that when these are spread at an air-water interface, only a negligible amount is lost into the substrate or by denaturation. He also found that myosin prepared below 0° C. does not spread, but can be made to do so by adding trypsin to the substrate. G. Philippi discussed some general theoretical considerations on the homallic state.

One of the most interesting papers read was that by J. H. Schulman on mixed unimolecular films. He described in some detail the phenomenon of 'film penetration'. If a very dilute solution of, for example, a long-chain acid is introduced into the substrate beneath a monolayer of an alcohol, complex formation occurs between the head groups, and the Van der Waals adhesion of the chains leads to formation

of a stable mixed film, composed of equal numbers of acid and alcohol molecules whatever the initial proportions. This complex formation is accompanied by a marked increase of surface pressure and a simple proportional change of phase boundary potential. When adsorption on to a protein film occurs without penetration, as in the case of tannic acid or silicic acid, there is no change of surface pressure but only a change of surface potential, although the film has become much more stable and can now resist displacement by fatty acids. The relationship of these phenomena to immunological specificity and to hæmolysis by saponin, fatty acids and complement was discussed.

J. F. Danielli, working with invertebrate ova, discussed the surface conditions of animal cells. O. Gatti described an investigation of the origin of electrical potentials in living tissues. By correlation of the potential difference across frog's skin with its electrical resistance and oxygen uptake, in the presence of various inhibitors, he brought forward strong evidence suggesting that bioelectric potentials have their origin in oriented monolayers and that the effective interfaces are occupied almost entirely by lipins and sterols, proteins being of much less importance.

The meeting was concluded by a beautiful demonstration of intertraction at liquid-liquid interfaces by Sir Almroth Wright.

Ionospheric Studies in India*

By Prof. S. K. Mitra, University of Calcutta

SINCE the middle of the last decade, the study of the conducting upper atmosphere—the ionosphere—has been proceeding vigorously in various parts of the world. The countries where the study originated—England and the United States—are situated at high latitudes, far from the equator. In view of the fact that ionospheric conditions in a subtropical region of low latitude, like that of India, were likely to differ considerably from those in a region of high latitude—particularly with regard to the effect of meteorological disturbances of terrestrial or solar origin, such as thunderstorms, magnetic storms, etc.—the study of the ionosphere was taken up at Calcutta¹ (22° 34' N., 88° 22' E.) in 1933 and has been continued uninterruptedly since then. Recently, measurements have been made at Allahabad² (25° 26' N., 81° 50' E.) and Bangalore³ (12° 58' N., 77° 35' E.) on ionospheric heights—at the former on ionisation density as well—and at Dacca⁴ (23° 43' N., 90° 24' E.), on fading.

Measurement of the equivalent height of the lower *E* region, by the 'echo' method, carried out systematically at Calcutta according to the programme of the International Polar Year (1932–33), on a wavelength of 75 m. at normal incidence, gave the average value⁵ of the height as 90 km. This is lower by about ten per cent than the average value as obtained by the same method in England. Prior to this, measurement carried out with medium wave-length (370.4 m.) for oblique incidence, by the

'angle of incidence' method, had yielded the average value of the *E* layer equivalent height after sunset¹ as 80 km.

The Polar Year height measurements⁵, recording the appearance or disappearance of the echoes in different months of the year and at various hours of the day, indicated the nature of the seasonal and diurnal variation of ionisation at such low latitude as that of Calcutta. It was found that at midday in August and September the *E* ionisation density was greater than 2×10^5 equivalent electrons per c.c., that during October–November and April–May it was near this value, and that in the months December to March it was less. Direct measurement of ionisation density by observing the frequency of the wave which just pierces a particular region, after the method developed by Appleton, showed that during the summer solstice (1933) the *E* ionisation density at midday was more than 0.5 million (equivalent electrons) as compared with the corresponding average value in England of 0.18 million. At midnight, the *E* ionisation density was less than 0.2 million for the most part of the year, and the *F* density also less than 0.2 million in April, May and June. The maximum value of the *F* density was found by direct measurement to be more than 1.5 million, which is much greater than the value obtained at higher latitudes.

Records of diurnal variation of *E* ionisation density showed that the nature of the variation on a normal day, that is on a day not disturbed by thunderstorms or other causes, agrees with that

* Substance of a lecture delivered before the Maxwell Society at King's College, London, on January 30.

calculated after Chapman, for the latitude of Calcutta, by assuming that the ionisation is caused by the ultra-violet radiation of the sun. This assumption was justified by results of observations made during the total solar eclipse of August 1933, when the *E* ionisation was found to fall to a minimum value a little after the centre of the eclipse, as predicted by theory⁶. No indication was obtained of the so-called 'corpuscular eclipse' which was due about two hours before the optical eclipse.

The normal variation of ionisation caused by the varying obliquity of the sun's rays was very often disturbed by other causes, the chief among which in Bengal in summer months was thunderstorm. Such storms were of frequent occurrence in the months of April-September and were found to increase abnormally the *E* region ionisation⁷. This confirms the view of C. T. R. Wilson that the electric field of a charged thundercloud is capable of affecting the ionosphere, either directly by discharge or indirectly by shooting up high-speed electrons. It was found in this connexion that, of the abnormal increases of ionisation observed, the daytime increases were related to thunderstorms and the night-time increases to magnetic storms. Observations during the Leonid meteoric shower showed that the meteors by their

bombardment could increase considerably the ionisation of the upper atmosphere⁸.

Study of the absorption of radio waves during thunderstorm months had shown that the wavelength of the longest wave which could be reflected from the *E* region varied in a regular manner from sunrise to sunset, and did not follow the sudden and erratic outbursts of variation caused by thunderstorms⁹. This showed that during daytime an absorbing region of the ionosphere is formed which is distinct from the usual 'reflecting' region.

In conclusion, stress was laid on the fact that in order to make the ionospheric researches most fruitful, it is essential that there should be close co-operation between workers in different parts of the world. The need of a co-ordinating body in India like the Radio Research Board of England was also emphasised.

¹ H. Rakshit, *Phil. Mag.*, **12**, 897 (1931).

² G. R. Toshniwal, *Proc. Nat. Inst. Sci. India*, **1**, 243 (1935).

³ L. C. Verma, S. T. Char and A. Mohammed, *Proc. Inst. Rad. Eng.*, **22**, 906 (1934).

⁴ S. R. Khastgir and B. Sen Gupta, *Sci. and Culture* (Calcutta), **1**, 301 (1935).

⁵ H. Rakshit, *Phil. Mag.*, **18**, 675 (1934).

⁶ S. K. Mitra, H. Rakshit, P. Syam and B. N. Ghose, *NATURE*, **132**, 442 (1933).

⁷ J. N. Bhar and P. Syam (in the press).

⁸ S. K. Mitra, P. Syam and B. N. Ghose, *NATURE*, **133**, 533 (1934).

⁹ P. Syam, *Ind. J. Phys.*, **10**, 1 (1936).

French Statistics*

WE have received a copy of the "Annuaire Statistique" of France for 1934. This large volume contains a wide range of statistics on every branch of French life. The first part gives the annual tables for 1932, 1933 and in some cases 1934, of territory, vital statistics, education, health, production, transport, trade, finance and many other aspects. The second part, conveniently distinguished by a different colour of paper, gives comparative statistics for thirty or forty years and in some tables for more than a century. The last section gives figures of area, population, production, trade, etc., of the chief States of the world for the last fifty years. This section is particularly useful. Another official French publication received is the volume entitled "Statistique de Mouvement de la Population", 12, 1932, "Les causes de décès" which gives for the year under review the causes of death grouped under forty-three headings for every department and large town in France.

Some very interesting statistical information relating to French industry, though unfortunately incomplete, will be found in the Census of Production and Wages taken during 1931. In 1928, France signed an international convention on economic statistics at Geneva whereby the Government undertook to carry out a survey of industrial production as complete as might be possible at least every ten years. To implement this convention, the Government voted a credit of 750,000 francs for the purpose when the general Census was being made in 1931. Previously there had been no regular census of production, though so far back as 1669, Colbert had

carried out an industrial survey, and again in 1788, 1812, 1840 and 1860 censuses of industry were undertaken.

The present investigation of 1931 was limited to establishments employing more than ten persons, and only about a quarter of the firms above this size replied to the questionnaires, while in the more important industries such as textiles the proportion was even less. Out of 60,000 questionnaires issued only 25,000 were returned, and after eliminating incomplete returns and those obviously inaccurate, there were left 15,073 returns relating to establishments which between them occupied 159,000 employees and 1,105,000 employees in 1931. Of the employees 772,500 were men, 260,200 women and 72,400 young persons less than 18 years of age.

The summary of the returns shows that in the year previous to the Census, namely, 1930, the 15,000 firms consumed 10½ million tons of coal, 5½ million tons of coke, 426,000 tons of petrol and benzol, 115,000 tons of heavy oil, 690,000 tons of wood fuel and 269,000 tons of lignite. The power utilised, measured in kilowatts, was 690,000 kw. from steam engines, 246,000 kw. from gas engines, 169,000 kw. from water motors and 1,049,000 kw. from electric motors driven by current purchased from outside the works. The total motive force utilised in 1930 was 2,229,000 kw. and the average number of persons employed during that year was 1,189,000. Net production was valued at 27,303 million francs and the wages of the 1,189,344 employees amounted to 12,035 million francs.

In addition to the French statistics, the Census report provides an interesting summary and a valuable comparison of recent censuses of production in Great Britain and the United States. The historical notes on the early French censuses of production are especially useful and interesting.

* République Française: Présidence du Conseil: Statistique générale de la France. Statistique du mouvement de la population. Nouvelle Série, Tome 12, Année 1932. Partie 2: Les causes de décès. Pp. xlii+287. Annuaire statistique. Vol. 50, 1934. Pp. xi+360+512. Enquêtes annexes du recensement de 1931. Enquête industrielle. Pp. 87. (Paris: Imprimerie Nationale, 1935.)

Educational Topics and Events

CAMBRIDGE.—Prof. A. C. Seward has declared his intention of resigning the professorship of botany on September 30.

It is proposed that the degree of Sc.D. *honoris causa* be conferred upon Prof. Ludwig Prandtl, professor of applied mechanics in the University of Göttingen.

OXFORD.—Dr. W. Baker, New College, has been appointed to an official fellowship in chemistry at the Queen's College in succession to Dr. F. D. Chattaway. Dr. Baker, who is a Ph.D. and D.Sc. of the University of Manchester, has been a lecturer and demonstrator at Oxford since 1928.

Dr. U. S. Haslam-Jones, Queen's, has been appointed to an official fellowship in mathematics at the Queen's College in succession to Mr. C. H. Thompson. Dr. Haslam-Jones won the Junior Mathematical and Senior Mathematical University scholarships and has been lecturer in mathematics in the University of Liverpool since 1927.

Dr. L. E. Sutton, Lincoln, has been appointed to a tutorial fellowship in chemistry at Magdalen College in succession to Dr. E. Hope, now a research fellow. Dr. Sutton has been a prize fellow of Magdalen since 1932 and has held a Rockefeller Foundation fellowship. He was recently awarded the Harrison Memorial prize of the Chemical Society.

D. W. Geidt, of Merton College, has been granted the degree of doctor of medicine.

An anonymous donor has given £10,000 towards the establishment of an Institute of Experimental Psychology. Dr. William Brown is to be the director. There will also be an assistant director. It is proposed to add to the endowment £500, and an annual grant of £150 for five years, from the Rockefeller benefaction for research in the social sciences. Further details are to be settled next term.

DR. L. F. BATES, reader in physics, University College, University of London, has been appointed Lancashire-Spencer professor of physics at University College, Nottingham, as from September 1.

At a meeting of the Council of University College, Southampton, on March 2, it was announced that Miss Mary Chamberlain and Miss Charlotte Chamberlain had made a gift of £20,000 for the purpose of building new physics laboratories. Other donations were also announced. The building to house the laboratories will be about a hundred feet square with a rectangular courtyard. There will be two lecture rooms and three students' laboratories, together with a library. Research rooms, workshop, power and battery rooms will be housed on the ground floor.

THE spring conference of the Geographical Association will be held at the University of Sheffield on April 17-20. In addition to a programme of lectures, there will be excursions to steel and cutlery works and a whole-day excursion to the limestone dales and the Peak district of Derbyshire. On the social side there will be a reception by the University and a dinner of the Association. Members will be accommodated so far as possible in one of the University hostels. All communications should be addressed to Miss A. Garnett, The University, Sheffield.

Science News a Century Ago

The Colouring Matter in Leaves and Flowers

ON March 21, 1836, Dr. Hope read a paper to the Royal Society of Edinburgh entitled "Observations and Experiments on the Coloured and Colourable Matters in the Leaves and Flowers of Plants, particularly in Reference to the Principles upon which Acids and Alkalis act in Producing Red and Yellow and Green". After some general remarks, Dr. Hope said that de Candolle had applied the term 'chromule' to the various coloured matters presented by the leaves and flowers of plants. There existed in plants however, in addition to the chromule, some matter properly destitute of colour, which became red by the action of acids and yellow or green by the action of alkalis. To this colourable matter the name 'chromogen' had been given, and the object of the paper was to show that chromogen was not an individual substance; and that there were two distinct principles, one which formed the red compound with acids, which he denominated 'erythrogen'; and another which afforded a yellow compound with alkalis, which he called 'xanthogen'.

Gas Lighting in Ships

ON March 23, 1836, *The Times* said: "A steam-vessel is fitting in the river which is to be lighted by gas, on a plan suggested by Lieutenant Engledue, R.N.; two retorts are placed in the fires under the boilers about two hours before dark, which will supply gas sufficient to burn the whole night, lighting the cabins, engine room and masthead. This may be fitted at a trifling expense, and without the slightest danger, the whole of the apparatus being on deck."

Faraday as a Lecturer

AMONG those who paid tribute to Faraday as a lecturer was the German historian Friedrich von Raumer (1781-1873), whose "Letters on England" were translated into English by Mrs. Sarah Austin (1793-1867), and published in 1836. On March 26, 1836, the *Athenæum*, which had already printed some of Raumer's letters, gave a review of Mrs. Austin's book and quoted the following extract: "Mr. Faraday is not only a man of profound chemical and physical science (which all Europe knows) but a very remarkable lecturer. He speaks with ease and freedom, but not with a gossipy, unequal tone, alternately inaudible and bawling, as some very learned professors do: he delivers himself with clearness, precision and ability. Moreover he speaks his language in a manner which confirmed me in a secret suspicion I had, that a great number of Englishmen speak it very badly. Why is it that French in the mouth of Mlle. Mars, German in that of Tieck, English in that of Faraday, seems a totally different language?—because they articulate, what other people swallow or chew. It is a shame that the power and harmony of simple speech (I am not now talking of eloquence, but of vowels and consonants) that the tones and inflexions which God has given to the human voice, should be so neglected and abused."

The Wernerian Natural History Society

At a meeting of the Wernerian Natural History Society in Edinburgh held on March 26, 1836, Prof. Robert Jameson (1774-1854) exhibited a series of birds from northern India collected by Mr. Hamilton

Stirling. Speaking of British birds in general, in connexion with Indian ornithology, Prof. Jameson stated that more than one third of them occur in India, either identical with or undergoing certain slight modifications in the colour, size, etc. He particularly directed the attention of the Society to the diurnal rapacious birds and said that of the eighteen diurnal birds of prey found in this island the following striking distribution was presented, namely, in common with Europe, 3; Europe and Asia, 2; Europe, Asia and New Holland, 1; Europe, Asia, Africa and New Holland, 3; Europe, Asia and North America, 5; Europe, Asia and South America, 1; Europe and North America, 3.

Occultation of One Star by Another

WRITING from Bedford on March 26, 1836, to Mrs. Somerville, Admiral W. H. Smyth said: "Knowing the great interest you take in sidereal astronomy, of which so little is yet known, I trust it will not be an intrusion to tell you of a new, extraordinary and very unexpected fact, in the complete occultation of one 'fixed' star by another, under circumstances which admit of no possible doubt or equivocation.

"You are aware that I have been measuring the position and distance of the two stars γ^1 and γ^2 Virginis, which are both nearly of similar magnitudes, and also that they have approximated to each other very rapidly. They were very close last year, and I expected to find they had crossed each other at this apparition, but to my surprise I find they have become a fair round disc, which my highest powers will not elongate—in fact, a *single star*! I shall watch with no little interest for the reappearance of the second γ ."

Medicine in Spain

"THE medical profession in Spain, as regards its present condition, is in complete harmony with everything else—that is to say, it is in a state of revolution. Medical men belong, and with a few exceptions have always belonged to the Liberal party, and the class of *pure Physicians* consisted almost to a man of warm Constitutionals in the year 1820. By the term *pure physicians* we understand, in Spain, all those who belong to the universities, in contradistinction to those who belong to the colleges of surgery. When the Constitution was overthrown in 1823, the then absolute king, Ferdinand, incensed against the whole body of *pure physicians*, worked them all sorts of annoyance, and with much success. At last, and with the view of punishing them most effectually, he issued a decree, in which he commanded that no *pure physician* should be employed in the palace, the hospitals, or any establishment under government; that is to say, in no public situation whatsoever, since in Spain all establishments are more or less under the control of the government; and, to supply their places, he converted surgeons into physicians by royal order, commanded that the colleges of surgery should be of medicine also, and created a great many young men at that time in the colleges *Physician-Surgeons* (*Medico-Cirujanos*). . . . The present state of Spain is very adverse to the cultivation of science and literature; nobody thinks of anything but politics. Six months ago we had only four medical journals in all Spain, and at present we have only two." (*British and Foreign Medical Review*, Jan.-March, 1836.)

Societies and Academies

DUBLIN

Royal Irish Academy, February 24: The late R. SOUTHERN: The Turbellaria of Ireland. An annotated list of the Turbellaria found in Ireland, amounting to 103 species, based, with a few exceptions, on specimens examined in a living state by the author.

PARIS

Academy of Sciences, February 10 (*C.R.*, 202, 445-524). RICHARD FOSSE: The synthesis of hydrocyanic acid and of formaldehyde by the oxidation of organic substances. Formaldehyde can be obtained by oxidation of various organic substances in ammoniacal solution: hydrocyanic acid may be regarded as the next stage of oxidation. N. SMIRNOFF: The distribution of ω^2 (Criterion of R. v. Mises). DANIEL DUGUÉ: The maximum of precision of the limit laws of estimations. FLORENT BUREAU: The elementary solutions of linear partial differential equations, totally elliptic. JEAN DELSARTE: The series of Schlömilch. CHARLES BLANC: Classification of the singularities of inverse functions of meromorph functions. RENÉ LEDUC and JEAN VILLEY: The problems of aviation at very high velocities. GILBERT ROUGIER: The photometric comparison of the moon and sun. The photo-electric albedo of the moon. HENRI GROULLER: The curve of light of Nova Herculis, 1934. Up to September 30, 1935, 1425 determinations of brightness have been made by 21 observers, and during the interval of 289 days there were only five days without an observation. The results are given graphically. H. LEMONDE: Isotherms of diffusion in binary mixtures. JEAN ROULLEAU: Barrier layers and photo-electricity. The photo-electric effect and rectifying effect of contact are independent of the specific resistance of the mass of cuprous oxide; both increase with the contact resistance. D. MILOSSAVLÉVITCH: The detection of high-frequency current by the condenser shunted in the grid circuit of an electronic tube. L. DUNOYER: Mirrors obtained by evaporation in a vacuum. Discussion of the various methods available for obtaining uniform deposits over a large area, with special reference to aluminium. ROGER SERVANT: A spectro-polarimeter for the extreme ultra-violet with metallic mirrors. Lenses are replaced by aluminium-coated concave mirrors. MME. RENÉE MONTAGNE and RAYMOND RICARD: Photographic photometry in the extreme ultra-violet. JEAN GRÉVY: The influence of the alkalinity of the glass on the viscosity of dilute ether-alcohol colloidions. A considerable reduction in the viscosity of colloidion may be produced by the alkalinity of the glass container, and in studying dilute colloidion this fact necessitates special precautions. HENRI PARISELLE and FAZLOLLAH CHIRVANI: The polarimetric study of the formation of molybdosaccharic complex compounds VICTOR AUGER and MLE. NINA IVANOFF: The etherates of bismutho- and antimoniohydriodic acids. PIERRE STÉ: Double decompositions in solution of two sodium niobates with some metallic salts. MLES. HORTENSE VAN RISSSEGHEM and BLANCHE GREY: Allylic isomerism in the case of the bromohexenes. The gradual isomerisation of the bromohexenes has been followed by means of Raman spectra. MORICE LETORT: The influence of the reaction products on the thermal decomposition of gaseous acetaldehyde. The velocity of the thermal

decomposition of gaseous acetaldehyde is reduced by the addition of carbon monoxide and methane, the products of the decomposition. The retarding action is practically independent of the initial pressure and of the temperature. ROGER PERROT: Chlorination and nitration by nitrosyl chloride. By the action of nitrosyl chloride on unsaturated aromatic hydrocarbons, in addition to the formation of nitrosochlorides, chlorination and nitration take place. LÉON ENDERLIN: Contribution to the study of the rubenes: the isomerisation of diphenyl-*bis-p*-bromophenylrubene into the corresponding pseudo derivatives. RENÉ JACQUEMAIN and ALFRED MUSKOVITS: An iodo-argento-nitrobenzoic acid complex compound and its action upon some allyl derivatives. Nitrobenzoic acids behave like benzoic acid in C. Prevost's reaction, and the iodo-silver complex combines similarly with unsaturated compounds. GEORGES BAECKEROOT: The presence of obtrusive Pliocene deposits on the Haute-Ardenne. MME. RENÉE HERMAN-MONTAGNE and LEWI HERMAN: Measurements relating to the presence of dusts and smoke in the Lyons atmosphere. Curves are given showing results obtained with the Owens apparatus at Lyons. Comparisons of the dust at different times of the day in London, Berlin and Lyons show a general similarity, all showing a maximum at about 10 a.m. EMILE MICHEL-DURAND: The metabolism of phosphorus compounds of the 'glands' of the oak in the course of germination in the dark. PAUL BUDKER: An osteoclasia determining the fall of the placoid scales or cutaneous teeth of the Equaloids. PIERRE FEYEL: The concentration of the blood in chlorides and the renal secretion of urea in mice. STANISLAS MARCZEWSKI: The gelatinisation of human serum by bases. BASILE LUYET: The direct measurement of the lethal dose of electric current in the Paramecia. L. ALBERT ROBIN: The evolution of a hæmogregarine of a Saurian in mosquitos. GASTON RAMON, ALBERT BERTHELOT and MME. GERMAINE AMOUREUX: A new culture medium for the production of the staphylococic toxin. ANTON PHILIP WEBER: The influence of crystallised hormones on the growth of certain species of yeasts. JEAN LAIGRET, ROGER DURAND and JOSEPH BELFORT: Antiexanthematic vaccination in a Tunis typhus focus: the immediate arrest of a severe epidemic. The use of the living virus, coated with egg yolk and olive oil, has been shown previously to be innocuous. An epidemic at Sidi Naceur in Tunis has afforded an opportunity of proving the effective action of the treatment. ROBERT DEBRÉ, JULIEN MARIE and D. NACHMANSON: The chemical study of muscle in myopathy.

AMSTERDAM

Royal Academy of Sciences (*Proc.* 39, No. 1, January 1936). J. BÖESEKEN and J. STUURMAN: Ring tension of cyclenes. Determinations of the activation energies from the reaction velocities at different temperatures. W. H. KEESOM and MISS A. P. KEESOM: Measurements concerning the specific heat of solid helium and the melting heat of helium. C_p for solid helium lies between 1.2 and 3.0° K. Debye's formula is not valid. J. G. VAN DER CORPUT: Distribution functions (3) and (4). J. A. SCHOUTEN and J. HAANTJES: General conformal geometry in projective treatment (2). J. BÖESEKEN: Valency shifting in cyclanes. Strain in 3- and 4-membered rings is re-interpreted as valency shifting due to ring closure. J. BÖESEKEN and E. DE ROY VAN ZUYDEWIJN: Tautomerism of

butadiene sulphone. C. ARIËNS KAPPERS: The character and spread of associated cephalic and cranial index peaks in Africa. T. HAMADA: Determination of the temperature in the column of a discharge from the intensity measurement of rotational band spectra. Dependence of the measured temperature on pressure and current density. K. MAHLER: On 'pseudobewertungen' I α (decomposition theorems). F. TRAUTH: *Aptychus* discoveries in Cuba. The paper identifies most of the varieties with known examples of *Lamellaptychus* from Europe and the Cape Verde Islands. The names suggested by O'Connell should not be retained. F. FLORSCHÜTZ and I. M. VAN DER VLIERK: The Pleistocene human skull from Hengelo. (1) Geological palaeontological part. A. J. P. VAN DEN BROEK: *ibid.* (2) Anthropological part. F. C. BURSCH: *ibid.* (3) Archæological part. The skull dates from the Masurian interstadium of the Würm Glacial Stage and shows, with the implements also discovered, great affinity with the relics of the Maglemosean culture of Denmark. A. GORTER: Production of nicotine in *Nicotiana* after feeding with prolin. This controverts the work of Klein and Linser, and shows that there is no increase of the nicotine content. A. MEESTERS: Influence of hetero-auxin on the growth of root hairs and roots of *Agrostemma gythago*, L. Growth of both roots and root hairs is inhibited, but to different extents, by indolylacetic acid (hetero-auxin). W. RIESE: Development of the brain of the whale. J. H. DIEMER and P. H. VAN THIEL: Remarks with regard to the "Courte instruction pour la détermination des variétés d'*Anopheles maculipennis*" by the Malaria Committee of the League of Nations. The paper deals with the nomenclature of the "Courte instruction" and points out that *Anopheles maculipennis* is composed of two geobiotype circles, each comprising a few biotypes, and of one biotype which stands apart. W. HUREWICZ: Contributions to the topology of deformations (3). Classes and homology types of mappings. D. VAN DANTZIG: Electromagnetism, independent of metrical geometry (5). Quantum theoretical commutability relations for light waves. A. N. J. HEYN: X-ray investigations on the molecular structure of chitin in cell walls. The unit cell of the chitin crystal has been determined; and evidence is given regarding the mechanism of cell elongation. (See also NATURE, Feb. 15, p. 277.)

LENINGRAD

Academy of Sciences (*C.R.*, 4, No. 1-2, 1935). N. EFIMOV: Some connected grids and their invariants. J. DUBNOV: Contributions to differential geometry of grids. L. KANTOROVITCH: Semi-ordinate linear spaces and their applications to the theory of linear operations. L. S. LEIBENSON: The centre of flexure of the non-closed thin-walled section. S. FRISCH: Some remarks on nuclear momentum. W. NAEDLER: Quantitative spectral analysis under variable discharge conditions. A. TOPOREC: Atomically distributed silver. A. D. PETROV, K. I. KARASEV and M. A. CHELCOVA: Action of tert.-butyl magnesium chloride upon methyl-propyl ketone and upon ethyl laurate. M. POLJAKOV: Induced oxidation of nitrogen. E. SLUTSKY: The eleven-year periodicity of sunspots. Excellent mathematical correlation is found between the periods of sunspot maxima and minima, and the intensity of the arctic aurora. E. K. GERLING: Helium emanations of the earth. E. S. BURKSER: Radioactive waters at Starobelsk. B. B.

POLYNOV and A. I. TROICKIJ : Absorption of anions in the red soils of Adzharia. Z. S. KATZNELSON : Investigations on the development of muscles in Urodela. G. V. LOPASHOV : Variation with age of the potential ability to produce organs in the isolated ectoderm of a gastrula of *Triton*. A. R. WERNER : (1) Biological activators of *Azotobacter*. Soil-grown green algae possess high value as biological activators of nitrogen fixation in the soil. (2) The role of bios in the biology of the fungi of the genus *Fusarium*. The presence of bios in the medium is necessary for the sporulation of *Fusarium*. A. A. OBRAZCOV : Micro-organisms of the rhizosphere in the Batum red soils. G. LEVITSKY and M. SIZOVA : Further studies on regularities in chromosome transformations induced by X-rays in *Crepis capillaris*. D. A. POVOLOCHKO : An autotetraploid of *Nicotiana sylvestris* obtained by regeneration effected by growth hormones. A. I. ZUITIN : Chromosomes of the yak (*Paephogus grunniens*, L.). I. B. PANSHIN : New evidence for the position effect hypothesis. V. V. SACHAROV : (1) 'Mottled' in *Drosophila* as a case of the position effect. (2) A cytological study of the lethals of the sex chromosomes in *D. melanogaster*. I. I. NOVIKOV : Chromosomes in the spermatogenesis of interspecific hybrids of the European mouflon and the domesticated sheep (merino). N. V. DUBOVSKIJ : The question of the comparative mutability of stocks of *Drosophila melanogaster* of different origins. M. I. SALTYKOVSKIJ and E. S. SAPRYGINA : Frost resistance of winter cereals at different stages of development. V. GROMOVA : The finds of wild sheep and wild goats in the quaternary deposits in the Crimea. S. S. SMIRNOV : Contribution to the morphology of rudimentary legs in Copepoda. A. P. ANDRIASHEV : New data on deep-water fishes of the Bering Sea. D. RAUSER-CHERNOUSOVA : Notes on the genus *Wedekindellina*, Dunbar et Herbert, and its stratigraphical significance.

VIENNA

Academy of Sciences, January 9. K. FEDERHOFER : Characteristic vibrations of an arc of a circle vibrating perpendicular to its plane. F. REINITZHUBER : The displacement planes of spatial structures. OTTO WETZSTEIN : Results of a zoological expedition to the Dodecanese. OTTO REDLICH and PETER ROSENFELD : The calculation of activation coefficients. OTTO REDLICH and FRITZ PORDES : Raman spectrum of deuteriochloroform and deuteromethanol ; a vibration model of the type XY_2Z . OTTO REDLICH and WALTER STRICKS : The Raman spectrum and vibrations of monodeuterobenzene and *p*-dideuterobenzene. G. JÄGER : Characteristic notes of closed and open spaces of streets and squares. WALTER WAGNER : Chromium oxide as a catalyst. ARTUR KUTZELNIGG : General survey of researches on oxidation catalysis. BERTA KULIK : The limits of detectability of the heavier rare gases in helium. The limiting concentrations of the heavier rare gases which may still be detected in helium are determined by a spectrographic method.

January 16. RUDOLF INZINGER : The differential geometry of Pfaff manifolds. GEORG KOLLER and HERMANN CZERNY : On the bitter principle of orange pips. Two bitter compounds are found to be present : limonin with a melting point at 280°, and isolimonin with a melting point at 264°. The method of separation of the two compounds is described. F. SCHEMINZKY : Electrical narcosis.

Forthcoming Events

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

Monday, March 23

VICTORIA INSTITUTE, at 4.30.—Dr. M. Gaster : "The Present Position of the Jews in Relation to World Events".

Wednesday, March 25

ROYAL SOCIETY OF ARTS, at 8.—Sir Roy Robinson : "Forestry in the British Empire."

Friday, March 27

INSTITUTION OF PROFESSIONAL CIVIL SERVANTS, at 5.30.—(at the Royal Society of Arts, John Street, Adelphi, W.C.2).—Dr. H. J. Gough, F.R.S. : "Robert Hooke".*

ROYAL INSTITUTION, at 9.—Prof. Julian Huxley : "The Race Problem".

Official Publications Received

Great Britain and Ireland

Proceedings of the Royal Irish Academy. Vol. 43, Section A, No. 1 : The Settling of a Suspension Flowing along a Tube. By W. B. Morton. Pp. 4. Vol. 43, Section A, No. 2 : The Diffusion Coefficients and Velocities of Fall in Air of Atmospheric Condensation Nuclei. By J. J. Nolan and V. H. Guerrini. Pp. 5-24. 1s. Vol. 43, Section A, No. 3 : Integrals of MacCullagh's Equations. By Dr. A. W. Conway. Pp. 25-34. 1s. (Dublin : Hodges, Figgis and Co. ; London : Williams and Norgate, Ltd.) [262
The One Hundred and Second Annual Report of the Royal Cornwall Polytechnic Society. New Series, Vol. 8, Part 2, 1935. Pp. 104. (Falmouth : Secretary, 1 Restormel Terrace.) 5s. [272
Race and Culture. Pp. 24. (London : Le Play House Press ; Royal Anthropological Institute.) 1s. [272
The National Institute of Agricultural Botany. Sixteenth Report and Accounts, 1934-35. Pp. 28. (Cambridge : National Institute of Agricultural Botany.) [23
Scientific Horticulture (formerly the H.E.A. Year Book) : the Journal of the Horticultural Education Association. Vol. 4, 1936. Pp. viii+218+ix-xlii. (Wye, Kent : South-Eastern Agricultural College.) 3s. 6d. net. [23
Liverpool Observatory and Tidal Institute. Annual Report, 1935. Pp. 16. (Liverpool : Liverpool Observatory.) [43

Other Countries

Comité international des Poids et Mesures. Procès-verbaux des séances. Deuxième série, Tome 17 : Session de 1935. Pp. viii+372. (Paris : Gauthier-Villars.) [232
Legislative Assembly : New South Wales. Report (together with Appendices) of the Minister of Public Instruction for the Year 1934. Pp. 45. (Sydney : Government Printer.) 3s. [23
Department of Agriculture : Straits Settlements and Federated Malay States. General Series, No. 23 : The Coconut Industry of the Philippine Islands ; Report on a Visit to the Philippine Islands for the purpose of studying the Conditions of the Coconut Industry. By F. C. Cooke. Pp. v+101+12 plates. (Kuala Lumpur : Department of Agriculture.) 50 cents. [23
Allahabad University Studies. Vol. 11 (Arts and Sciences). Pp. v+486. (Allahabad : Senate House.) 7.8 rupees. [23
Union of South Africa : Department of Mines. Geological Series, Bulletin No. 6 : Corundum in the Union of South Africa. By Dr. W. Kupferberger. Pp. 81. (Pretoria : Government Printer.) 6s. [33
U.S. Department of Commerce : National Bureau of Standards. Research Paper RP 856 : Uniconcort Radio Receiver for Ultra High Frequencies using Concentric Lines as Interstage Couplers. By Francis W. Dunmore. Pp. 609-618+3 plates. (Washington, D.C. : Government Printing Office.) 5 cents. [43
U.S. Department of Agriculture. Circular No. 370 : Food Habits of Common Hawks. By W. L. McAtee. Pp. 36. (Washington, D.C. : Government Printing Office.) 5 cents. [43
Field Museum of Natural History. Anthropology Leaflet 32 : Primitive Hunters of Australia. By Wilfrid D. Hambly. Pp. 59+12 plates. (Chicago : Field Museum of Natural History.) 30 cents. [43
Annales de l'Institut technique du bâtiment et des travaux publics. Année 1, No. 1, Janvier-Février. Pp. viii+120. (Paris : Institut technique du bâtiment et des Travaux publics.) [43
Ministry of Finance, Egypt : Survey of Egypt. Geology of Egypt. By Dr. W. F. Hume. Vol. 2 : The Fundamental Pre-Cambrian Rocks of Egypt and the Sudan ; their Distribution, Age and Character. Part 2 : The Later Plutonic and Minor Intrusive Rocks, with a Special Chapter dealing with Dynamical Geology (Cataract Structure and Contact Metamorphism) and the Age of the Pre-Cambrian Rocks in Egypt. Pp. xxxv+301-688+108+plates 97-158. (Cairo : Government Press.) 300 P.T. [43
Ministry of Agriculture, Egypt : Technical and Scientific Service. Bulletin No. 154 : Water-Table Effects. 2 : Relative Incidence of Diseases on Stone-fruit Trees. By Dr. A. Fikry. Pp. ii+52+33 plates. (Cairo : Government Press.) 8 P.T. [43