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DIRECTION AND UTILIZATION OF RESEARCH

IT is not always realized that, when research in the laboratory has succeeded in producing a new article or product for manufacture, it is probable that a considerable amount of capital has to be spent—not only on plant, but also on overcoming engineering and chemical difficulties, and often in creating a demand for the product—before any return can be obtained. Under modern conditions one individual can rarely take all the steps required for the development of a new product—the research work, the design and running of the small-scale plant, the market investigations, the design of the full-scale plant, the building of the factory, the running of it, the management of labour, the control of output to meet the demand, the creation of demand, the actual selling and the finding of the capital to erect the plant and for trading. Most of these steps require specialists, and it could scarcely be expected that one man should have the knowledge to do them all well; if he had, it would be difficult for him to decide to which he should give his chief attention as the development proceeded.

Let us consider where and how research comes into the scheme of things. In the beginning, it is not usually obvious that a research reaching a successful conclusion is one suitable for development. Although a successful development may afterwards seem to have been very obvious, it was probably not so obvious at the time. There are always doubts as to the potentialities of the market, and even perhaps as to the availability of the raw materials at a cost which will leave a profit. A decision has to be made; a risk has to be taken. Hence the question of finance enters into the problem, for those responsible for finding the capital have to be persuaded that the risk is a reasonable one. This task is an important function of the 'director of research', and without him there are sure to be difficulties, misunderstandings, and perhaps in some cases recriminations. It is a matter of experience that the research worker who makes the discovery or devises the process is rarely the best person to win the necessary confidence of an administrative board.

It is of first-rate importance, therefore, to consider the qualifications of a successful director of research. First of all, he must be himself a scientific worker. He must understand the research workers' outlook; he must encourage their enthusiasms. On the other hand, he must have a keen appreciation of developments on which the administrative body is prepared to spend money. He must know as much as he can of all branches of the industry from manufacture to sales, or he will never be able to understand the outlook of the administrative board. His knowledge of science should enable him to have a broad idea of the lines on which the industry may be expected to develop, and he should continually keep the board and departmental managers informed of the lines on which he expects development to be made.

Although the director of research will not find much time for doing research himself, he must not allow administration to become his chief interest. He must believe in the scientific method of approach to a subject; he must be continually assisting in summarizing and relating the results of incompleted researches, and to do this he must have been a successful research worker himself. He should be a helpful critic of the researches of his staff.

While it may be conceded that an able director of research is needed in a commercial company to obtain the confidence of the administrative body for the development of scientific discoveries, it is not generally appreciated that directors of research of Government departments and research associations have similar tasks. There are now a considerable number of directors of research in Great Britain, and they have been an essential factor in the successes which science has achieved in industry and in the arts of peace and war. But the functions of these men are not generally understood by men of science, by Government departments, or by politicians, though these services are realized by many industrialists. Their services to science itself are rarely recognized, although some of them have been elected to the fellowship of the Royal Society before they became directors of research. It is generally impossible for the successful director of research to devote himself sufficiently to one subject, and in consequence this acknowledgment from the world of science rarely comes his way.

At the present time, when ministries and Government departments are being subjected to frequent scrutiny, it is opportune to recommend to them the inclusion of a director of research in their organizations. Some of the ministries have them, and probably would not be without them now. Others have scientific advisers who give advice when asked, but this is not what is required. Every ministry should have, as an integral part of its personnel, a director of research, in close touch with *all* its problems, whose principal duty would be to advise the ministry when the man of science can be helpful. The director of research would not, as a rule, attempt to give the scientific advice himself, but a small organization under his control would see that it was obtained from the best sources available, and, as further research would be needed in most cases, he would arrange for it to be done. The Ministry of Food should certainly have a director of research, and the Ministry of Agriculture too ; he would enable these ministries to make fuller use of the Agricultural Research Council, and the Medical Research Council, as well as other research workers. Another department which might well have a director of research is the Board of Trade, to enable the Board to make use of the potentialities of the Department of Scientific and Industrial Research. Appointments such as these would add relatively little to the budgets of the departments concerned, but would go a long way towards ensuring efficiency in the utilization of the scientific resources of Great Britain.

DESIGN IN NATIONAL LIFE

The Shape of Things

An Introduction to Design in Everyday Life. By Noel Carrington. Pp. xv+209. (London : Ivor Nicholson and Watson, Ltd., 1939.) 6*s*. net.

A SUGGESTIVE chapter in Bavink's "Anatomy of Modern Science" is devoted to a discussion of the technological ideal of fitness for a purpose. Over an increasingly wide sphere of life we are becoming aware to-day that the squalor, ugliness and lack of beauty in our surroundings are due at least in part to the neglect of this principle. The deplorable position of the Special Areas can be directly attributed, as the successive reports of the commissioners for those areas show, to our lack of design in the planning of industry. The acuteness of the problems in the government of London can be traced to a like cause, and chaos in transport, ribbon building and the destruction of amenities have a similar origin in the absence of any comprehensive design sufficient to compel planning and control on an adequate scale.

It is not only in such matters that we have failed to utilize the possibilities which new materials and new means, put at our disposal by science, have afforded. In the smallest things of everyday life, the use of such materials or forces is apt to be determined less by their intrinsic qualities than by the traditional forms in which the materials they are superseding or displacing have found expression. Outstanding examples are to be found in the tardiness with which the motor-car has freed itself from forms imposed by the tradition of the horse-drawn vehicle, and the resistance of the building industry to the adoption of new forms and possibilities inherent in the steel framework or the new plastics.

Resistance or delay of this type is, however, not due entirely to the conservatism of the manufacturer. It is also partly due to the absence of a public awake to the possibilities and sufficiently

alive to the fundamental principles of design to demand appropriate forms of expression for the new means and materials.

Mr. Carrington's little book has the great merit of giving in a very brief compass a comprehensive picture of the incidence of design in everyday life, from the ordinary utensils of house or office, houses, streets and vehicles to the larger problems of planning a city or a countryside. Much more is indeed being done than Mr. Carrington suggests to interest the general public in design, and he does not mention the distributor, the advances recently made in the education of salesmen, or the efforts of the Royal Society of Arts to raise the status of the artist in industry. Apart from such omissions, Mr. Carrington covers the field well, and the brief notes on books appended to most of the chapters contain numerous excellent suggestions for the guidance of those who wish to proceed further with any particular subject.

The appearance of the book is opportune even in war-time for two further reasons. In the first place, as Mr. Milner Gray has pointed out, industrial design is of the utmost national importance in the development of our export trade. If we are to maintain our position in the markets of the world which remain open to us, or to capture those to which Germany no longer has free access, the design of our export goods must be second to none. It will not be sufficient to produce the most obvious export goods under the rigorous conditions now existing. We must demonstrate that on top of meeting all our war-time needs, we also have capacity for quality production.

The importance of this to our economic position is obvious. If we cannot get loans, we can in this way obtain orders for goods, the making of which is as truly war work as any other. For this purpose the mere repetition of old patterns and shapes will not suffice. We have to show that our goods are not only better but also more attractive, and we shall have to make full use of all new good designs if the opportunity is not to be missed.

The second reason why Mr. Carrington's book is timely lies in the opportunities for improved design which should be ours in the reorganization and reconstruction which must be involved during and after the war. The profound disturbance of the fabric of our social, educational and business life under the demands of civil defence, no less than the adjustment of industry in general to meet the problems of supply or the reorientation of administration, whether in local or national affairs, present opportunities as well as problems. The present chaos in our physical surroundings persists less because we lack the knowledge of a remedy than because we lack the collective will to set things right. Not enough people have trained themselves to appreciate the nature of the problem. Scientific research and technique have far outstripped our ability to put them to proper use.

While the same principles inspire design wherever it operates, a wider cultural education is desirable if a sense of design is not to be departmentalism. This is indeed the gravest danger and the biggest obstacle to rational design in the larger matters of traffic problems or town planning and the like. A highly developed aptitude for design in a particular field may be accompanied by complete indifference to it either in the intimacy of the home or in civic or rural surroundings. The design so essential in our major collective enterprises can only be secured as individuals appreciating the value of design in some particular field are led to appreciate its importance everywhere.

Recognition of the place and value of design is indeed essential if the resources of modern science are to be utilized to rebuild our physical surroundings to serve adequately both our needs and our desires. One of the real tragedies of this age is that the divorce of the artist from the business of life has led to the great reconstruction which the machine age has necessitated being carried through without his aid. Only here and there are the new materials finding expression in new and more appropriate ways which satisfy not merely utility but also the æsthetic and creative sense.

There are indeed increasing signs that we are coming to recognize that the artist as designer is as essential a factor in our mechanized activities as he was in ancient Greece or any other period of history. If, however, in a few fields the opportunities which new materials offer for creative expression are being explored, the opportunities which are to be found in the planning of our cities, the development of transport, the preservation and development of the countryside are largely ignored. To awaken the mind of the ordinary citizen to these possibilities, to assist him to form an intelligent opinion upon them and to lend his support unhesitatingly and persistently to those seeking to use them is an urgent need, if those opportunities are not to be missed. In this task of education, leaders of art and industry with vision and creative force are imperative. Mr. Carrington's little book is well calculated to stimulate thought upon these larger issues, to facilitate the understanding which will assist the reintegration of the artist into society, and to inspire a concern for creative work which should enable us to build a nobler culture and a saner social order out of the chaos and destruction in which we are at present involved.

R. BRIGHTMAN.

EARLY MAN IN UPPER EGYPT

Rock-Drawings of Southern Upper Egypt

1 : Sir Robert Mond Desert Expedition, Season 1936–1937 ; Preliminary Report. By Hans A. Winkler. Pp. viii + 44 + 41 plates. (London : Egypt Exploration Society, and Oxford University Press, 1938.) 18*s*. net.

THE interest of the late Sir Robert Mond in the rock-drawings of the Egyptian desert was aroused by a collection of copies which had been made by Dr. Winkler in 1936 ; and with characteristic generosity and an equally characteristic ready appreciation of the possibilities of this line of research for the early history of man in Egypt, he undertook the responsibility for an expedition for the systematic study of the rock-drawings of Upper Egypt. In this preliminary report, Dr. Winkler summarizes and illustrates the results of his first season's work in 1936–37, dealing only with the most interesting and instructive examples, comprising about one tenth of his photographs. The material collected by the expedition has been deposited at the office of the Egypt Exploration Society, where it is available for consultation by students.

Of the possible methods of investigation, the author selected on this occasion the intensive study of a circumscribed area, choosing the country between Qena and Asswân. Most of the work has been carried out in the Eastern Desert between Quft and Qosêr, while in the Western Desert two small districts were worked near Armant, when Dr. Winkler enjoyed the advantage of being helped by members of an expedition of the Egyptian Exploration Society then excavating there.

The conditions in the two regions are markedly different. On the eastern bank of the Nile, profitable investigation was in the main confined to the sandstone formations of the Quft wadi-system, by which go the shortest routes to the Red Sea and the Sinaitic Peninsula. An old road with wells crosses the desert. On the west there are no such natural limitations. A seemingly endless limestone plateau borders the Nile, which is crossed by many roads. It is especially along such roads that rock-drawings are found ; and, indeed, the presence of rock-drawings has sometimes indicated the existence of a road which had vanished. The author, however, draws a distinction. He points out that frequenters of the desert fall into two categories : those who are permanent inhabitants, such as the Beduin, and those who visit it as travellers. This distinction applies no less to early than to modern times, with the result that while drawings by travellers from the Nile valley as well as drawings by desert tribesmen are found along the lines of the roads, the drawings of the desert peoples may also be found anywhere in the desert.

Forty sites were visited. The subjects of the drawings are of a greatly varied character, ranging from purely geometrical signs to relatively realistic figures of men and animals. Boats of more than one type are plentifully represented—in fact, more plentifully than in any other group of rock-drawings, with the possible exception of Scandinavia. One rock painting only was discovered. This was in the Eastern Desert. It represents a man (dark red), archer (light red), ibex, and another animal (brown). It shows no artistic sense and its date is uncertain.

A proportion of the petroglyphs can be classified on adequate grounds as modern or ancient Arab, while others belong to either the Græco-Roman-Coptic period or the Dynastic. The majority of those of the Græco-Roman-Coptic period are assigned to the people known in antiquity as the Blemyans, a desert people, who rose to ascendency in the period from the third to the sixth century of our era. With them the camel appears for the first time in desert drawings ; and its use was, no doubt, at the root of their political and economic domination.

The greater number of the drawings, however, cannot be dated with this certainty ; and the conclusion as to their age rests upon the character of the drawings themselves and attendant conditions—position, superposition, patination, archæological finds, and the like. They are classified as Early, Pre-dynastic, and Prehistoric. Dr. Winkler assigns them to four distinct ethnic groups, for whom he has worked out a relative chronology.

These groups are as follows : (1) Autochthonous Mountain People, Hamites and cattle-breeders, who lived not only in the Eastern Desert, but also penetrated deeply into the Western Desert. The men wore the Libyan sheath. They may be regarded as the ancestors of the Blemyans. They appear to have outlived the elephant and giraffe, and probably introduced cattle into this region. (2) Early Nile Valley Dwellers, with boats showing affinities with those appearing on pre-dynastic pottery. This people was an intrusion from the Nile, and lasted down to dynastic times. (3) Eastern Invaders, a people previously almost

unknown. They appear with boats of a foreign type, first recognized as such in Dr. Winkler's expedition of 1936. The boat, though a proof of early Mesopotamian influence, is probably of other, but unidentified, origin. This people is contemporary with elephant and giraffe, and was in contact with both Mountain Dwellers and the Nile Valley people. They did not penetrate the Western Desert. (4) Earliest Hunters, whose discovery must be placed to the credit of this expedition. They hunted elephant and giraffe, and are represented in both the Eastern and the Western Desert.

Though no specimens of the common type of Libyan sheath-wearing peoples have been found adjacent to the river on the western bank of the Nile, parallels to the older wedge-style of the Libyan sheath wearer, but with not unimportant differences, are known from the distant 'Uweinât' and elsewhere in the Libyan desert. At the same time, it is to be noted that the author claims a possible Hamitic origin for a group of drawings on the west side of and near the Nile, otherwise remarkable as the only example in the whole collection which can be called a work of art. An appendix deals with the characters of the boats and their relation to other representations of boats in early Egypt and Mesopotamia.

Dr. Winkler displays great acumen and powers of observation in his interpretation of these drawings as indications of the respective material culture, social organization and religious beliefs of his four ethnic groups. He is to be congratulated on the successful result of his investigations ; and the continuation of a study which promises to throw so much light on the movements and cultures of the early peoples of these regions will be awaited eagerly.

MECHANICAL ANALYSIS OF SEDIMENTS

Manual of Sedimentary Petrography

1. Sampling, Preparation for Analysis, Mechanical Analysis, and Statistical Analysis, by W. C. Krumbein ; 2. Shape Analysis, Mineralogical Analysis, Chemical Analysis, and Mass Properties, by F. J. Pettijohn. (Century Earth Science Series.) Pp. xiv + 549. (New York and London : D. Appleton-Century Co., Inc., 1938.) 30*s*. net.

THIS interesting book is divided into two portions : the first by Krumbein deals with size determination of sedimentary particles, and the second part, by Pettijohn, is largely concerned with the optical properties of minerals. All who are interested in sediments will find this book most useful, as it contains descriptions of various techniques and methods of interpretation.

Krumbein, after discussing the collection of samples, suggests methods for the preparation of stable suspensions. One chapter is devoted to grade scales, and the advantages of a geometrical scale are pointed out. A theoretical discussion on the principles of size analysis follows, and those who are unacquainted with this subject will find a clear and adequate explanation. Although there is a wide choice of methods available for mechanical analysis, the present tendency is to use mechanically operated sieves for particles greater than 50μ, and the pipette method for smaller particles. For accurate work elutriation methods find to-day little favour in sedimentary laboratories. The pipette method is described in detail, but the accuracy of this method is not discussed. It would seem, however, important that the investigator should not only realize the experimental errors, but should also carry out occasional duplicate analyses, preferably adopting a slightly different technique. Only one page is devoted to the application of centrifugal force to mechanical analysis ; a method which is most useful in fine-grained sediments.

The remainder of Part 1 is largely concerned with graphic presentation of results. Histograms, cumulative curves, frequency curves are described, as well as the elements of statistical analysis. The reader will find a clear and non-mathematical introduction to quartile measures, moment measures, measures of central tendency, of dispersion, skewness and kurtosis. Finally, some special statistical methods are briefly described and a discussion is given concerning the choice of statistical devices.

To the mineralogist Part 2 of this book is not very important, as optical methods of identification have been frequently described, but to the non-mineralogical student the inclusion of this portion will be useful. The procedure for analysis of shape and roundness is also discussed, as well as methods for mineralogical separations ; but chemical methods of investigation are limited to five pages.

The book as a whole can be thoroughly recommended, and the authors are to be congratulated on collecting together from many sources a large amount of information, and thereby making it more readily accessible. J. D. H. W.

FOUNDATIONS AND DEVELOPMENT OF HEAT

A Text-Book of Heat
By Prof. H. S. Allen and R. S. Maxwell. Part 1. Pp. ix + 527 + xvi. 10*s*. Part 2. Pp. x + 531 – 849 + xi. 10*s*. 6*d*. (London : Macmillan and Co., Ltd., 1939.)

RECENT years have seen the production of several books on heat such as Roberts's "Heat and Thermodynamics" and Saha and Srivastava's "Treatise on Heat", to say nothing of more special works such as Hoare's "Thermodynamics". But the work now before us occupies a place of its own and will be welcomed by teachers who wish for something between an elementary text-book and a comprehensive treatise. It gives the best of the earlier work and at the same time includes some account of recent investigations.

The authors emphasize the fact that they treat the subject from the historical point of view, and there are full accounts of fundamental experiments by Joule and others, quotations from authorities, and many biographical notes. But while this undoubtedly makes the subject more interesting, there is little difference between the order of historical development and that of logical development, and the historical treatment does not impress the reader so much as the easy and gradual way the student is led into the subject.

There are two contrasting ways of writing a text-book of physics. One way is to give clear, concise statements suitable for reproduction in an examination and not going much beyond the range of the examination ; the other is to proceed by degrees, to build up a mental picture of every equation and to make the accounts of the experiments as full as possible. This is pre-eminently the method of the authors of this book and the reason for its 849 + xlvi pages. They read very easily because every chapter is obviously the result of teaching experience. After reading and understanding a book such as this, the average student is able to make his own synopsis of the subject, whereas if the concise statement were thrust at him at first, he might make nothing of it. It is, of course, for the student of physics the book is written ; the mathematical honours man may wish to travel faster.

Part 1 is intended for students preparing for the Higher School Certificate or Intermediate Examination in physics or for a university scholarship. The calculus is used occasionally, but the mathematical treatment is very simple. Part 2 is intended to meet the requirements of those reading for a pass degree in physics and to furnish a foundation for an honours course.

Near the beginning of Part 1 we notice the customary account of Davy's experiment on rubbing the plates of ice together. Prof. E. N. da C. Andrade (NATURE, **135**, 359 ; 1935) has some hard things to say about this experiment. It was carried out when Davy was a country lad of nineteen years of age. If the ice is covered with a film of water, the friction is so small that scarcely any work is done at all, whereas if it is really dry it is liable to stick. To make the frictional heat appreciable it is necessary to have a normal force holding the two surfaces together, and then there is the well-known lowering of the freezing point and consequent melting. Again, the amount of heat required to melt 1 gm. of ice is very large ; the criterion is a very insensitive one, and no one has ever tried to repeat the experiment. The effect was due to conduction, and the experiment should cease to rank with such a convincing demonstration as that of Rumford. The customary account of the experiment must be allowed to stand in the old text-books ; but in view of these statements something different is called for in a new one.

In a book written as a text-book for definite examinations, it is not possible to be very original, and Part 1 develops on conventional lines. Everything that could possibly be asked for in the examination is given ; this is saying a lot, because examiners in physics do not keep to well-defined curricula, which makes it anything but a safe subject in Civil Service and other examinations. There are also questions from the examination papers of different British universities, with the answers.

But while this first volume is, generally speaking, on conventional lines, some things such as the steam and internal combustion engines, the liquefaction of gases, etc., are done unusually well, and the last three chapters, which deal with meteorology and the dimensions of thermal quantities, are an interesting innovation. We note in passing that the theory of the experiment of Clément and Desormes is given and that it is followed by the statement that the experiment does not work ; but we are not told definitely that Gay-Lussac and Welter's modification of the experiment is any better.

Part 2 gives more scope for originality of treatment. The first half of the book is thermodynamics, but thermodynamics treated from the experi-

mental point of view, which makes it easier to assimilate. The experimental physicist will, of course, object to the chapter on thermodynamic functions and relations, but this is inevitable. Then after an account of the approach to the absolute zero, which includes the paramagnetic method and a full account of Nernst's heat theorem, there are accounts of the mathematical theory of conduction, convection, the measurement of radiation, the quantum theory and the modern theory of the specific heat of solids. The last thirty-five pages deal with statistical mechanics, the Bose-Einstein statistics and the Fermi-Dirac statistics each receiving a couple of pages. Larmor's indirect pressure theorem is a welcome innovation. The simplest definition of entropy is omitted, namely, that the increase of entropy of a substance multiplied by any low temperature gives the increase of unavailable energy of the substance with reference to that temperature, and there is no description of the photo-electric rectifier cell in the chapter on the measurement of radiation. It is difficult nowadays to say where heat stops and electricity begins, but we think this instrument ought to have been included. These are minor points.

The space given to statistical mechanics and probability is undoubtedly a move in the right direction. These concepts are becoming very important for the purpose of understanding the world around us. But it is not easy to write an account of them for the average student.

Altogether the work is a notable addition to the text-books on heat. It is the work of practised teachers and is written with great care. It is alive with modern information and research; besides being a text-book it is a storehouse of information, reference to which is greatly facilitated by the excellent indexes at the end of each volume. Much of this information the student will find unnecessary, but it will serve as a background to his knowledge and perhaps as a basis for research. The type and paper are excellent. R. A. HOUSTOUN.

SYSTEMATICS OF MILLIPEDES

Myriapoda 3, Polydesmoidea II, Fam. Leptodesmidæ, Platyrhachidæ, Oxydesmidæ, Gomphodesmidæ

Bearbeitet von Dr. Graf Attems. (Das Tierreich: eine Zusammenstellung und Kennzeichnung der rezenten Tierformen. Im Auftrage der Preussischen Akademie der Wissenschaften zu Berlin. Herausgegeben von F. E. Schulze, W. Kükenthal, K. Heider, fortgesetzt von R. Hesse. Lieferung 69.) Pp. xxviii + 487. (Berlin und Leipzig: Walter de Gruyter und Co., 1938.) 81·25 gold marks.

ANY work on the Polydesmoidea from the pen of Count von Attems must command repsect. His contributions to our knowledge of a taxonomically difficult group have been very numerous and he is of course well fitted for the task of drawing together the threads of description and weaving them into a serviceable whole. The volume under notice begins with a list of works of reference occupying ten pages, and similar space is devoted to a clear and very useful systematic index. The author then plunges into the real business in hand to give nomenclatural particulars and full descriptions of the families mentioned in the title and to deal with all their subdivisions down to subspecies and varieties. It is a formidable task, for more than eight hundred species, certain and uncertain, need consideration.

In the nomenclatural jungles where Chondrodesmus, Allarithmus and Phlyzakium roam there are pitfalls for the wary as well as for those less careful. Even specialists find the name of Platyrhacus (a genus with more than 180 described species) difficult to spell. Since C. L. Koch first used the name in 1847, it has also been Platyrhachus, Platyrhachis, Platyrrhachus, Platyrrhacus, Platyrrachus, Platyrachus and Platyracus, but we seem to have got it right at last. Not so the family appellation, for here even Attems himself goes astray with Platyrhachidæ, a name that appears both on the cover and title page of his work.

In his description of colours, Attems meets a difficulty most naturalists encounter. Until some general colour standard is adopted it seems best to decide upon the fundamental colour 'brown', 'yellow', 'black' or whatever it may be and then to add adverbial modification where this is necessary.

In spite of the thorough treatment adopted by Dr. Attems, there is a sense of disappointment with the way in which this expensive work is illustrated. Figures that are of great value for taxonomic purposes are liberally included, they are admirably clear in spite of the variety of their sources, and the lettering is excellent, but there is no adequate reminder that we are really dealing with living animals and that it is, after all, a branch of natural history that is under consideration. We go back in mind nearly eighty years to H. de Saussure's paper on the myriapods of Mexico. To look at those wonderful plates was to realize that millipedes are really alive, and it gives the naturalist a sense of satisfaction for

which the scientific accuracy of the present day is no real substitute. We want both kinds of illustration; at least a few figures of the old kind to cheer the pages and make them less dull, and to take away the impression that we are dealing with nothing but dried specimens in a museum collection and that the subject is a drab one. *Eutheatus erythropygos* (Brandt, 1841) is a good example because it is on de Saussure's first plate. Attems gives us a neat little figure (after Carl) of the gonopod, and very useful it is; but how much more satisfactory it would have been if we could have had de Saussure's delightful drawing of the whole animal reproduced as well. When no figure of the gonopods is available, it is still more to be deplored that no such illustration as that given by de Saussure is included by Attems. An instance of this is provided by *Rhysodesmus zapotecus* (Sauss.); de Saussure admirably depicts the whole animal.

Sometimes the treatment adopted by Attems is difficult to understand. Take *Platyrhacus* (*Tirodesmus*) *mexicanus* (Lucas); although Attems gives no description, this species is fully described and segments figured by de Saussure. Of the species *P*(*T*) *bilineatus* (Lucas) which de Saussure regards as near *P*(*T*) *mexicanus*, Attems gives a full description with one figure (side-view of gonopod).

When all is said, however, and we come to the end of a series of minor criticisms, we feel that Count Attems has done systematists a great service. More power to his pen!

S. GRAHAM BRADE-BIRKS.

GEOLOGY OF INDIA

Geology of India

By D. N. Wadia. Second edition. Pp. xx+460+20 plates. (London: Macmillan and Co., Ltd., 1939.) 24*s*. net.

THIS book, which from its first appearance has been the standard text-book of Indian students, has now been brought up to date by the addition of recent advances in Indian geology. The new geological map is an added attraction.

The revision has not, however, been sufficiently far-reaching and thorough. As a result, a novice to the subject of Indian geology will occasionally be puzzled by finding both the old and the modern view stated without due explanation.

The Salt-Range is regarded (p. 104 and Fig. 8) as a block-faulted structure, but later in the book we are told that over-thrust faulting is a marked structural feature.

On pp. 146 and 147, it is noted that the Upper Gondwanas of the Madras coast and probably the Rajmahal beds also must now be regarded as Lower Cretaceous and not as Jurassic. These recent conclusions—the work of Dr. Spath and Prof. Sahni—should have caused a more extensive revision of the whole subject, including alterations in the tables on pp. 51 and 130.

In the table of the Siwalik stages on p. 271, the views of Dr. Pilgrim as to age are given. But in a later table on p. 280 we find an entirely different view of the ages put forward by Dr. de Terra. An explanatory note was here called for.

Before writing his account of the Bagh Beds and the "Cenomanian Transgression" (p. 206), Mr. Wadia would have done well to have studied the views of Dr. Spath on the subject (*Pal. Ind.*, New Ser. **15**, Part 5, 64).

The account of the Samana section and the Hangu Shale fauna is too brief in view of its importance (see p. 246).

Perhaps the most disappointing chapters are those dealing with the Indian pre-Cambrian. There is no basis for the separation of the Himalayan pre-Cambrian into Archæan and Algonkian, as is attempted on pp. 81 and 99, and, as the age of the supposed Burmese pre-Cambrian is even more doubtful, it was not correct to place the Mergui series in the Archæan (p. 54).

Considering the great advance made in the study of the Peninsular pre-Cambrian by the Indian and Mysore Geological Surveys of recent years, the account is meagre and not free from intermixture of old and new views (for example, age of Bundelkhand gneiss on pp. 62, 63 and 73). The modern correlation of these rocks should have been given, and the views of M. S. Krishnan (Twenty-second Indian Science Congress, 1935), which admirably express the general opinions of the staff of the Indian Geological Survey, might have been studied.

In short, the entire rewriting of these chapters, and of that dealing with the Upper Gondwanas, would have improved the book. Nevertheless there is much valuable new material, especially regarding the Salt-Range, North-West India, and Kashmir. The structure of the Himalaya—the results of the work of West, Auden and Wadia himself—is excellently summarized in Chapter xxv. Those portions dealing with marine fossiliferous rocks and with economics are also of a high standard, and, in spite of such defects as those noted above, Mr. Wadia is to be congratulated on his new edition.

G. DE P. COTTER.

ERNST ABBE (1840-1905)

THE ORIGIN OF A GREAT OPTICAL INDUSTRY

THE great optical works of Zeiss in Jena, employing round about ten thousand people, is one of the leading firms of the world in the production of fine optical apparatus. This firm owes its high scientific standard, its economic efficiency and its growth to the creative genius of Ernst Abbe. The optical works of Carl Zeiss were originally the workshop of a skilful mechanic producing the necessary equipment for the laboratories of a small provincial university. The scholar Abbe gave to the mechanic Zeiss the results of his original scientific research. This was then leading to new methods in the design of optical apparatus, especially of microscopes. Those new instruments were of extraordinary perfection, so that an enormous demand from every part of the world made possible an extremely rapid expansion of the business. When after twenty years of growth, the well-known company had developed, Abbe renounced all his rights and gave the firm of Zeiss a constitution which has enabled it to survive its creator and to continue into our own turbulent times.

Ernst Abbe was born on January 23, 1840, as the eldest child of a poor workman. It was beyond the means of his father to provide a higher education for him. The boy started in an elementary school. Later, the generosity of the employers of the father secured a scholarship at a higher school for the boy, who early showed signs of an unusual intelligence.

In 1857, Abbe began his studies in Jena, which was at that time still a small town with a population of less than seven thousand. Jena was living then in idyllic isolation from the great world ; no railway touched it. The university was incredibly small. Its faculty of science consisted of three professors only, who were paid an average salary of £30 a year. Abbe studied in poverty ; his father could provide very little for him. He augmented his income by giving private lessons. It is not surprising that he had to live in the cheapest quarters, and it was no unusual event for him to replace a hearty meal by a pipe of tobacco. But in spite of all hardships, the two years in Jena meant a happy time for Abbe, who there acquired a knowledge of the fundamentals of the mathematical and physical sciences.

In 1859 Abbe continued his studies in Göttingen. He left Göttingen in 1861 with a Ph.D. The next two years were spent as lecturer to a private physical association in Frankfort. Although this engagement for popularizing science was not to the taste of a personality like Abbe, it brought him social contacts which proved to be important. When, in 1863, he was admitted as an unpaid lecturer at the University of Jena, a rich merchant of Frankfort enabled him to start his academic career by a personal grant sufficient to cover all his initial expenses. During his early years Abbe was kept busy with running practical classes and with preparing and delivering lectures. This was the beginning of his activity as a university teacher, which was destined to last for thirty-five years until 1898. He became associate professor in 1870 and full professor in 1878. He refused the most tempting offers of appointments in other universities, and spent the whole of his time in Jena. During the course of time he gradually dropped his mathematical lectures, specializing more and more in physics and eventually in optics only. His last lectures were of the widest interest, and were attended by the staff of his industrial co-operators and by distinguished scholars from all over Germany. From his early years he was closely attached to the professor of physics, K. Snell, whose daughter Elise he married in 1871.

While still a young lecturer, in 1866, Abbe came in close contact with Carl Zeiss. The little workshop of Zeiss was then successfully producing simple microscopes which could well compete with other instruments of this kind. All these microscopes were made according to a practical tradition developed by empirical methods. Abbe was the first to introduce scientific methods and systematic design. He recognized that the magnification of an even ideally corrected microscope was limited. There were no prospects whatsoever of resolving optically two parts of an object separated by less than about half the wavelength of the illuminating light, that is, about 0·0003 mm. This is of the greatest importance, because it indicates clearly that the only possible way of developing the microscope was by elimination of the optical errors within the limitation of reasonable magnification. Two lines of attack were available : first, the geometrical shape and the arrangement of the refracting lenses ; secondly, their physical properties, that is, their refraction and dispersion. Abbe made fundamental progress in both directions. His new results were at once applied in the optical workshops of Zeiss.

The new microscopes were far better than anything on the market, and thus the business of Zeiss's workshop expanded rapidly. Soon after (in 1876), the sale of the three thousandth microscope was celebrated, and in the same year a contract was concluded making Abbe an equal partner in the business. The glass sorts which were commercially available and which Zeiss used as a raw material were very much alike. Abbe tried to interest leading glass manufacturers in the production of new glass sorts with different optical characteristics. The small quantities of glass consumed in the microscope industries, however, did not guarantee a reward for these expensive experiments. In an interesting lecture during the London international exhibition in 1876, Abbe tried to interest scientific societies in his problem, but he was unsuccessful.

Abbe's appeal, however, was taken up by a young glass manufacturer, O. Schott, who was able to see beyond the immediate small practical prospects towards the great scientific and technical importance of the problem. Schott's father owned a small factory producing plate-glass in eastern Germany. Abbe persuaded Schott to move to Jena and to start a glass technical laboratory with him. New glass sorts—especially borate and phosphate glasses—were developed there, opening up new prospects for the optical industry. From this laboratory arose the famous Jena glass-works. In 1884 these glass works were started with twelve employees ; the Ministry of Finance of the State of Prussia secured a subvention for the first two years. In the years which followed, the Zeiss works took up the manufacture of all kinds of optical gear, including, besides microscopes and telescopes, fine photographic objectives, prism-telescopes, telecomparators and periscopes, which are all produced in relatively large quantities. Of more specialist interest is a large number of types of other apparatus which were originally designed by Abbe, for example, spectrometers, refractometers, spherometers, apertometers and many more.

In the meantime, the firm of Zeiss expanded year by year. In 1899, a thousand workers were employed. At the time of Abbe's death in 1905, the number of 1,500 employees was passed. Before the War of 1914–18, six thousand employees were engaged in the works. Owing to the heavy demands for optical gear for war purposes, this number increased temporarily to nearly ten thousand, but it dropped to a half this number immediately after the War. Since then, the number of employees has gradually increased again, and to-day it has probably passed the former peak-level.

Of Abbe's scientific papers his discussion on image production in microscopes is still of great interest. At the age of twenty-eight, he formulated his famous sine law. A few years later, in a fundamental theory, he demonstrated the connexion of the projection of optical images with the diffraction of light waves. According to his theory, the aperture of the microscopic objective has to be large enough to collect an essential part of the diffraction pattern.

It is remarkable how quickly Abbe's discoveries became known in England. He was in the closest contact with English men of science—Crisp, Mayall, Wenham, Lettsom and Stephenson. A correspondence of more than a thousand letters with these English friends is preserved. All of them showed the greatest affection and admiration for Abbe. Stephenson wrote of him :

> "Objectives and their laws lay hid in night,
> God said : 'Let Abbe be, and all was light.' "

Abbe had worked for fifteen years managing and directing the great optical firm when, in 1891, he gave it its well-known constitution. He renounced all his property rights, making himself an employee of the great organization. The fact that one of the statutes of the constitution limits the maximum salaries in this firm to ten times the amount of the minimum wage paid, shows that the remuneration of the directors cannot be excessive. The Zeiss Institution is registered as the legal owner of the company, no shares being issued. Care and custody of the Institution is entrusted to the Ministry of Education of the country. The undertaking, however, is not subject to the control of the Government administrator, but solely to the provisions of the charter, and the function of the official administrator is to see that these provisions are carried out. The works are controlled by a board of three or four directors who have to be elected by the Minister of Education from the scientific staff and from the technical and administrative employees of the company. All the earned income is received and distributed by the Zeiss Institution. In these circumstances, the employees enjoy extraordinary benefits and their health and social welfare are first considerations.

Abbe was a true Christian, though he was not a member of any official church, and, declaring himself a dissenter, he even avoided any contact with organized religion. In opposition to many relatives and to his father-in-law, he refused the religious ceremony for his marriage and the christening of his two daughters. Politically, Abbe may be called a liberal ; he joined in his later years a liberal democratic party. He disliked any extreme nationalism ; he was known even to be in opposition to the policy of Bismarck. Any racial prejudice of 'blood and soil' was quite alien

to his mind. His closest co-operator and friend, S. Czapski, whom he chose as his successor in leading the great organization, was of purely Jewish descent.

Later in life, Abbe suffered from insomnia, which he tried to overcome by an excessive use of drugs. In the end his nervous system showed all the signs of exhaustion and at the early age of sixty-three he had to retire. Two years later, in 1905, he died from pneumonia.

It will be widely agreed that the firm of Carl Zeiss occupies the first place among the optical firms of the world. This distinction is merited on the ground of the size of the firm and the variety of its products, coupled with the general excellence of its work. Its reputation for many years has been so high as to have given rise to a superstition that any Zeiss instrument is better than a corresponding instrument made by any other firm. In passing, it should be said that this superstition has many adherents in Great Britain, though it is unquestionably and inevitably false. Just as other firms have imitated Zeiss instruments, so a number of the finest Zeiss products are more or less copies of designs introduced by other manufacturers ; indeed, the firm makes a special point of knowing exactly what its rivals are producing, and to this end makes a practice of purchasing on the open market a sample of all new designs of optical instruments. But the fact that the lead in particular instruments changes at times from one maker to another in no way detracts from the many valuable contributions made by Zeiss to the progress of optical science.

The foundations of the firm's greatness were laid by Abbe. Its reputation in the first place was built on the notable improvements he introduced in the microscope. It is interesting to note that from the beginning he followed the plan, which has since proved so valuable to the firm, of publishing papers in scientific journals.

Abbe's theory of image formation in the microscope has been of great assistance to large numbers of microscopists, though many physicists find Rayleigh's treatment of the subject more fundamental and convincing. Among the new glasses produced in an endeavour to secure better microscopic images were some which led to greatly improved photographic lenses—the anastigmats—Zeiss being one of a number of firms to bring out new designs at about the same time.

Although these new instruments were calculated trigonometrically on lines laid down by Abbe, whose aim was to use computers with limited mathematical knowledge, the problems involved were considered in a general way in a treatise planned by S. Czapski. This and a number of later volumes, notably those due to M. von Rohr, are among the best modern works on optics and have added to the prestige of the firm.

The prosperity of Zeiss to-day is in no small measure due to the form of control set up by Abbe—there are no shareholders and no family claims, so that it has always been possible to secure the finest machine equipment as well as to advertise effectively, and to select able men for responsible posts. The great size of the business, which in part was brought about by the large continuous demand for military instruments for the German Army, has enabled research and development to be carried out on a scale impossible in much smaller businesses. By way of illustration, the firm studied the problems that would be presented if maps were to be prepared from photographs. The outcome was the construction of a series of instruments, used to-day in several countries, for mapping from aerial photographs. Some of these instruments are of extreme complexity ; despite their great interest and the ingenuity shown in their construction, they have found less favour in Great Britain than in other countries. As another example, possibly built largely for their advertising value, the Zeiss planetaria may be mentioned.

In recent years the firm of Zeiss has built a number of beautifully designed and made instruments of great value to engineers in setting up difficult work accurately, and in other ways. A number of laboratory instruments has also been marketed, but some of these show a tendency which ought to be discouraged. Instead of measurements being recorded on scales which can be defined apart from the instrument, readings are obtained which must be compared with others made on the same type of instrument. Apparently conversion to values obtained in other ways can only be made if the Zeiss apparatus is purchased to experiment with. This course appears to have been adopted deliberately : it tends to create a closed market for instruments in fields where one or two leading investigations have been carried out with Zeiss apparatus. The remedy is clearly in the hands of scientific workers.

This note must not close without reference to the equipment made for ophthalmic opticians and to the firm's spectacle lenses. Apart from such special products as contact lenses and cataract lenses, the Punktal series of lenses is designed to give the best possible vision over a large field with the most varied kinds of visual correction. This is a service of great humanitarian value. The moderate price of these lenses, which are highly finished, shows that the firm can manufacture a wide variety of aspherical surfaces with good accuracy by mass-production methods.

CARBON MONOXIDE AS A HAZARD OF POLAR EXPLORATION

BY PROF. YANDELL HENDERSON AND J. MCCULLOUGH TURNER, YALE UNIVERSITY

PETER FREUCHEN, speaking from his long experience in the Arctic, has said recently that "only when modern times came in did the exploration of the Polar regions begin to amount to anything real. The invention of the Primus stove did more than anything else. After that came the dog sledge." Certainly modern polar explorers have a great advantage in the hot food and ample supply of drinking water that the Primus stove affords.

THE PRIMUS STOVE AND NANSEN COOKER

Shackleton, in describing the outfitting of his expedition to the Antarctic, says, "a vitally important article of the equipment for the Polar explorer is the cooker and cooking stove. Here again we are indebted to the practical genius of Nansen, who designed the form of cooker that is now invariably used in Polar work. The stove was the ordinary 'Primus' burning kerosene vaporized in the usual way. This stove is highly efficient and with strict economy one gallon of oil will last three men for ten days, allowing three hot meals per day. This economy is due in a large measure to the qualities of the cooker. The form we used consisted of an outer covering of aluminium drawn out of one piece, inside which was a ring-shaped vessel so designed that the heated air could circulate around it. Inside this vessel was the centre cooking pot, and these pots were all mounted on a concave plate of aluminium which fitted over the top of the Primus lamp. The middle cooker was first filled with snow or ice, pressed tightly down, the lid was put on and this vessel placed inside the outer, ring-shaped cooker, which was also filled with snow ; over all this apparatus the aluminium outside cover was placed, inverted. The heated gases from the stove, after heating the bottom of the centre cooker, mounted into the space between the two vessels and then were forced down the outside of the ring-shaped cooker by the cover, finally escaping at the lower edge. Experiments showed that about 92 per cent of the heat generated by the lamp was used in the cooker, a most satisfactory result, for economy in fuel is of great importance when the oil has to be carried on sledges. . . . Such was the efficiency of the cooker and the stove that, in a temperature of 40 or 50 degrees below zero, the snow or ice, which would be at this temperature, could be melted and a hot meal prepared within half an hour from the time the cooker was first placed on the Primus. The whole apparatus, including the Primus, did not weigh more than 15 pounds."

Such are the advantages of the Primus stove and Nansen cooker. It has only recently been realized that in this combination lurks a danger—that of asphyxiation by carbon monoxide—greater perhaps than any other to which modern arctic explorers are now exposed.

Beside the fatalities, which leave no witness, there have been several narrow escapes. Amundsen was once near death from asphyxiation during his exploration of the North-East Passage. Byrd has recently published an account of how near he came to collapse from a badly adjusted kerosene stove ; but in his case fumes additional to carbon monoxide were also involved. Stefansson has now focused attention on this hazard and its insidiousness. He reports that, in a snow house that became iced and impervious to gases, one of his Eskimo companions "all at once threw himself backward upon the bed. I asked Anderson to see what Tannaumirk was up to—and Anderson fell face forward on top of Tannaumirk. I extinguished the Primus stove. Natkusiak broke away the loose block of snow by which we had a few minutes before closed up the door. He then crawled outside on all fours, but was too weak to stand up. I followed him out and had strength enough to stand up. But that was only for a moment and I fell down beside Natkusiak." Fifteen minutes after the door was opened, Anderson crawled out and after another ten minutes, Tannaumirk, "but neither had any realization of what had happened." An hour later three of the party were well enough to go into the house again, but "Tannaumirk was ill throughout the night and into the next day". All the features of this adventure—including the collapse on reaching fresh air—are characteristic of partial asphyxiation and justify Stefansson in referring to it as "the narrowest escape from death we had on our whole expedition".

With this experience in mind Stefansson, in his "Unsolved Mysteries of the Arctic", has discussed the question, "How did Andrée die ?" : and has marshalled the evidence suggesting that that intrepid explorer, and at least one of his two companions, died of carbon monoxide asphyxia. The tragedy, as told in "Andrée's Story", the

official account published by the Swedish Society for Anthropology and Geography, was briefly as follows : On July 11, 1897, after several years of careful preparation Andrée and two companions, Strindberg and Fraenkel, embarked from Spitsbergen in a balloon and floated away over the Arctic sea. Their object was, if possible, to get close enough to the North Pole to permit them to land on the ice and walk back to the coast. For that part of the expedition they were fully equipped.

They disappeared for thirty-three years. Then, in the summer of 1930, by pure chance, their remains were found on White Island, a bit of land between Spitsbergen and the Franz Joseph Islands. Enough of their records were salvaged and later deciphered to show that, although they had not attained the Pole, all else had gone essentially as planned until, on their return journey, White Island was reached. There, in some unexplained manner, Strindberg lost his life and was buried ; and a day or two later Andrée and Fraenkel appear to have died peacefully in their tent.

Carbon monoxide is believed by Stefansson, Pallin, Sverdrup and others to have been responsible for two of the deaths. The Swedish committee, on the contrary, even after the most thorough investigation, has not felt justified in adopting this hypothesis. A critical piece of evidence is lacking ; it concerns the Primus stove.

The Primus stove which Andrée and his companions used, was found in good condition and still contained some fuel. But it is uncertain whether the pressure-release valve was open or closed. In carbon monoxide asphyxia, muscular control fails when the blood is about 50 per cent saturated with the gas ; unconsciousness occurs at about 60 per cent saturation ; and death at 75–80 per cent. If then this valve was open, the explorers must have been still conscious and able to move ; and their blood was probably not more than 40–50 per cent saturated with carbon monoxide, when they turned this valve and extinguished the flame. In that case even a slight leak of air in and out of the tent or snowhouse would have prevented asphyxiation. If, on the contrary, the valve was still closed when the stove was found, they must have neglected to turn the valve, release the pressure in the stove, and extinguish the flame. The Primus then continued to produce carbon monoxide, until the gradual fall of pressure in its reservoir and cessation of the flow of kerosene extinguished the flame. But before that occurred, the blood of the explorers became 75–80 per cent saturated with that gas ; and they died. The question will probably remain for ever undecided.

Conditions for Production of Carbon Monoxide

Whatever the fate of Andrée and his companions may have been, it is important for future explorers to know whether a Primus stove, with vessels above it for cooking and for melting ice, arranged as that of Andrée was, is capable of producing, within one or two hours, sufficient carbon monoxide to render the atmosphere of a small tent or hut lethal, and whether the arrangement may not be altered so as to eliminate this hazard. This we have attempted to determine.

The Primus, although it consumes liquid fuel, is essentially a gas stove. Like other gas stoves, it may produce carbon monoxide in any one or two or all of three ways. If the supply of air to the flame is inadequate for complete combustion, or if the draught in a flue above the flame is insufficient to carry off all the products of combustion, some of the carbonaceous substances in the gas are oxidized only to carbon monoxide, instead of carbon dioxide. The other mode of production of carbon monoxide is not so generally realized, although it is probably quite as common. It occurs whenever a tea kettle is heated over a gas ring with a fairly large flame. That part of the flame which impinges upon the kettle or other vessel is cooled below the temperature requisite for complete combustion ; and carbon monoxide is formed and escapes. Similarly in gas water-heaters in which the flame plays upon a coil of metal pipe through which the water flows, dangerous amounts of carbon monoxide may be formed. For the health of our cooks, even if on a given consumption of gas the kettle heats more slowly, the rack on which the kettle rests should support it 2–3 centimetres higher than is common now and just above the flame, instead of in it. For safety all gas heaters should have flues.

Mere inspection of the diagrams of the Primus stove and Nansen cooker in Nansen's "Farthest North", "Andrée's Story" and other books of polar exploration is sufficient to raise a suspicion that one or even all these conditions for the production of carbon monoxide have vitiated their cooking apparatus. The access of air is not entirely free. The passage through which the burned gas must pass is long and for half its length is against gravity ; and the Primus appears to be held so close below the central cooking vessel that a considerable part of the flame impinges upon the vessel.

For the analysis and improvement of these conditions the first question to be decided is whether the stove itself is responsible for a production of carbon monoxide, or whether it is the arrangement of the cooker above it that is to blame. To decide this and related questions we

made use of a galvanized iron box or chamber of one cubic metre capacity in which the stove and vessels were placed for a few minutes at a time. An electric fan kept the air in the chamber thoroughly mixed. A metal rod inserted through the wall of the chamber enabled us to turn off the pressure-release valve on the stove and extinguish the flames before the chamber was opened. The oxygen remaining in the air at the end of each test was determined by means of a Haldane apparatus and the carbon monoxide by means of an iodine pentoxide train.

The Primus, when well pumped up (50 strokes of the pump) and burning freely, produces a remarkably clean, hot flame. When it was tested with no small vessel above it in the cubic metre chamber, we found that it produces virtually no carbon monoxide at all. It produces very little even when—after it has burned for three or four minutes—the oxygen of the air in the chamber has been reduced nearly to 17 per cent, at which point the flame is extinguished.

When a cooking vessel full of cold water was placed upon the frame over the stove at such a height that the upper part of the flame impinged upon the vessel, some carbon monoxide was produced. But the amount was sufficiently small so that the concentration of monoxide in the air in the chamber rose to only 2–3 parts of that gas in 10,000 of air, or 0·02–0·03 per cent, before the oxygen in the air had been reduced nearly to 17 per cent and the flame was nearing extinction. From this we infer that a man could sleep fairly safely in a small airtight room, or hut, with a

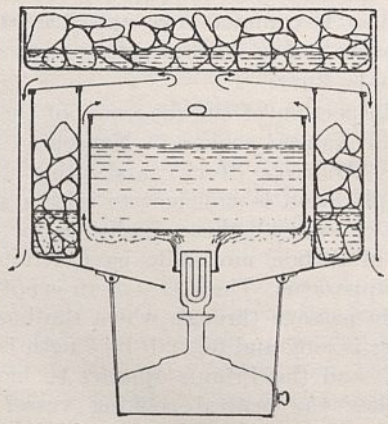

FIG. 1.

PRIMUS STOVE AND NANSEN COOKER AS COMMONLY USED IN POLAR EXPLORATION. HEATING EFFICIENCY UP TO 90 PER CENT. FOR EACH LITRE OF OXYGEN CONSUMED, 20–30 C.C. OF CARBON MONOXIDE MAY BE PRODUCED. IN A SMALL AIRTIGHT CHAMBER ENOUGH CARBON MONOXIDE MAY ACCUMULATE TO ASPHYXIATE A MAN BEFORE THE DECREASE OF THE OXYGEN IN THE AIR TO ABOUT 17 PER CENT EXTINGUISHES THE FLAME OF THE PRIMUS.

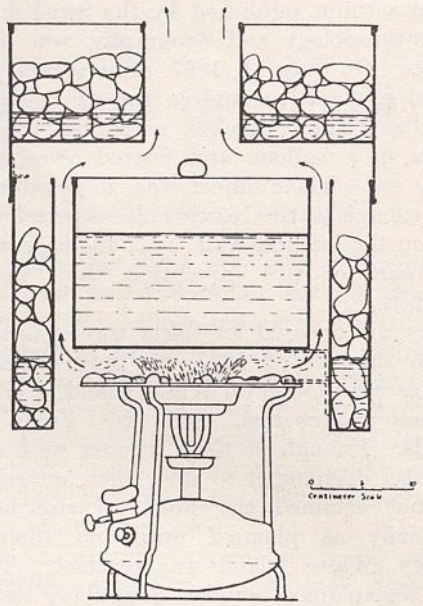

FIG. 2.

PRIMUS AND MODIFIED FORM OF COOKER. HEATING EFFICIENCY ABOUT 70 PER CENT. IF ANY CONSIDERABLE PART OF THE FLAME IMPINGES ON THE CENTRAL POT SMALL AMOUNTS OF CARBON MONOXIDE ARE PRODUCED. IF THE DISTANCE BETWEEN THE BURNER OF THE PRIMUS AND THE BOTTOM OF THE CENTRAL POT IS SUFFICIENT—3–4 CM.—SO THAT THE COMBUSTION IN THE FLAME IS COMPLETE BEFORE THE FLAME IMPINGES ON THE POT, NO CARBON MONOXIDE IS PRODUCED.

Primus and one cooking vessel. The flame would be extinguished by the decrease of oxygen before enough carbon monoxide could be produced to endanger him, although he might wake with a headache. He would not be appreciably affected by the decrease of oxygen to 17 per cent. (For comparison it may be recalled that a candle is extinguished at about 17 per cent of oxygen, but a Bunsen burner or 'gas ring' burning town's gas is extinguished only at 12 or 13 per cent of oxygen, which are about the amounts at which a man begins to be markedly affected even during a short exposure.)

When not only the cooking vessel was placed above the Primus, but also the annular vessel for melting ice was placed around it and an additional pan over it, but without the final cover of the cooker, the flame still burned brightly without the slightest smoke or soot ; and the concentration of carbon monoxide in the cubic metre chamber did not rise appreciably higher than with only one vessel on the stove.

When, however, in addition to the three vessels, the cover was placed over all, as Nansen, Andrée and others have all used the Primus and cooker, the production of carbon monoxide became so considerable that 8–10 or more parts of that gas

in 10,000 of air were developed in the chamber before the flame was extinguished by the decrease of oxygen; and 8–10 or more parts of carbon monoxide in 10,000 of air, if inhaled for more than an hour, can induce a dangerous degree of saturation.

The reasons for the elaborate arrangement of the three vessels and a cover over all, as first adopted by Nansen, were economy and efficiency in the use of fuel. In our hands when well pumped up and burning strongly, the Primus (silent type, large size, capacity 1,100 c.c.) consumes 4–5 grams of kerosene (liquid paraffin) per minute. Taking into account the heat of combustion, the volume of water and the increase of temperature in the contents of the vessels, we have found that when only one vessel is used the efficiency is only 50–60 per cent. When all three vessels are used, but without the cover, the efficiency and economy rise to 70–80 per cent; and with the cover over all, it reaches 80 or even 90 per cent, as Nansen, Shackleton, and others have reported.

With these facts before us, it appears that in Nansen's arrangement (Fig. 1), safety has been too far sacrificed to economy. We suggest, therefore, that the metal cover be omitted, and one of asbestos, or felt, or blanket substituted, with a vent sufficiently wide to offer no obstruction to the escape of the products of combustion; and in addition that some such arrangement of the vessels as that shown in Fig. 2 be adopted: an arrangement suggested to us by Mr. Anthony Fiala.

Even with this arrangement, in which there is a full supply of air and a good draught, some carbon monoxide is produced when the distance between the inner, or cooking, pot and the top of the Primus is so small that some of the flame impinges upon the cold surface of the pot. We find, however, that if this distance is increased so that it is 2 cm. more than the distance now provided between the top of the burner of the Primus and the bottom of the vessel when the vessel is set directly upon the frame of the Primus—or 3–4 cm. in all between burner and pot—no carbon monoxide whatever is produced. With this arrangement, the efficiency of the stove is, however, decreased; and only about 70 per cent of the heat produced by the burning of the fuel is caught in the contents of the three vessels of the cooker.

Whatever arrangement of the cooking and melting vessels may be adopted by future explorers, it would be well, before the expedition starts, to test it by filling the vessels of the cooker with ice and placing it with the lighted Primus in a small room, together with an electric fan to mix the air, and a canary, white mouse, or rat. To be safe, the depletion of oxygen in the chamber should extinguish the flame before the test animal is noticeably affected. With the modified cooker this test may be performed by conducting some of the air from the cooker into a box in which the animal is placed.

REFERENCES

Freuchen, P., "Living Age" 355, 561 (1939).

Shackleton, E. H., "The Heart of the Antarctic", London, **1**, 154, (1909).

Nansen, F., "Farthest North", New York, vol. 2, 122 (1897).

Byrd, R. E., "Little America", New York (1930); "Alone", New York (1938).

Stefansson, V., "Unsolved Mysteries of the Arctic", New York, Chapter iv (1939).

Andrée, S. A., "Andrée's Story". Translated from the Swedish by Edward Adams-Ray, New York (1930).

Henderson, Y., "Adventures in Respiration", Chapter vi, Carbon Monoxide Asphyxia, Baltimore (1938).

Drinker, C. K., "Carbon Monoxide Asphyxia", London, New York, Toronto (1938).

Brumbaugh, I. V., "Causes of Some Accidents from Gas Appliances". Tech. Papers, U.S. Bureau of Standards, **20**, No. 303, 47 (1926).

Burrell, G. A., "The Use of Mice and Birds for Detecting Carbon Monoxide after Mine Fires and Explosions". U.S. Bureau of Mines, Tech. Paper No. 11 (1912).

Burrell, G. A., Seibert, F. M., Robertson, I. W., "Relative Effects of Carbon Monoxide on Small Animals", U.S. Bureau of Mines, Tech. Paper No. 62 (1914).

NEWS AND VIEWS

Gold Medal of the Royal Astronomical Society

THE Gold Medal of the Royal Astronomical Society has been awarded to Dr. Edwin Hubble, Mount Wilson Observatory, California. Edwin Hubble joined the staff of the Mount Wilson Observatory in 1919. His first work was an investigation of the spectra and luminosity distributions of galactic nebulæ, and he established the now accepted connexion between the light from such nebulæ and the spectra of the stars involved. He proceeded to a general classification of what are now known as extra-galactic nebulæ, and then turned to intensive studies of M31 and M33, which considerably extended the list of novæ observed in them, and he identified Cepheid variables of galactic type as occurring in them. By means of the period-magnitude law for Cepheids he evaluated the distances of these nebulæ, which led in turn to estimates of their dimensions and masses and definitely established not only their extra-galactic nature but also their general similarity to our own galaxy. From this fundamental work followed the recognition of the nebulæ in general as extra-galactic but comparable with our own galaxy in structure. The 'island universe' controversy was thus settled.

Combination of nebular distances with measures of red-shifts (discovered by Slipher but enormously extended by Hubble and Humason) led to the enuncia-

tion of the 'velocity-distance proportionality', often called Hubble's Law. This law underlies all modern theoretical cosmology and the concept of the expanding universe. Recent refinements due to Hubble himself have called in question the interpretation of the red-shifts as velocities; but, in whatever form, the apparent increase of velocity at the rate of about 500 km. sec.$^{-1}$ per 10^6 parsecs is a fundamental world-datum. Hubble's more recent researches have been concerned with the distribution of the nebulæ in space and the discovery of their average homogeneity, modified by a tendency to form groups and clusters; with the determination of the mean density of matter in space, another fundamental constant; with space absorption and obscuration in the galactic plane; with the effects of red-shifts on apparent magnitudes; and with the character of the 'local' group of nebulæ. It may fairly be claimed that the modern picture of the universe of extra-galactic nebulæ is largely due to Hubble's researches. He has recently collected them in a book, "The Realm of the Nebulæ", a work of epic quality. His contributions are characterized by the power and originality of his methods, by his observational skill, by the objective character of his deductions and by the general brilliancy of his results.

The Earthquake in Turkey

THE first official estimate of the earthquake losses was given to the Kamutay on January 11 by the Health Minister, who said that there were 23,131 dead and 7,994 injured, and that 29,131 houses had been ruined. Further news of the disaster comes from the affected areas as communications are restored. The Susheri district north-east of Erzinjan had been completely cut off for a fortnight except for the dropping of food and medicaments by a squadron of aeroplanes. There were 3,950 dead and 590 injured. It appears that the Malatia Erzinjan railway was not so greatly affected by the earthquake as the Sivas Erzinjan line, though the blizzards and snow affected this line tremendously. According to eye-witness accounts from Rechadiye, there were crevices 400 yards long and several yards wide in different directions. Streams and rivulets have changed their courses. At a place 12 kilometres from Rechadiye a mountain had its shape completely altered, giant precipices being formed and roads being blocked. The Yeshil-Irmak overflowed and further threatened Amasya.

Sailors report that between Kerasun and Shebin-Karihisar an entire mountain has subsided. Photographs from Erzinjan show that movement there took place in all directions, as there appears to have been no predominant direction of fall of the columns and other debris. The town of Erbaa near Tokat has apparently suffered almost as much as Erzinjan, and in many places the bursting of drains due to the earthquake and floods has added new terror. It is reported that typhoid has broken out at Fatsa. After-shocks of decreasing intensity have been felt at intervals in the widely separated areas of Samsun, Amasya, Bursa, Kersund, Yozgad, Inebolu, Bolu, Burdur, Isparta, Karahisar, Erbaa, Akhissar, Odemish, Duzic, Sivas, Tokat, Bergama, Smyrna and Kikili, that is from northern to south-western Anatolia, according to a *Times* report.

The entire body of survivors from Erzinjan, numbering 3,200, have been removed to Alexandretta, Mersin, Adana and other towns of Southern Anatolia, except about 130 injured, who have been placed in hospitals in Istanbul, and the surviving military cadets who have been sent to Konia. It is reported that the Government is discussing a proposal to rebuild Erzinjan on its present site, and temporary wooden cottages are to be erected. Dr. G. Van Dyk states that the first pulse to arrive at De Bilt (Holland) after the earthquake was dilatational, and that possible after-shocks were registered there on December 27 at 22h. 44m. 3s. G.M.T. and on December 28 at 3h. 30m. 45s. and 3h. 35m. 15s. G.M.T. We are indebted to Rev. J. P. Rowland, S.J., of the Stonyhurst College Observatory, for a copy of the seismogram of the principal earthquake. This seems to indicate the possibility of three distinct shocks having occurred within the first minute. They appear to have been of increasing intensity and from very nearly the same epicentre.

Drug Standardization

THE Harrison Memorial Lecture was delivered by Mr. A. D. Powell, chief analyst of Boots Pure Drug Co., Ltd., at the evening meeting of the Pharmaceutical Society on January 9. His subject, "Drug Standardization", was chosen, he said, in token of the work done in that connexion by the late Colonel E. F. Harrison prior to his undertaking the responsibilities of his post as chief of the Defensive Gas Warfare Department during the War of 1914–18. Mr. Powell surveyed the progress of standardization from the time when, as a result of the disclosures of the *Lancet* Analytical Sanitary Commission, the Adulteration Act 1860 was passed, and concluded by outlining his own ideas of the desirable features of a satisfactory drug standard.

Mr. Powell put forward five points: (1) The description and principal requirements of strength should be free from ambiguity, and the descriptive paragraph, if it referred to a drug of definite chemical composition, should not be so restrictive as to insist on a particular method of preparation. (2) The degree of purity in terms of the substance, or of an active principle, should be defined wherever possible, unless, as with many organic chemicals, the melting point gave a sufficient indication of a high degree of purity. (3) The tests for purity should be diagnostic, and preferably capable of application under conditions varying within reasonable limits. (4) The number of tests for purity should cover all the impurities likely to be present in significant proportion, but should be limited by this consideration. (5) Tests to detect traces of unlikely impurities, or a redundance of tests for the same impurity, may weaken rather than strengthen a standard. In general, standardization should be definite and free from ambiguous interpretation; this should not

enforce an academically high degree of purity involving artificially high cost of preparation without corresponding advantages in safety and therapeutic activity.

A Pioneer of the Oil Engine

As long as there are oil engines, there will be discussions as to the relative merits of the work of Herbert Akroyd Stuart in Great Britain and of Rudolph Diesel in Germany. Designers of engines to-day utilize the ideas of both, but whereas the name of Diesel has become a household word, that of Stuart is known only among engineers. It was said at the time Stuart died that he "belonged to that rather tragic fraternity of inventors whose achievements have not secured from the world at large the recognition they merited". That his work is fully appreciated in engineering circles was shown by the Diesel Engine Users' Association, which on January 11 held a luncheon at the Connaught Rooms, London, to commemorate the fiftieth anniversary of his most important patents.

After the luncheon, a sketch of Stuart's life and work was given in a paper by Mr. T. Hornbuckle and Mr. A. K. Bruce. Stuart was born in Yorkshire in 1864 and died in West Australia in 1927. He was among the earliest students of the Finsbury Technical College. While engaged at his father's engineering works at Fenny Stratford, Buckinghamshire, he began experimenting with internal combustion engines, and in the years 1886–92 took out nine British patents for improvements. His leading patents were No. 7146 of May 8, 1890, and No. 15994 of October 8, 1890. These were taken out in collaboration with C. R. Binney. In that of May 8, 1890, he claimed the novelty of compression ignition. Diesel's patent was not taken out until February 28, 1892. The manufacture of oil engines according to Stuart's patents was taken up by Messrs. Hornsby and Sons, Ltd., of Grantham, in 1891, and Stuart had little more to do with them. Unfortunately, the engines became known as "Hornsby-Akroyd" engines, and in America even as "Hornsby-Diesels". At his death, Stuart left instructions for his papers to be destroyed, but he bequeathed sums of £500 and £700 respectively to the Institution of Mechanical Engineers and the Institute of Marine Engineers for prizes for papers on oil engines.

British and American Civil Engineers

IN September last it had been arranged that representatives of the Institution of Civil Engineers should visit the United States in response to an invitation from the American Society of Civil Engineers, but international unrest in Europe resulted in the cancellation of that visit. Had the visit taken place, it was intended that Mr. W. J. E. Binnie, who was then president of the Institution, should present to the American Society of Civil Engineers a replica of the Myddelton Cup, as a token of the friendly relations which have existed between the two societies. Lord Lothian has now, however, on behalf of the Institution, handed the replica to Colonel D. H. Sawyer, president of the American Society, at a gathering of the members of that Society held in Washington on January 9.

The original Cup was presented to Sir Hugh Myddelton in 1613 by the Worshipful Company of Goldsmiths of London for his services in providing London with a supply of potable water. It remained in the possession of the Myddelton family until 1922, when it was acquired by the Goldsmiths' Company. Lord Lothian has, by completing the ceremony of presentation, cemented the cordial feeling between the two societies and strengthened that part of the bond of international friendship which is based upon the creative genius of the civil engineer in all parts of the world.

Non-Political Work of the League of Nations

A REPORT by the Secretary-General on the work of the League of Nations (July–mid-November, 1939), which has just been issued, is an immediate sequel to the regular report on the work of the League, 1938–39; but is the first of a series which will be published periodically to keep the States Members informed of the progress of the League's work (League of Nations. Report on the Work of the League (Continuation), July–mid-November, 1939. (Official No. A.6(a), 1939.) Pp. 62. (Geneva: League of Nations; London: George Allen and Unwin, Ltd., 1939.) 1*s.* 6*d.*). The report shows that with certain exceptions—the European Conference on Rural Life, which was to have met at Geneva in October, for example, had to be postponed *sine die*—the League has been able to carry on, in spite of the War, its essential activities in the non-political fields in which it has been responsible for so much successful and constructive work in recent years. For the development of international co-operation in economic and social affairs, the creation of a Central Committee to direct and supervise the work of the League's Committees dealing with those questions has been recommended and a draft constitution submitted for the approval of the Assembly.

A section in the report on economic and financial questions refers to the meeting of representatives of National Nutrition Committees held at Buenos Aires in October and to measures taken to adapt the publications of the Economic Intelligence Service to the new conditions. Other sections deal with communications and transit, health questions, and traffic in opium and other dangerous drugs. It is interesting to note that maintenance of supervision of this traffic in war-time has been strongly urged by the United States of America, although not a member of the League.

Vital Statistics of a Primitive People

A STUDY of the vital statistics of the lowland Sĕnoi (Sakai) of Perak, Malay Peninsula, by H. D. Noone (*J. Fed. Malay States Mus.*, 15, 4; 1939) is of interest in its bearing on the effect of the interracial and cultural contacts of a primitive people on their chances of survival. A generation ago it was regarded as a matter of time only before the then

dwindling pagan tribes of the Malay Peninsula would disappear. The observations which Mr. Noone now records, however, suggest that in the group under notice recuperative forces are at work, which enable them at least to hold their own against the effects of Malayan contacts and the adoption by some of their number of the tenets of the Mahommedan faith. In the course of an economic and demographic survey in 1936, Mr. Noone found that in fourteen groups with a population estimated at 1,600 the number of children born to the average lowland Sĕnoi married woman is 4·15, the model family also being four, but with a tendency to increase. The size of the family which occurs so many times as to contribute potentially more to a future generation than any other is five. With this figure as a characteristic, there is ground for hope for the future.

Fertility, reckoned on the basis of the number of children who grow to maturity and become effective in adding offspring to the group, is assessed on the average survival figure of 3·003, the largest number of deaths before maturity taking place under the age of six years. The sex ratio is 100 females to 107·38 males born; and this is practically unchanged at maturity at 100 and 107·54 respectively. These figures, taken in conjunction with other data recorded by Mr. Noone, point to the conclusion that while groups in which contacts have been recent appear to enter upon a stage during which the population suffers a disturbance of its reproduction rate, other groups have passed through this stage and have adjusted themselves well enough to be at least as viable as their more primitive and remoter hill cousins.

Disease and Race

A CASE which is of considerable interest in its bearing upon the racial incidence and distribution of disease is reported from Egypt by S. Azmy Pasha and A. F. Zanaty of Cairo (*Lancet*, 237, December 30, 1939). The patient in question, a man, thirty-five years of age, who had lived in Cairo for twelve years, but previously to that in the country, was admitted to hospital with anæmia in August 1938 and after discharge was re-admitted in a relapse in 1939. After a fortnight's treatment without improvement, a bone marrow puncture not only excluded an aleukæmic leucosis as well as a plastic anæmia, but also showed megaloblasts typical of Addisonian anæmia. Addisonian anæmia, the authors point out, has a distinct racial incidence. It is generally regarded as a disease of Nordic races and as less common among southern races. In America also a higher incidence has been recorded among immigrants from northern Europe (Anglo-Saxon) than among those of Latin extraction. It is also regarded as further supporting this view of racial susceptibility that the Finns, out of all races, are more liable to develop the disease when infested with *Diphyllobothrium fatum*—a parasite which produces a blood-picture indistinguishable from that of genuine Addisonian anæmia. The disease rarely occurs in Asiatics and is unknown in the tropics. In Egyptians it is extremely rare. The authors, after examining hundreds of anæmias, have found only this case now recorded, while another authority has encountered two cases only since 1935.

Demography of Madagascar

IN his inaugural thesis (Thèse de Paris, No. 657; 1939) Dr. Félix Randriamanana states that a study of the population of Madagascar since the beginning of the century shows an annual rise, which was very pronounced during the first twelve years but underwent a decline during each of the subsequent twelve years. In 1936 the population was 3,777,951 as compared with 2,244,876 in 1900. In 1904 and 1908 various devastating epidemics, especially smallpox, measles, malaria and influenza, had a considerable effect upon the population. The annual birth-rate has increased from 64,847 in 1906 to 88,351 in 1936; but the increase is probably more apparent than real owing to the notification of births being carried out more completely then previously.

During 1933–36 the death-rate was 20·7 per 1,000, as compared with 28·5 in Réunion (1933–35), 24 in Egypt (1930–34), 22 in Cochin-China (1931–35) and 15·7 in France (1931–35). During the first year of life the mortality in 1934–36 was 177 per 1,000 births as compared with 83 in France (1930–34) and 206 in Japan (1934). The maternal mortality in childbirth showed a rate of 100 per 1,000 births, this high rate being due to disease and the poor constitution of the mothers. The most prevalent epidemic diseases in Madagascar are plague and malaria at the beginning of summer (December), followed in April by influenza, measles, whooping cough and dysenteries. In June and July pulmonary diseases, especially pneumonia, predominate, followed by influenza, while in September and October more or less severe outbreaks of alimentary diseases are prevalent.

Animal Organisers

Current Science is to be congratulated on presenting to Indian readers a comprehensive résumé of research on organisers ("Organisers in Animal Development", Supp. *Curr. Sci.*, August 1939, Bangalore). There are eight articles contributed by the distinguished investigators, O. Mangold, E. Rotmann, J. Holtfreter, P. Weiss, W. Luther, C. H. Waddington, S. Hörstadius and C. M. Child. Four of the articles are in German, the remainder in English. There are numerous illustrations. The subjects discussed range from the general work of organisers during development and the special factors influencing their activities, to collateral fields of research such as the study of regeneration of lost parts and physiological gradients. A certain amount of repetition and overlapping is inevitable in a series such as this, and it would have been helpful if a summary of the articles could have been provided.

The story of the experimental work undertaken by Spemann and his collaborators at Freiburg im Breisgau on blastoporic organisation centres in the amphibian egg is well known in Great Britain. The old 'epigenesis' versus 'preformation' controversy

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was thereby revived in a new form. Yet where has it led us ? To a slightly better understanding of the laws governing development, but also to obstacles which defy further progress in the present state of our knowledge. For the moment, zoologists have exhausted the subject and await the arrival of a new idea. Some even deny the validity of the organiser theory, and it is possible that much of the work that has been done may be relegated historically to one of those attractive side avenues in science which forms a pleasant rendezvous for a while but is destined to be neglected later because it leads nowhere.

Teaching of Statistics

IN a paper read to the Royal Statistical Society on June 20, 1939, and printed, with the ensuing discussion, in its *Journal* (**102**, 532 ; 1939), Dr. John Wishart pointed out, among other things necessary for the progress of the subject, the urgent need for a standard treatise on its mathematical side. There are many text-books on practical statistical methods, usually restricted to one particular field of application, such as economics, business statistics, psychology, or biology and medicine, in which the reader has to accept the statements without proof. If a mathematical student asks where these proofs may be found, he may be told "You must look up the original papers, which you will not be able to understand". It is urgently necessary that a text-book should be produced to end this unsatisfactory state of affairs.

Dr. Wishart discussed in some detail what such a text-book should contain, and feared that it was beyond the powers of any one man to produce ; he favoured a co-operative venture. However, many will differ from Dr. Wishart on this point, and prefer the incompleteness which may be found in the work of a single writer to the lack of unity characteristic of a book produced by a committee. In the interests of science it is desirable that we should not have to wait indefinitely until the ideal treatise can be produced. Let someone have the courage to make the attempt now ; there is no one better qualified for the task than Dr. Wishart himself.

Meteorology in Southern Rhodesia

THE meteorological report of the Department of Agriculture, Southern Rhodesia, for the year ended June 30, 1938, covers the period during which the Northern Rhodesia Weather Service was taken over from the British East Africa Meteorological Service by arrangement with the Governments concerned. After the transfer, the establishment of a new air route in Northern Rhodesia was announced by the Government of that country to replace the existing route via Broken Hill and Mpika, and this led to the setting up of a first-order meteorological station at Lusaka, while arrangements were made to open another at Kasama later. Civil aviation developed to twice its initial volume during the period in Southern Rhodesia, and the Service found it difficult to meet the increased demands for weather reports.

The formula used for the previous ten years for forecasting the seasonal rainfall gave a prediction of abundant rainfall for 1938–39, with a result that could not of course be indicated at the time of completion of this report. The only previous comparable prediction of abundant rainfall was for 1934–35, and was the most conspicuous of only three failures out of the previous nine predictions to forecast whether the rainfall would be above or below the average. On one of these three occasions the predicted and actual departures were so small that it can reasonably be regarded as a successful forecast, making the successes nearly eighty per cent, which is a very satisfactory result. It is stated that the predictions have proved of value, as may easily be credited in view of this high percentage. The report, as usual, includes extensive meteorological tables for a large number of stations for the year, among them those giving hourly values of several items for Salisbury Observatory.

Mistletoe, Magic and Medicine

THE October issue of the *Bulletin of the History of Medicine* contains an excellent survey by Dr. Leo Kanner, of Baltimore, of the history of mistletoe from the earliest times until the present day. The magic virtues formerly attributed to it were as follows : it was regarded as a promoter of grain and fruit harvests ; a fattener of live-stocks ; an incentive to milk production ; a safeguard against ghosts and witches, nightmares and conflagrations ; a bringer of luck to farmers, home owners, hunters, warriors, wrestlers and travellers ; an agent which forces spirits to reveal their secrets ; a discoverer of buried treasures, and a feeder of the mystic mandrake. It was also characteristic of its magic powers that mistletoe was regarded as a panacea, as it was used for the prevention and cure of plague, leprosy, fevers, syphilis, consumption, hæmorrhages, diseases of the heart and lungs, intestinal disorders, poor appetite, skin affections, nervous troubles and, most of all, epilepsy.

On the other hand, mistletoe was sometimes regarded as a baleful plant and was supposed to possess poisonous properties for which numerous remedies were prescribed by Galen and others. In the first half of the nineteenth century all the therapeutic properties of the mistletoe had become discredited, and it was not until 1906 that it became permanently established as a useful drug for the treatment of hypertension and later as a diuretic and styptic.

Tests of a 4,000 kw. Gas-Turbine Set

PROF. A. STODOLA, in *Engineering* of January 5, gives a description and test results of a 4,000 kw. combustion-turbine generating set, recently constructed by Messrs. Brown, Boveri and Co., Ltd., of Baden, Switzerland, for the city of Neuchâtel. The set was built for installing in a bomb-proof chamber for use in emergencies, and consists of an axial-type air-compressor, a combustion chamber, a

gas-turbine exhausting direct to the atmosphere, and an electric generator. "The present-day possibilities of realising a successful gas-turbine, resulting from the improvement of the compressor efficiency on the one hand, and the availability of heat resisting materials on the other hand, would have appeared unthinkable but a short time ago."

When the set is working, with the temperature of the atmosphere about 77° F., air from the compressor is discharged at a pressure of about 60 lb. per sq. in. and a temperature of nearly 400° F. to the combustion chamber. The fuel is gas oil. Only a part of the air is used for combustion, the remainder being used to bring down the temperature of the burnt gases to about 1,000° F., at which temperature they enter the turbine. After doing work in the turbine, the gas is exhausted to the atmosphere at a temperature of about 500° F. The set is rated at 4,000 kw., and revolves at 3,000 r.p.m., producing three-phase current at 50 cycles. The thermal efficiency is 17·38 per cent. The gas turbine, says Prof. Stodola, has many promising possibilities which merit the attention of prime-mover designers and of leaders of industry.

Swiss Watch-making Industry

IN *Swiss Technics*, published by the Swiss Office for the Development of Trade, in Zurich and Lausanne, during November–December 1939, it is stated that although less trade was carried out during the first few months of the year than during the corresponding months of 1938 there was decided improvement in the summer, so that exports to most foreign countries very nearly reached the 1938 figures. This progress would certainly have been maintained had it not been for the War. It would be absurd to give way to despondency with regard to the future of the Swiss watch-making trade. There are two good reasons for looking forward hopefully. The first is the great improvements made by the industry in perfecting watches during the last ten years. The improvements have been continuous.

The 1939 steel watch is proof against fall, shock and damp. It is antimagnetic and does not oxidize. It unites a number of advantages and improvements not found in the best watches made before the War of 1914–18. The manufacturers are not afraid of losing their customers. As an example they give Great Britain, where the demand is increasing owing to the greater need for punctuality. The second reason lies in the organization of the Swiss watch-making industry. The watches are made of good materials and with great technical skill. Quite poor people will always find good watches at a price suited to their purses. Competition which the Swiss might justly have feared has now disappeared. They are therefore prepared to provide the world with the three types of watches produced by a trade that is built up on sound principles: chronometers and precision instruments, suitable for observatories, beautiful high grade watches, and cheaper watches which nevertheless keep good time. It is thus that the Swiss industry faces the great crisis.

Earth Tremors in Belgium

ON January 7 two earthquake tremors were distinctly felt in the district immediately to the east of Mons, one at about 4.30 p.m. and the other at about 8.30 p.m. These were recorded at the Uccle Observatory at 4.29 p.m. and 8.32 p.m. respectively and the epicentre appears to have been near latitude 50° 26′ N., longitude 4° 0′ E. No damage or casualties are reported. It will be remembered that a much stronger earthquake did damage to property and caused injury to ten people in Belgium on June 11, 1938 (NATURE, **144**, 950; 1939). On that occasion the epicentre was determined by the chief of the Belgian Seismological Service, Dr. O. Somville, to have been between Audenarde and Renaix, latitude 50° 47′ N., longitude 3° 35′ E. The 1940 epicentre thus appears to have been a little to the south and east of the 1938 epicentre, though any connexion between them is doubtful. The 1938 earthquake had a depth of focus of 45 km. though the 1940 one may have been superficial.

Development of Moscow

A BOOKLET recently issued in Moscow entitled "Moscow in Figures" (London: Russia To-day Press Service) shows the development of the Soviet capital in recent years. According to the figures given, during the last thirteen years the population of Moscow has more than doubled, at present numbering 4,137,000. Moscow is now the third largest city in the world. The number of workers and employees in the factories and institutions of Moscow in 1939 reached 2,300,000, as against 600,000 in 1913. In 1938 there were 117,200 births in Moscow. The city has 175 scientific research institutions in which 9,000 scientific workers are engaged. The higher educational institutions of Moscow have 95,000 students. During the last four years 350 new schools have been built. The number of pupils at present attending the Moscow schools is 608,300.

Hygiene in South China

THE November issue of the *Bulletin de l'Office d'Hygiène Publique* contains an account by Inspector-General Dr. A. Lasnet, the delegate of Algeria, of a sanitary mission sent by the Health Section of the League of Nations to South China in December 1937, six months after the onset of the war between China and Japan. The work of the mission consisted in (1) a campaign against infectious diseases, especially smallpox during the cold season, cholera during the hot season and malaria in the spring and summer; (2) wholesale destruction of insanitary houses, construction of wide sunny streets, proper disposal of excreta, and protection of the water supply; (3) education of the population in hygiene.

Detection of Toxic Gases

LEAFLETS 8 and 9 of "Methods for the Detection of Toxic Gases in Industry", published by the Department of Scientific and Industrial Research

(H.M. Stationery Office, 2*s*. 6*d*. each net) deal with phosgene and arsine, respectively. The methods used are colorimetric, the reagents being diphenylamine and *p*-dimethylaminobenzaldehyde in the case of phosgene, and mercuric chloride in the case of arsine. Full directions for performing the tests are given.

Colonial Service Appointments

THE following appointments and promotions in the Colonial Service have recently been made: M. Lunan and C. Mansfield, agricultural officers, Tanganyika Territory; A. H. Milne, veterinary officer, Nyasaland; H. W. C. Newlands, veterinary officer, Tanganyika Territory; R. H. Owen, veterinary officer, Gold Coast; C. D. V. Georgi, senior chemist, Research Branch, chief research officer, Agricultural Department, Malaya; R. R. Glanville, senior agricultural officer, Sierre Leone, principal agricultural officer, Nigeria; W. G. Leckie, senior agricultural officer, Kenya, deputy director of agriculture, Basutoland; F. A. Squire, entomologist, Windward and Leeward Islands, entomologist, Sierra Leone; C. A. Thorold, plant pathologist, Kenya, plant pathologist, Department of Agriculture, Trinidad; R. G. M. Willan, assistant conservator of forests, Nyasaland, assistant conservator of forests, Cyprus.

Prize Awards of the Paris Academy of Sciences

THE annual public meeting of the Paris Academy of Sciences was held in December, and the customary long list of prize and medal awards for 1939 has been published. Lack of space precludes publication of the complete list of awards, most of which naturally go to French workers, but the names of the following investigators outside France who received prizes may be put on record: Prof. Nicolas Coculesco, honorary director of the Observatory and honorary professor of the Faculty of Science of the University of Bucharest, the G. de Pontécoulant Prize for his studies of celestial mechanics, especially on the development of the perturbing function; Prof. Lucien Dautrebande, of the University of Liège, a Montyon (Unhealthy Trades) Prize of 2,500 francs for his researches during the past twenty years on the toxicology of the vapours of different solvents used in industry; Prof. Pierre Coulouma, of Lille, and director of the Institute of Anatomy of Fribourg, and Léon Devos, of the Faculty of Medicine of Lille, a Montyon Prize of 2,500 francs for their work entitled "Les zones pulmonaires. Anatomie et radiologie chez l'Homme. La lobation et la zonation des poumons. Études d'anatomie comparée chez l'Homme et les Mammifères".

Food Rationing: Special Diets

AT the request of the Ministry of Food, the Ministry of Health, and the Department of Health for Scotland, the Medical Research Council has appointed an expert committee "to advise from time to time on the question whether it is necessary on medical grounds to modify or supplement rations in the case of invalids and other persons on special diets". The following have accepted the Council's invitation to serve on the committee: Sir Edward Mellanby (chairman), secretary of the Medical Research Council; Prof. L. S. P. Davidson, professor of medicine in the University of Edinburgh; the Right Hon. Lord Dawson of Penn; Prof. F. R. Fraser, professor of medicine in the British Postgraduate Medical School, London; Prof. H. P. Himsworth, professor of medicine in University College Hospital Medical School, London; Dr. R. D. Lawrence, King's College Hospital Medical School, London; Dr. R. A. McCance, reader in medicine in the University of Cambridge; Dr. J. C. Spence, Victoria Infirmary, and clinical teacher in medicine in King's College, Newcastle-on-Tyne. The committee will hold its first meeting at once, when the question of diabetic diets will be particularly considered.

Announcements

DR. C. H. DESCH retired from the post of superintendent of the Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, on December 31 last, having attained the normal age limit. Dr. Desch will be succeeded by Dr. C. Sykes, of the Metropolitan-Vickers Research Laboratories, who will take up his duties at Teddington on March 1.

THE annual general meeting of the London and Home Counties Branch of the Institute of Physics will be held on January 25, in the lecture theatre of the Royal Institution, London, W.1. At the conclusion of the business, a lecture will be given by Dr. H. Spencer Jones, Astronomer Royal, entitled: "The Measurement of Time".

THE next meeting of the Plastics Group of the Society of Chemical Industry will take the form of a joint symposium with the Faraday Society at Caxton Hall, Caxton Street, Victoria Street, S.W.1, on January 26, at 6.30 p.m. The symposium will be entitled: "Molecular Size and Structure and their Influence on the Properties of Plastics". Further information can be obtained from the Hon. Secretary of the Plastics Group, Society of Chemical Industry, Clifton House, Euston Road, London, N.W.1.

THE Hotel Dieu of Quebec, the oldest hospital in Canada, and with the possible exception of one in Mexico, the oldest hospital in North America, has recently celebrated the tercentenary of its foundation.

THE centenary of the foundation of the Belgian Royal Academy of Medicine will be celebrated on September 19, 1941.

THE New York office of the United States Public Health Services is sponsoring the formation of a Society for the Study of Syphilis for all physicians in the city who are interested in the diagnosis and treatment of the disease.

LETTERS TO THE EDITORS

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IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 111. CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Evidence for Transformation of Mesotrons into Electrons

ONE of the outstanding questions regarding the mesotron is that of its ultimate fate. Certain properties of this particle are remarkably like those of the hypothetical particle assumed by Yukawa in his theory of nuclear forces and β-disintegration, and this has led to the view that the two may be identical. Within a rather large experimental error they have the same mass, and both are unstable in the free state, having an average life of the order of 10^{-6} seconds. The disappearance of the particle of Yukawa's theory at the end of its life takes place through its transformation into an electron and a neutrino, and it is regarding this that hitherto there has been no evidence of a parallel between it and the mesotron of cosmic rays. In fact, existing experimental evidence has rather gone to show that mesotrons suffer at the end of their life some other fate than befalls the Yukawa particle.

With the object of obtaining information on this crucial point we constructed a large cloud-chamber (24 in. diameter, 20 in. deep) which, with its large sensitive period and volume, might catch a cosmic ray mesotron coming to the end of its range in the gas of the chamber. A recent photograph taken with this shows a mesotron track terminating in the gas as desired. From its end there emerges a fast electron track, the kinetic energy of which is very much greater than the kinetic energy of the mesotron, but is comparable with its mass energy. This indicates that the mesotron transforms into an electron, in which case the remarkable parallel between the mesotron and the Yukawa particle is taken one stage further. In terms of Yukawa's theory, the phenomenon observed may be described as a disintegration of the mesotron with the emission of an electron, thus constituting the most elementary form of β-disintegration.

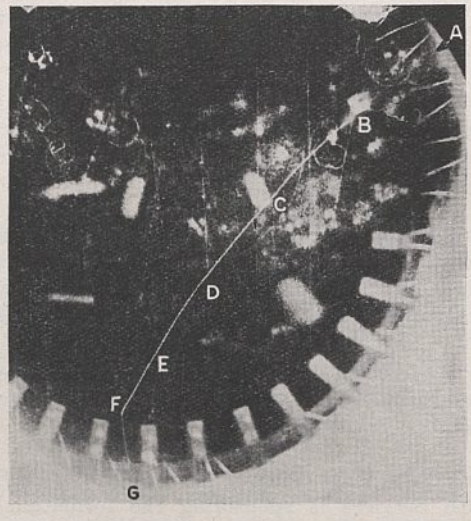

Fig. 1.

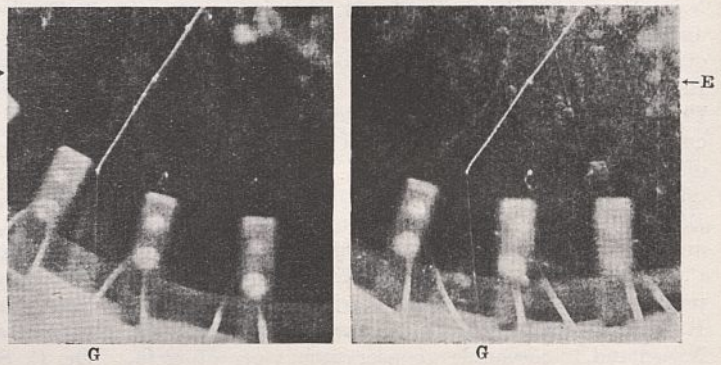

Fig. 2.

a AND *b* ARE ARRANGED FOR STEREOSCOPIC OBSERVATION WITH THE NAKED EYE, WHEN USUALLY THE LEFT EYE SEES THE RIGHT-HAND PICTURE.

Fig. 1 is a reproduction of one of the photographs of the stereoscopic pair. The dense track *AF* is that of the mesotron, and the faint track *FG* leaving its end, near the bottom of the chamber, is that of the fast electron. It will be noticed that the latter is comparable in density with the tracks of other fast particles which happened to traverse the chamber in the same region. Fig. 2 is a larger reproduction of the stereoscopic pair, showing only the end portion of the mesotron track and the emergent electron (2*a* is not in as good focus as 2*b*). Fig. 3 is a heavily exposed reproduction of the last few millimetres of the mesotron track to bring out its shape though the electron track is thereby nearly lost, and Fig. 4 is an enlargement of the δ-track at *E* to show more clearly its initial direction. The tracks in the present reproductions are much less distinct than in the original negatives and photographic prints, and this particularly applies to the fast tracks (including

FG) and the short δ-tracks, of which there are at least six obvious ones to be seen between *C* and *F* on the original negative.

That the dense track is that of a mesotron follows from its range and curvature, and from the δ-tracks. An accurate estimate of the mass from the curvature is not possible because the scattering which the particle suffers interferes appreciably with the curvature due to the magnetic field. The straightness of *FG* and of neighbouring fast tracks shows that there was no appreciable distortion from air motion. The radius of curvature, ρ, at *B*, measured over *AC* (~ 20 cm.), is 70 cm., giving $H\rho = 1180 \times 70 = 8{\cdot}3 \times 10^4$. The range beyond *B* is 33 cm. in the chamber, corresponding to 41 cm. of normal air. These data give a mass, μ, of (250 ± 70) *m*, where *m* represents electronic mass. This is of the same order as previous estimates of the mass of the mesotron, and is sufficiently far removed from the mass of the proton (1840 *m*) to establish the particle as a mesotron. The number and range of the δ-tracks also indicate mesotronic mass, and rule out a proton. In particular the long δ-track at *E*, which in the reproduction in Fig. 3 is seen to be directed nearly forward, has a path-range, *R'*, equal to 0·06 ± 0·03 times the remaining range, *R*, of the heavy particle. This is roughly the range that would be expected for a secondary electron knocked nearly forward by a mesotron with the observed remaining range. It is, however, at least five times greater than the range of the longest δ-track that could be produced by a proton. The latter is approximately $(2^{3{\cdot}4}/1840)R = 0{\cdot}006R$. Regarding the 'scattering' of the track, while it is more pronounced than the *average* effect expected for a mesotron, it is more compatible with the latter than with a proton or any other known particle. The natural 'curvature' of cloud-tracks due to multiple and single scattering is discussed by one of us in a paper now in the press (*Physical Review*). It is there shown that towards the end of its range—last 5 cm. or so—the natural curvature of a mesotron track may well exceed its magnetic curvature in a field of 1,200 gauss. (The 'kink' at *D* contributes little to the average curvature and is possibly more a thinning of the track on one side than a true deflection. The 'single' scattering at *C* appreciably reduces the overall curvature.) The bending of the track in the last 5 mm. or so (Fig. 3) is of interest. It indicates that the mesotron has come to the end of its range, thus discounting the possibility that the photograph represents the production of a mesotron and an electron by a neutral particle. Against this supposition are also the facts that the long δ-track at *E* is initially directed forward, and that the δ-tracks are more numerous in the lower half of the track. Both indicate motion of the mesotron towards *F*.

2 cm.

Fig. 3

Fig. 4

The curvature of the electron track, *FG*, is very small. Actually there is detectable (Fig. 2*b*), a small curvature in a direction indicating a positive charge, which is also the direction of the curvature of the mesotron. The photograph thus represents a positive mesotron transforming into a positive electron. So far as it can be estimated, the radius of curvature of *FG* is 200 cm. ± 50 per cent, which in the field of 1180 gauss (neglecting any distortion due to air-motion) indicates an energy of 70 Mev. ± 50 per cent. Taking $\mu = 200\ m$, and assuming that a neutrino takes half the energy, the energy of the electron would be $100\ mc^2 = 50$ Mev.

The large energy of the electron shows, quite apart from Yukawa's theory, that mass has been annihilated—for the mesotron, even if we suppose it has disintegrated before 'stopping', has certainly less than 4 Mev. of kinetic energy. Actually, the large bending of the end of the mesotron track indicates (as already pointed out) that *E* is the normal end of its range, where it has reached too low a velocity to ionize further. In this connexion it is of interest that an upper limit to the lifetime, τ, of this mesotron, since its entry into the chamber, can be set from the fact that the electron track starts from a point certainly not more than 0·4 mm. from the end of the mesotron track. Assuming the mesotron, after it ceases to ionize, to diffuse with gas-kinetic free path (10^{-5} cm.) and thermal velocity (10^6 cm./sec.) this gives an upper limit to τ of $(0{\cdot}04^2/10^{-5} \times 10^6) \sim 2 \times 10^{-4}$ seconds. Actually it is likely that a mesotron, when it stops ionizing, has a velocity of at least 10^7 cm./sec., and a free path considerably greater than gas-kinetic values, so that τ must be much less than the above limit. The average value of τ deduced from the anomalous absorption of cosmic ray mesotrons is of the order of 10^{-6} seconds.

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Large Cosmic Ray Showers and Mesons

IT has been pointed out recently by Bhabha, Carmichael and Chou[1] that a meson may produce a large cosmic ray shower by knocking on an atomic electron in a close collision; this electron then produces a shower by the ordinary cascade process. Previously, Bhabha[2] had come to the conclusion that large knock-on showers are comparatively unimportant; but he had based his argument on the assumption that the scattering of mesons by electrons could be described by the Dirac relativistic theory. However, Massey and Corben[3] have shown that the effect of the spin of the meson is greatly to increase the scattering for high energies of the incident meson and the knocked-on electron. Using Massey and Corben's formula, Bhabha, Carmichael and Chou have shown that the experimental results of Carmichael and Chou[4] can be reasonably well explained, whereas the previous theory predicted too few large showers.

There is, however, another process which has to be considered. In passing a nucleus, a meson may emit a very hard γ-ray, and this γ-ray will start a cascade shower. Since γ-rays and electrons are about equally efficient in producing showers, it is only necessary to consider the relative magnitude of the cross-sections for knocking-on an electron and producing a γ-ray of the same energy, and it appears from calculations which we have recently carried out that at sufficiently high energies the production of a γ-ray is the more probable process.

The direct calculation of the radiation loss by mesons is distinctly complicated. We have, therefore, used the method of impact parameters employed by v. Weizsäcker and by Williams for discussing the

corresponding electron problem. This method requires a knowledge of the scattering cross-section for light quanta by mesons which are initially at rest. We have calculated this, using Kemmer's new matrix formulation of the meson equations[5], which is particularly well adapted to the treatment of problems not involving the nuclear interaction. We have then used this formula, which is too complicated to be quoted here, to obtain the radiation loss in the extreme relativistic case. We find that the differential cross-section for the process in which a meson of energy E collides with a heavy nucleus of atomic number Z and emits a γ-ray the energy of which lies in the range εE, $(\varepsilon + d\varepsilon)E$, is

$$\frac{1}{137}\frac{Z^2}{12}\left(\frac{e^2}{mc^2}\right)^2\frac{E}{mc^2}(2-2\varepsilon+7\varepsilon^2)d\varepsilon, \qquad (1)$$

where m is the mass of the meson. (This formula does not apply to very small values of ε.)

The corresponding cross-section for the knock-on process in which the meson gives up a fraction ε of its energy to one of the Z atomic electrons is

$$\frac{\pi}{3}Z\left(\frac{e^2}{mc^2}\right)^2(2-2\varepsilon+\varepsilon^2)\frac{d\varepsilon}{\varepsilon}. \qquad (2)$$

Hence, for energies greater than about 300 mc^2/Z, that is, about 4×10^9 ev. for air and about 4×10^8 ev. for lead, the emission of a γ-ray is the more probable process. It is, therefore, clear that the calculations of Bhabha, Carmichael and Chou must be modified; the revised theory will give an even greater number of large showers.

It is also of interest to compare (1) with the corresponding formula for electrons, which according to v. Weizsäcker is, with sufficient accuracy,

$$\frac{4Z^2}{137}\left(\frac{e^2}{m_ec^2}\right)^2\log\frac{137}{Z^{\frac{1}{3}}}\left[\frac{4}{3}(1-\varepsilon)+\varepsilon^2\right]\frac{d\varepsilon}{\varepsilon}, \qquad (3)$$

where m_e is the electronic mass. We see that in spite of the much larger mass of the meson, the cross-section for the emission of a very energetic γ-ray (for which $\varepsilon \sim 1$) is greater for mesons than for electrons, provided that the energy is greater than about $3 \times 10^{13} \log (137Z^{-\frac{1}{3}})$ e.v. Similarly, we can conclude that a γ-ray with energy greater than about 10^{14} ev. is more likely to produce a meson pair than an electron pair, provided of course that the electron theory and the meson theory both remain valid in this region. As a consequence of this we may expect to find cascade showers consisting mainly of mesons and γ-rays high up in the atmosphere. As the energies of the individual particles diminish, the number of mesons will decrease, since electrons will be created instead of mesons when the energies of the γ-rays fall appreciably below 10^{14} ev.

Full details of the calculations will be published when circumstances permit.

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[1] Bhabha, Carmichael and Chou, *Proc. Indian Acad.*, A, **10**, 221 (1939).
[2] Bhabha, *Proc. Roy. Soc.*, A, **164**, 257 (1938).
[3] Massey and Corben, *Proc. Camb. Phil. Soc.*, **35**, 463 (1939).
[4] Carmichael and Chou, NATURE, **144**, 325 (1939).
[5] Kemmer, *Proc. Roy. Soc.*, A, **173**, 91 (1939).

Series in Nuclear Energy-Levels

P. G. Kruger, F. W. Stallmann and W. E. Shoupp[1], investigating the γ-spectrum and the spectrum of the emitted neutrons of the reaction ${}^9_4\mathrm{Be} + {}^2_1\mathrm{D} \rightarrow {}^{11}_5\mathrm{B} \rightarrow {}^{10}_5\mathrm{B}^* + {}^1_0n \rightarrow {}^{10}_5\mathrm{B}$, have found a system of excitation energy-levels of the nucleus ${}^{10}_5\mathrm{B}$ with the values 0·26; 0·50; 0·61; 1·44; 1·93; 2·92; 3·64 and 4·73 Mev., which they interpret as ${}^3D_{1,2,3}$ ${}^1S{}^1D{}^3D{}^1D{}^3F$ levels.

It is worth remarking that the second, fourth, sixth and eighth terms can be represented by the formula $E_K = 0{\cdot}239\ K(K+1)$ Mev., with $K = 1; 2; 3; 4$; that is, 0·478; 1·434; 2·868 and 4·780 Mev. (by the method of least squares), the deviation of the experimental data being much smaller than the error of 5 per cent admitted by the authors. The formula above corresponds to the law of terms of the rigid rotator in quantum mechanics $E_K = K(K+1)\hbar^2/2J$, where K is the angular quantum number and J is the moment of inertia.

Also, the ratio of the third and the seventh term being 1 : 6 fits surprisingly well into the scheme above with $K = 1$ and $K = 3$. In consequence, we should expect a further term with $K = 2$; and there is such a term (the fifth) at 1·93. The method of least squares leads to 1·84 Mev., just within the limit of the error admitted by the authors, and to $E_K = 0{\cdot}307\ K(K+1)$ Mev., with $K = 1; 2; 3$. The moments of inertia are then $J_1 = 1{\cdot}45 \times 10^{-48}$ and $J_2 = 1{\cdot}13 \times 10^{-48}$ gm.cm.^{2}. Inserting the mass of ^{10}B, we can calculate a lower limit of the radius of the rotating nucleus to be $r > 2{\cdot}6 \times 10^{-13}$ cm., which appears a reasonable value. With spherical distribution of the particles ($J = \frac{2}{5}Mr^2$), we get $r_{\mathrm{sph.}} = 4{\cdot}15 \times 10^{-13}$ and $4{\cdot}71 \times 10^{-13}$ cm. respectively. That we find two different moments is due either to isomerism of the nucleus ${}^{10}_5\mathrm{B}$ or to a non-spherical symmetry of the nucleus. Thus all terms equal to or greater than 0·48 Mev. of ${}^{10}_5\mathrm{B}$ can be represented as terms of the rigid rotator, and the law is confirmed with eigen values 10^{10} times as great as in molecules.

The term law of the rotator can be applied also to other nuclei. For example, in ^{26}Mg, excitation levels are known[2] at 2·3, 4·0 and 5·0 Mev. With $E_K = 55{\cdot}5\ K(K+1)$ kv., $K = 6; 8; 9$; we get 2·33; 4·00 and 5·00 Mev. For the moment of ^{26}Mg we find $6{\cdot}25 \times 10^{-48}$ gm.cm.^{2}, $r_{\mathrm{sph.}} = 6{\cdot}06 \times 10^{-13}$ cm.

Even for nuclei as heavy as ^{223}AcX, the law of rotation holds and provides a description of the energy levels. Analysing the α-rays of ^{227}RaAc, S. Rosenblum[3] has found levels at 30; 61; 81; 135; 174; 197; 235; 247; 288; 313; 335; 386 kv. (some other very feeble ones are not yet determined exactly). With the formulæ $E_K = 1{\cdot}496\ K(K+1)$ kv. and $E_K = 1{\cdot}594\ K(K+1)$ kv., using least squares, we get corresponding levels at 29·9; 62·8; 83·6; 134·6; 175·3; 197·5; 233·2; 248·7; 290·1; 314·2; 334·7; 382·6 kv. These levels are also in conformity with the experimental data of γ-rays. In particular, we find for the highest term:

382·6 — 334·7; 233·2; 210·4; 62·8; 29·9 kv.
differences 47·9; 149·4; 172·2; 219·8; 352·7 kv.

γ-Rays are measured with
47·9; 149·2; 172·7; 219·4; 353·0 kv.

The moments of ^{223}AcX come out to be $J = 2{\cdot}18 \times 10^{-46}$ and $J = 2{\cdot}32 \times 10^{-46}$ gm.cm.^{2}

respectively; the radii $r_{sph.} = 1{\cdot}22 \times 10^{-12}$ and $1{\cdot}26 \times 10^{-12}$ cm. respectively.

In accordance with the assumption of equal density, the $\frac{2}{3}$ powers of the mean values of the moments of inertia of the three atomic nuclei described above are proportional to the atomic weight within 1 per cent, namely, 10 : 26 : 223.

A more detailed discussion and the application to other nuclei will be published elsewhere.

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[1] Kruger, P. G., Stallmann, F. W., Shoupp, W. E., *Phys. Rev.*, **56**, 297 (1939).
[2] May, A. N., Vaidyanathan, R., *Proc. Roy. Soc.*, A, **155**, 519 (1936).
[3] Rosenblum, S., *C.R.*, **204**, 175 (1937).

Wave-length Effect in the Reaction of Human Skin to X- and Gamma-Radiation

THE quantitative variation with wave-length of the reaction of human skin to X- and γ-radiation is of both clinical and biological importance. Of especial interest is the determination of the ratio of the biologically equivalent doses, appropriately measured in röntgens, of X-radiation of effective wave-length 110–170 X.U. and of γ-radiation of wave-length 10–20 X.U. It is an accepted clinical observation that the dose of X-radiation equivalent in the production of skin erythema to 1 r. unit of γ-radiation is less than unity, and recent work[1] suggests a value of the order 1/1·3. However, in this and most other studies, the depth dose distribution was very different for the two radiations.

During a clinical investigation with another object, I have examined the skin reactions produced by γ-radiation in which the depth dose at 0·5 cm. was 97–108 per cent; this distribution was attained during the treatment of cases of carcinoma of the lip by means of two-plane moulded applicators. Routine X-ray therapy has made comparison possible and ten of the γ-ray cases were selected together with ten suitable cases receiving X-radiation of approximate effective wave-length 145 X.U. In both groups, the end-point observed was the onset of moist desquamation and the overall time of irradiation was 192 hours. The dosage rates were 0·906–1·26 r./min. for γ-radiation and 28·0–31·5 r./min. for X-radiation; in the former case, the intervals between the exposures were never greater than 12 hours; but in the latter, two 48-hour intervals occurred together with the usual 24-hour intervals. Recent experiments[2,3] show that these differences in dosage rate and time spacing produce an error not greater than 5 per cent in the required ratio. The X-ray apparatus was calibrated using a rice phantom and a Victoreen dosimeter, and the measurements were kindly checked by Dr. D. E. Lea using a free air ionization chamber. The γ-ray intensities were calculated assuming that 1 Imc. hr. = 8·4 r., and the homogeneity of the field at the skin was checked photographically. Clinically similar reactions were observed, among these twenty selected cases, with X-radiation with a mean dose 4,250 r. (minimum 4,200 r., maximum 4,500 r.) and with γ-radiation with a mean dose 5,790 r. (minimum 5,490 r.; maximum 6,500 r.); the reaction did not occur with γ-ray doses 5,200 and 5,350 r. From the results, it is concluded that 0·7–0·8 r. unit of X-radiation of effective wave-length 145 X.U. is equivalent, in the production of moist desquamation of normal human skin, to 1 r. unit of γ-radiation of effective wave-length 15 X.U.

It is important to know whether this result is capable of quantitative explanation in terms of the contribution from photo-electric absorption in the heavier elements present, including the sulphur of the stratum corneum. Tedious but straightforward calculations, including once-scattered radiation, show that the 'physical erythemal effectiveness' W_λ, for radiation of primary wave-length λ, which is defined as proportional to the ratio of the energy absorptions per unit volume in tissue at depth $z \simeq 0{\cdot}1$ mm. and in a small air cavity at $z = 0$ half embedded at the surface of a phantom, is given by:

$$W_\lambda = k\frac{(\tau+\sigma_a)_{\text{tissue}}}{(\tau+\sigma_a)_{\text{air}}}e^{-[\mu_c z_c + \mu\ (z-z_c)]}\left\{1+K(\lambda)\right\},$$

where k is an arbitrary constant, τ and σ_a respectively the photo-electric and scattering absorption coefficients at λ, μ_c the absorption coefficient and z_c the thickness of the stratum corneum and μ the absorption coefficient of the subjacent tissues. $K(\lambda)$ is a slowly varying function of λ and is ≤ 3 per cent for $\lambda = 145$ X.U. This equation has been tested by calculating the value of $\frac{(\tau+\sigma_a)_{\text{tissue}}}{(\tau+\sigma_a)_{\text{air}}}$ for a large number of possible (and improbable!) tissue and nuclear compositions[4,5] using Sauter's formula to obtain τ.[6] From the results, the conclusion must be reached that these physical considerations cannot possibly lead to a value of the ratio less than 0·9, which is significantly greater than that observed.

In seeking an explanation in terms of a chemical process, the participation of excited molecules[7] appears to be supported by the similarity of the photo-chemical changes produced in certain organic compounds by ultra-violet and X- and γ-radiations[8]. Further, the theoretical possibility of a small wave-length effect, but in the opposite direction to that observed, is introduced by the work of Bethe[9], who showed that during the passage of fast electrons through atomic hydrogen the ratio of the probabilities of excitation to ionization processes increased slowly with the energy of the electron. The similarity of the values of the ionization and excitation potentials[10] suggests that the effect may be of the same order for water as for hydrogen. Calculations on this basis (including secondary processes) show that in water the ratio of the number of excitation to ionization processes for radiation of wave-length 12·1 X.U. is $\leq 1{\cdot}05$ times the value for the wave-length 121 X.U.; hence this effect is not likely to be of importance.

These considerations suggest that the observed response of human skin to X- and γ-radiations cannot be attributed quantitatively to its exceptional histological and chemical structure alone, as appears to be the case for the wave-length effect with ultra-violet radiation[11], and it is worthy of note that similar values of the ratio discussed are suggested by recent work on other living cells, assuming that 1 Imc. hr. = 8·4 r.; for example, 0·65 for Drosophila eggs[12], 0·73 for Drosophila pupæ[13]. Comparison of

the ratio for normal and neoplastic tissues would be of great radio-therapeutic interest.

I wish to express my grateful acknowledgment to the Medical Research Council for financial assistance.

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[1] For example, Cowell, M. A. C., Brit. Emp. Cancer Campaign. Annual Report, p. 162 (1938).
[2] Quimby, E. H., and MacComb, W. S., *Radiology*, **29**, 305 (1937)
[3] McWhirter, R., *Brit. J. Radiol.*, **9**, 287 (1936).
[4] *Cf.* St. Rothman and Fr. Schaaf, "Handbuch der Haut u. Geschlecktskr." Berlin (1/2), 161-377 (1929); Wilkerson, V. A., *J. Biol. Chem.*, **107**, 377 (1934); Schmid, R., *Arch. f. Derm.*, **175**, 493 (1937).
[5] Caspersson, T., *Skand. Arch. Physiol.*, Supp. 8 (1936).
[6] *Cf.* Heitler, W., "Quantum Theory of Radiation". Oxford, p. 125 (1936).
[7] *Cf.* Fricke, H., *Cold Spring Harbor Symposia*, **2**, 241 (1934).
[8] Becker, J. P., *Strahlentherapie*, **48**, 296 (1933); Allen, A. J., *et al.*, *Biochem. J.*, **31**, 195 (1936); *Cf.* Allsopp, C. B., "Medical Uses of Radium", p. 12 (1938).
[9] Bethe, H., "Handb. Physik.", **24**, 1, 518 (1933).
[10] Price, W. C., *J. Chem. Phys.*, **4**, 147 (1936); Bethe, H., "Handb. Physik.", **24**, 1, 278 (1933).
[11] Mitchell, J. S., *Proc. Roy. Soc.*, B, **126**, 241 (1938).
[12] Henshaw, P. S., and Francis, D. S., *Radiology*, **27**, 569 (1936). *Cf.* Exner, F. M., and Packard, C., *Radiology*, **25**, 391 (1935).
[13] Müller, J. H., *Strahlentherapie*, **64**, 633 (1939).

Cozymase in Adrenalectomized Rats

DURING recent years, Verzár and his co-workers have tried to demonstrate that the adrenal cortical hormone plays an important part in the phosphorylations of the body. They have, among other facts supporting this hypothesis, shown that lactoflavine has no B_2-effect in adrenalectomized rats. In these, however, the full vitamin effect is obtained by lactoflavine-phosphate[1]. They have further shown that in adrenalectomized rats the liver contains abnormally small amounts of fixed lactoflavine[2].

In view of these findings, we have thought it of interest to investigate whether the metabolism of cozymase, another prosthetic group carrying the PO_4 group at quite a different position from that of lactoflavine, is influenced by adrenalectomy.

White rats weighing 100–250 gm. were used. They were kept on a diet of white bread and milk. The adrenals were removed transperitoneally under light ether anæsthesia with aseptic precautions. In some cases the gastrocnemius muscle of one side was removed simultaneously and treated as described below.

Controls			Adrenalectomized		
Body weight (gm.)	Weight of brain (mgm.)	Cozymase (γ per gm. brain)	Body weight (gm.)	Weight of brain (mgm.)	Cozymase (γ per gm. brain)
♂ 187	1455	156	♂ 195	1188	94
♂ 202	1154	142	♀ 92	1199	126
♂ 215	1380	119	♂ 217	1320	144
♂ 220	1585	141	♂ 165	1317	151
♂ 160	1183	150	♂ 165	1320	106
♀ 125	1085	115	♂ 145	1255	139
♂ 175	1234	132	♂ 132	1339	87
♂ 195	1343	133			
♂ 202	1401	128			
♂ 245	1388	138			
♀ 123	1244	183			
	Mean 140			Mean 121	

When the animals were killed by decapitation after about 120 hours, they were with a few exceptions markedly adynamic. The organs were rapidly removed and placed directly upon a block of carbon dioxide 'ice'. They were weighed and minced in the frozen state. About 1 gm. of tissue was heated in 5 c.c. water just to the boiling point and then allowed to cool at room temperature. It was then kept in the ice-chest. Cozymase was determined in the supernatant fluid by the fermentation test with apozymase in Warburg vessels. The apozymase was standardized with a solution of almost pure cozymase (90–100 per cent).

Experiments with a few animals failed to show any difference between adrenalectomized and control rats in the cozymase content of heart, liver, muscle and kidney. There appeared, however, to be a marked increase of cozymase content of the brain after adrenalectomy. That this was only accidental is shown by the accompanying table giving the values obtained in a series of 11 normal and 7 adrenalectomized rats. The cozymase content is given in γ cozymase per gm. fresh weight. The difference between the means is obviously not significant.

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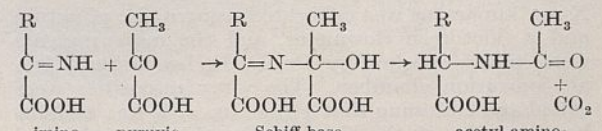
[1] Laszt, L., and Verzár, F., *Z. Vitaminforsch.*, **5**, 265 (1936).
[2] Verzár, F., Hübner, H., och Laszt, L., *Biochem. Z.*, **292**, 125 (1937)

Mechanism of Enzymic Decarboxylation

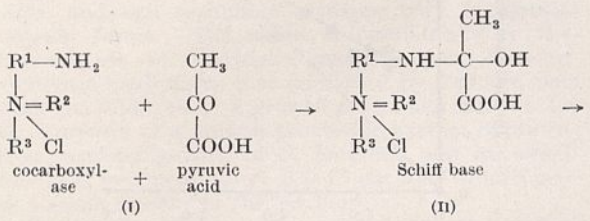
A THEORY of the mechanism of the enzymic decarboxylation of pyruvic acid is suggested, which, though not yet capable of strict experimental proof, is consistent with many recent observations.

Langenbeck[1] predicted the amine nature of cocarboxylase. He showed with various amines serving as carboxylase models that the first step of the catalysis is the formation of a Schiff base. Schiff bases have been postulated as intermediaries in several biological reactions, such as transamination[2] and synthesis of amino-acids[3–6], in the course of which they undergo intramolecular oxido-reductions. Of special interest, because it involves a decarboxylation of pyruvic acid, is the following mechanism of amino-acid synthesis originally proposed by Knoop[3,4] and experimentally corroborated by the recent work of du Vigneaud *et al.*[5,6]:

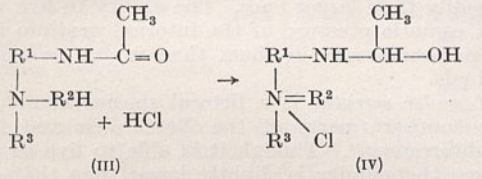


In this scheme pyruvic acid acts as hydrogen donator for the imino acid, being itself oxidized to acetic acid and carbon dioxide.

Besides possessing a free amino group, cocarboxylase contains pentavalent nitrogen which is capable of reduction[7]. The initial steps of decarboxylation may therefore be pictured by the following reactions involving an intramolecular oxido-reduction of the Schiff base primarily formed :



Although the decarboxylating systems of yeast and animal tissues possess the same coenzyme, they differ in that the former converts pyruvic acid into carbon dioxide and acetaldehyde, whereas the latter, in common with certain bacteria, form carbon dioxide and acetic acid by an oxidative mechanism. On the basis of the proposed mechanism a natural explanation is possible if we assume that in animal tissues compound (III) is dehydrogenated to acetyl-cocarboxylase only by a specific carrier[8], whereas in yeast a second intramolecular oxido-reduction occurs resulting in the Schiff base of acetaldehyde (IV) :



Besides accounting for the difference between yeast and animal carboxylase, the scheme outlined above is capable of explaining various other facts. It has been observed that acetic acid is very slowly metabolized by isolated animal tissues, yet it has been shown to be formed by the decarboxylation of pyruvic acid which is metabolized very vigorously. An 'active form' of acetic acid has therefore been postulated[9] which can be rapidly metabolized, probably by way of condensations leading to succinic, citric and acetoacetic acids. It is suggested that this 'active form' is identical with acetyl cocarboxylase.

It has recently been reported by Quastel and Webley[10] that the ability of propionic acid bacteria to oxidize acetic acid is greatly enhanced in presence of vitamin B_1. This can be explained by the assumption that this organism possesses the faculty of synthesizing the 'active form' of acetic acid, namely, acetyl cocarboxylase, from acetic acid and cocarboxylase.

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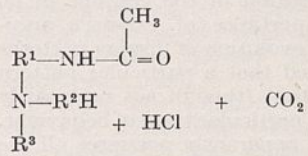
Dec. 11.

[1] Langenbeck, W., *Ergebn. Enzymforschung*, **2**, 314 (1933).
[2] Braunstein, A. E., and Kritzmann, M. G., *Enzymologia*, **2**, 129 (1937).
[3] Knoop, F., *Z. physiol. Chem.*, **67**, 481 (1910).
[4] Knoop, F., and Kertess, E., *Z. physiol. Chem.*, **71**, 252 (1911).
[5] du Vigneaud, V., and Irish, O., *J. Biol. Chem.*, **122**, 349 (1937).
[6] du Vigneaud, V., Cohn, M., Brown, G. B., Irish, O., Schoenheimer, R., and Rittenberg, D., *J. Biol. Chem.*, **131**, 273 (1939).
[7] Lipmann, F., and Perlmann, G., *J. Amer. Chem. Soc.*, **60**, 2574 (1938).
[8] Lipmann, F., NATURE, **143**, 436 (1939).
[9] Weil-Malherbe, H., *Biochem. J.*, **31**, 2202 (1937).
[10] Quastel, J. H., and Webley, D. M., NATURE, **144**, 633 (1939).

The Releaser Concept in Bird Behaviour

LORENZ[1] has provided a wealth of data and analysis to show that many instinctive acts in birds are 'released' not by the external situation as a whole, but by some characteristic part of it. This greatly assists in explaining the evolution of plumage patterns and rhythmical movements in display in birds, particularly with regard to their 'improbable' and specific nature.



Recent work[2] on the British robin (*Erithacus rubecula melophilus* Hartert) suggests modification of the releaser concept. First, there is the obvious point (with which presumably Lorenz would agree) that the internal state of the bird must also be considered. Thus the copulatory behaviour of the male robin is released when the female assumes a characteristic flattened attitude. But sometimes the male does not copulate when the female assumes this attitude, and sometimes he tries to copulate without the female assuming this attitude ; the former can be accounted for by an exceptionally weak, the latter by an exceptionally strong, copulatory drive in the male at the time.

The robin attacks all other robins intruding in its territory, and analysis of the external situation releasing this aggressive behaviour well illustrates Lorenz's point that a characteristic pattern can be the most important factor involved. For a mounted specimen of a robin lacking the red colouring on the breast was attacked much less often than a specimen reduced to just a bundle of red breast feathers and lacking head, wings, legs and back. However, analysis showed that no single factor releases aggressive behaviour, for the robin at times attacks (1) various other species of birds of most diverse coloration, chiefly in flight ; (2) a mounted robin lacking red on the breast ; (3) a bundle of red breast feathers ; which three objects have no factor in common. Further analysis showed that the aggressive behaviour could be divided into three main reactions : (1) pursuit-flight, primarily elicited by a small bird flying away ; (2) direct striking, primarily elicited by a stationary bird of approximately robin-shape (the presence or absence of red on the breast being unimportant) ; (3) threat-posturing, primarily elicited by a red breast. Hence the facts could almost be reconciled with the releaser concept provided that the aggressive behaviour was separated into three reactions, each with its own releaser. However, further work showed that this separation, while it undoubtedly existed, was only a tendency, and not a complete division, for, rarely, a mounted red breast was struck and a specimen lacking red on the breast was postured at.

Hence, at least in this case, the releaser concept is too simple. The general implications are important, for they suggest that releasers are not the fundamental units of bird behaviour. Rather, the bird reacts originally to a more general situation. At a later stage (later in evolution if the releasing complex is inherited, later in the life of the individual if it is acquired : this issue is not discussed here), the bird tends to react primarily (but not necessarily exclusively) to a characteristic part of the external situation. The characteristic part or pattern may

then appear to 'release' the behaviour concerned; but it is not (at least always) the sole factor which will elicit the behaviour.

On the above view, releasers are considered to be specialized and secondary. The ability of birds to evolve releasing complexes is clearly of value to the species, and this modification of the concept in no way diminishes the importance of Lorenz's arguments on the nature and evolution of display patterns in birds, since it is agreed that a particular pattern is often the most important (though not necessarily the sole) factor eliciting a particular train of behaviour.

The robin's own mate apparently possesses all the main factors eliciting aggressive behaviour but is attacked extremely rarely and only mildly. This and other facts discussed in the paper cited show the complexity of the problem, which I have been unable to reconcile with any theory of behaviour. The partial separation of the behaviour into particular stimuli with particular responses suggests a mechanistic rather than a holistic interpretation; but the incompleteness of the separation shows a simple mechanistic interpretation to be inadequate.

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Totnes, Devon.
Dec. 27.

[1] Lorenz, K., *J. Orn.*, **83**, 137–213, 289–413 (1938); *Auk*, **54**, 245–273 (1937).
[2] Lack, D., *Proc. Zool. Soc.*, A, **109**, 200–216 (1939).

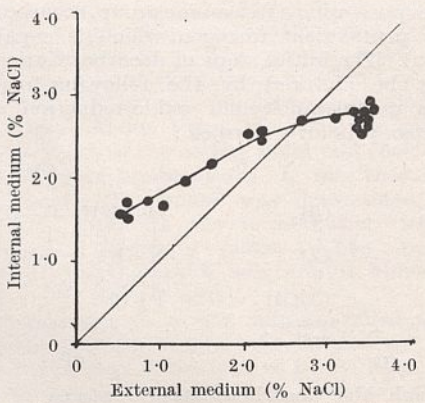
Osmotic Properties of the Common Prawn

IN a previous communication[1] I referred to the homoiosmotic behaviour of *Palæmonetes varians* and its ability to maintain hypotonicity in normal sea water. Further experiments on the osmo-regulatory mechanism of some Crustacea have revealed that the common prawn, *Leander serratus* (Pennant), is also definitely hypotonic when in normal sea water.

The blood of this prawn when taken from sea water has an osmotic pressure equivalent to 2·6–2·9 per cent sodium chloride, the difference between the external and internal media being round about 0·7 per cent. This osmotic pressure is more or less retained by the animals up to dilutions of about 2·5 per cent in the external medium; but in lower dilutions there is a steady decline. In laboratory experiments 0·5–1·0 per cent was the lowest range of salinities at which the prawns could live; and an osmotic pressure equivalent to that of 1·3–1·6 per cent sodium chloride would seem to be the minimum internal osmotic pressure compatible with life.

Compared with Palæmonetes, Leander has a higher osmotic pressure when in normal sea water, and the ability to maintain the osmotic pressure of the blood near the optimum is also much less developed in Leander, as may be seen from the accompanying graph. The difference between the highest and lowest values for the blood of Leander in different dilutions is nearly 1·5 per cent, while the corresponding difference for Palæmonetes is only 0·5 per cent.

Studies on the rate of change of osmotic pressure when prawns are put in dilute sea water have shown that the reduction of the internal osmotic pressure goes on steadily and slowly during the first 14–24 hours, but after the lowest value has been reached there is a slight rise. It is worthy of note that the



RELATION BETWEEN THE OSMOTIC PRESSURE OF BLOOD AND THE EXTERNAL MEDIUM OF *Leander serratus*. Values in per cent sodium chloride. Abscissæ, sea water; ordinates, blood. Straight line indicates where points would fall if blood and medium were isotonic.

rate of change of osmotic pressure is different in individuals of different sizes. Young prawns 45–65 mm. long respond to external osmotic changes more speedily than larger ones. The ability to live with a low osmotic pressure of the internal medium is also more pronounced in them than in full-grown individuals.

Leander serratus is a littoral species abundant in the southern parts of the North Sea and in the Mediterranean[2]. Though it is able to live in places where the salinity is slightly lower than that of the sea as observed at Plymouth, its habitat is essentially marine; but the osmotic behaviour of *L. serratus* is most unusual for a marine invertebrate. It is of great interest, since certain prawns like *Leander longirostris* M. Edw. are known to migrate many miles up rivers[2] and many tropical species are known to be typical brackish-water and freshwater inhabitants[3]. If the osmotic properties of *Leander serratus* are shared by other species (and it seems very likely), it would explain their peculiar habits and distribution. The physiological evidence would seem to be in favour of considering this species of Leander as having taken secondarily to marine life, since its osmotic behaviour is so unlike that of most other marine invertebrates that have developed powers of osmo-regulation.

N. KESAVA PANIKKAR.

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Plymouth.
Dec. 11.

[1] Panikkar, N. K., NATURE, **144**, 866 (1939).
[2] Gurney, R., *Proc. Zool. Soc. London*, 97 (1923).
[3] Kemp, S., *Rec. Ind. Mus.*, **27**, 287 (1925).

Utilization of Nitrogen by *Ophiobolus graminis*

THE survival period of the fungus *Ophiobolus graminis*, causing the 'take-all' disease of wheat, in infected wheat straw buried in the soil is increased by the application of nitrogen in such forms as calcium nitrate, ammonium nitrate, ammonium

sulphate, ammonium carbonate, and dried blood[1,2]. I have recently suggested[2] that these sources of nitrogen are directly utilized by *O. graminis*, which is thereby enabled to decompose more of the carbohydrate material of the straw, and hence to prolong its existence. Fellows has claimed[3], however, that *O. graminis* is unable to utilize nitrates or ammonium salts, and can assimilate nitrogen only in certain organic forms. His claim is invalidated by the experiments of Padwick[4], using a very similar synthetic medium to that employed by Fellows, but with the addition of a growth-promoting factor. In the presence of a growth-promoting extract obtained from carrots, growth of *O. graminis* was increased four-fold by the addition of 0·15 per cent of nitrogen as sodium nitrate to the medium.

The results of a recent experiment here support those of Padwick. 6-gm. portions of chaffed wheat straw were bottled with the addition of 24 ml. of water or calcium nitrate solution. The calcium nitrate series received 0·25 gm. of nitrogen per 100 gm. air-dry straw. The bottles were plugged and autoclaved for 30 minutes at 15 lb. pressure on three successive days, inoculated with a pure culture of *O. graminis*, and incubated at 25° C. The loss in dry weight in the two series with and without additional nitrogen was as follows (each determination is a mean derived from three bottles):

	Percentage loss in dry weight (oven-dry basis)	
	After 3 months	After 6 months
No additional nitrogen	21	23
With 0·25 gm. nitrogen as calcium nitrate	27	33

Determinations of nitrate nitrogen in the calcium nitrate series, kindly made for me by Mr. R. G. Warren, of the Department of Chemistry, were as follows:

Sterilized but not inoculated control—240 mgm. nitrate nitrogen per 100 gm. air-dry straw.

Inoculated and incubated for 3 months—13 mgm. nitrate nitrogen per 100 gm. air-dry straw.

Inoculated and incubated for 6 months—0 mgm. nitrate nitrogen per 100 gm. air-dry straw.

These results show that a pure culture of *O. graminis* growing on sterilized wheat straw can utilize nitrate nitrogen, and hence support the conclusions of Padwick[4].

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Dec. 20.

[1] Garrett, S. D., *Ann. Appl. Biol.*, **25**, 742 (1938).
[2] Garrett, S. D., *Ann. Appl. Biol.*, in the press.
[3] Fellows, H., *J. Agric. Res.*, **53**, 765 (1936).
[4] Padwick, G. W., *Sci. Agric.*, **16**, 365 (1936).

Occurrence of Some Off-shore Amphipods in the Littoral Zone

IT has been pointed out by various investigators that *Echinus esculentus* L., an animal usually confined to off-shore waters, is found in some places in the littoral zone. Reid[1] showed that it occurred intertidally only on those coasts washed by the North Atlantic Drift, while elsewhere it was confined to deeper waters.

During a period of collecting in August at Oldany Bay Harbour, near Drumberg, Sutherland, *Echinus esculentus* was found intertidally. But it is of interest to note that the following amphipods were also found above low water of spring tides beneath stones and in algæ (Dictyosiphon sp.).

Gammaridea: *Ampelisca spinimana* Chevreux, *Harpinia antennaria* Meinert, *Leucothöe spinicarpa* (Abildg.), *Coremapus versiculatus* Norman.

Caprellidea: *Phtisica marina* Slabber, *Caprella acanthifera* Leach.

A search of the literature has so far shown that, with two exceptions, these amphipods have only been recorded in deep water or below the tidal zone. The two exceptions are *C. versiculatus* and *C. acanthifera*, and it is significant that these records are from the Clyde area and Lough Ine, both of which regions are bathed by Atlantic water. This discovery is of interest and suggests that the phenomenon shown by Echinus may be of a more general character than is supposed. A study of the intertidal distribution of other animal groups round the British Isles might prove of value.

C. B. GOODHART.
RICHARD HARRISON.

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Cambridge.
Dec. 15.

[1] Reid, D. M., *J. Animal Ecol.*, **4**, 7, (1935).

Scientific and Technical Literature and Information

AMONG the important suggestions made in the editorial in NATURE of November 25 is included the desirability of establishing a new organization which would, among other things, "establish a system of co-ordination among the various provincial libraries of the university and research types". Although it is stated that "the National Central Library is still functioning as a clearing-house for demands for books on loan", it is apparently not realized that this Library is already acting as the national centre for the inter-library lending of books and periodicals, not only between libraries of "the university and research types", but also between libraries of all types, among which must be included our larger public libraries, which frequently contain—and lend—scientific and technical books not available in any other library in the British Isles.

It would appear to be extravagant and unnecessary to set up a new organization to do work which the National Central Library is already doing and for which it has the necessary machinery, even if this is still far from perfect. The service of the Library is used by Government departments, the universities, and almost every library in the British Isles. In normal times it is used also by libraries throughout Europe and elsewhere. The extent of the service is illustrated by the fact that, in addition to the books on its own shelves, the Library has access to more than 21,000,000 books in other libraries in the British Isles. The libraries lending and borrowing through the National Central Library include many of the leading scientific and technical libraries in the country.

It is true, as is stated in the article, that the National Central Library depends upon the Science Library for many books and periodicals—in fact the value of the co-operation of the Science Library cannot be too strongly emphasized—but it is only fair to the other scientific libraries and to the National Central Library's own stock to point out that last year only approximately three per cent of the scientific and technical books lent were obtained from the Science Library.

It is suggested that a union catalogue of war-time holdings of important foreign periodicals should be compiled, but it is not pointed out that, in addition to the entries in many printed union and other catalogues, the National Central Library has tens of thousands of manuscript entries of periodicals in British libraries. This information is constantly being brought up to date.

Experience so far suggests that no great difficulty is likely to arise in buying current numbers of foreign, including German, periodicals through the authorized agents. It may not, therefore, be necessary to establish "a central body" for this particular purpose.

As is now well known, the service of the National Central Library is available to any person, provided that he applies for books through his university, public, or other library, and not directly to the National Central Library.

L. NEWCOMBE.
(Librarian).

National Central Library,
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London, W.C.1.

THE services provided to the scientific and technical research worker by the National Central Library are too well known to need emphasis in the present emergency. So far as text-books and pre-war volumes of periodicals are concerned, these services will doubtless find increasing utilization during the War. However, the original editorial more specially concerned itself with the supply and use of current issues of scientific and technical periodicals, especially European publications. The only portions of Colonel Newcombe's memorandum that are relative to this specific problem are his statements that the entries in the National Central Library relating to holdings of such periodicals by British libraries are constantly being brought up to date, and his optimism concerning the facilities for obtaining European periodicals at the present time.

Regarding the first claim, it may be true that, from time to time, the entries relating to holdings of periodicals are revised by the libraries concerned, and copies of the revisions incorporated in the archives at the National Central Library. Nevertheless, it is a well-known fact that contributor libraries to union catalogues of holdings are exceedingly dilatory in communicating information that reflects the deficiencies of their stocks, and this is especially true of current volumes. All librarians naturally hope to fill any lacunæ that arise, and hesitate to revise even their own catalogues until the entries are closed up finally. It is quite certain that, unless the urge to revise entries and betray gaps is stimulated by a prospect that the gaps may be filled from some 'pool', librarians will see no reason to notify the National Central Library of the deficiencies in their holdings of current volumes.

As regards Colonel Newcombe's optimism about present facilities for purchasing European periodicals, it is not irrelevant to point out that already the National Central Library has taken the precaution of removing its records to a relatively obscure site, and has thus provided evidence of a dislocation that may have been temporary in some aspects, but is permanent in others. It can scarcely be said to have facilitated the operations of this particular centre. There are, however, many other aspects of this problem of supply. Many libraries have closed down; many others have seen their periodicals, previously obtained by presentation or exchange, come to an abrupt termination in the middle of volumes; most libraries have to economize in their purchases. The effects of these three factors alone will render the National Central Library's union catalogue of doubtful efficacy in regard to holdings of current issues of European periodicals unless drastic revisions are made therein. Finally, we have to consider the possible extension of hostilities to include those neutral countries that are at the moment serving as sources of supply for these periodicals, the effects of intensive hostilities at sea, and the possibility that sooner or later extensive air-raids over Britain may occur.

THE WRITER OF THE ARTICLE.

Archæology in the U.S.S.R.

IT would be a pity if dislike of the Soviet's foreign or domestic politics should lead men of science to take an unduly gloomy view of the position of archæology in Russia[1]. Prof. Tallgren's last visit to the U.S.S.R. coincided with mine in 1935, and since then many changes have supervened, one may hope for the better. For example, in 1936 a new periodical, *Sovietskaya Archeologiya*, better printed and illustrated than its immediate forerunners, began to appear, to make up a little, admittedly inadequately, for the deficiencies in publication which Tallgren deplored.

The editorial in No. 1 might indeed reinforce his apprehensions—"La lutte implacable contre les écrits pseudo-scientifiques fascistes en matière d'archéologie, le dévoilement incessant des falsifications fascistes des faits archéologiques constituent le devoir direct des archéologues soviétiques qui édifient la véritable science objective"; "La lutte sans merci contre les altérations de tout genre du marxisme-léninisme"—and similar sentiments were discouraging. However, the introduction to No. 2 is devoted to a repudiation of the scholasticism No. 1 apparently approved, a rehabilitation of migrations, the typological method and other devices and an elaboration of the theme "Les recherches historiques exigent une étude approfondie, méthodique et objective des sources premières au lieu que le schématisme corrompait la pensée des historiens, les habituant à mépriser les faits".

Far from making a gulf "completely effective against Western archæological thought", the Institute for the History of Material Culture in the Academy of Sciences seems to welcome exchanges with archæological societies in Great Britain and with individuals, including the writer. "Gentile", "pre-class", . . . may be inconvenient categories; I doubt if they are really more deceptive than the terms "neolithic",

"Bronze Age" as used in English as late as ten years ago. Prehistoric archæology, being based so largely on a study of tools and weapons, naturally lends itself to a "materialist" interpretation. That does not exclude a study of non-economic activities even in Russia, as for example Zamiatnin's long discussion on fertility rituals in his memoir "Gargarino".

V. GORDON CHILDE.

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University, Edinburgh.

[1] NATURE, **144**, 971 (1939).

PROF. V. GORDON CHILDE utters a timely protest against "dislike of the Soviet's foreign or domestic politics" leading men of science "to take an unduly gloomy view of the position of archæology in Russia". It was, however, precisely with the view of deprecating any political colouring whatsoever, and of whatever shade of opinion, in scientific matters that protest was made in these columns against the way in which political doctrine under the Soviet Republics had not only affected archæological theory, but had also intervened to check international exchange in scientific research.

Attention was then directed to a specific instance of such interference by which an end has been put to Prof. Tallgren's work—this at a date subsequent to that to which Prof. Childe looks for the appearance of some signs of improvement. Even more abhorrent to the spirit of scientific investigation is the regimentation and even 'liquidation' of the individual, from which archæology, with other sciences, in the U.S.S.R. has suffered severely. This is no question of like or dislike of a political policy as such.

THE WRITER OF THE NOTE.

Points from Foregoing Letters

Evidence, in the form of a cloud-chamber photograph, is given by E. J. Williams and G. E. Roberts for the transformation of mesotrons into electrons. This bears out the supposition that the mesotron is identical with the particle assumed by Yukawa in his theory of nuclear forces and β-disintegration.

A. H. Wilson and F. Booth have calculated the probability that, when a fast meson collides with a nucleus, a very energetic γ-ray will be emitted. They find that the cross-section is proportional to the energy of the meson, and that for very high energies the energy loss is mainly due to the emission of γ-rays. The bearing of this upon the cascade showers in the atmosphere is discussed.

The known nuclear energy levels of ^{10}B, ^{26}Mg and ^{223}AcX are interpreted by K. M. Guggenheimer as eigenvalues of the rigid rotator, which can thus be applied to nuclei. The moments of inertia are in accordance with the assumption of equal nuclear density.

Quantitative clinical observations by J. S. Mitchell, under conditions with equalized depth dose distribution, show that 0·7–0·8 r. unit of X-radiation of effective wave-length 145 X.U. is equivalent, in the production of moist desquamation of human skin, to 1 r. unit of γ-radiation of effective wave-length 15 X.U. Theoretical considerations suggest that this result cannot be attributed entirely to the exceptional histological and chemical structure of skin.

A mechanism for the enzymic decarboxylation of pyruvic acid is proposed by H. Weil-Malherbe involving the formation of a Schiff base from cocarboxylase and pyruvic acid followed by an intramolecular oxido-reduction leading to acetyldihydrococarboxylase. It is suggested that this compound is oxidized in animal tissues and in certain bacteria by a specific carrier, whereas it undergoes a second intramolecular oxido-reduction with yeast carboxylase resulting in the formation of the Schiff base of acetaldehyde. Acetyl cocarboxylase may be identical with the 'active form' of acetic acid postulated for animal tissues.

Analysis of aggressive behaviour in the British robin by D. Lack shows that it can be divided into three main reactions, each primarily elicited by a different external factor; but this division is only partial. While colour pattern is particularly important, it is not the sole releasing factor, and, in general, releasers are considered specialized, and not fundamental, units of bird behaviour.

N. K. Panikkar finds that, like Palæmonetes, the common prawn *Leander serratus* is definitely hypotonic when in normal sea water, though it is less homoiosmotic than the former. Its osmotic behaviour is unusual for a typical marine invertebrate and is of interest when the habits of allied species are considered. The osmotic properties would seem to indicate its having taken secondarily to marine life.

S. D. Garrett reports assimilation of nitrate nitrogen by a pure culture of the fungus *Ophiobolus graminis* growing on sterilized wheat straw plus calcium nitrate.

C. B. Goodhart and Richard Harrison report the occurrence of six off-shore species of amphipods in the littoral zone on the north-west coast of Scotland.

War-time co-ordination of library resources, as advocated in a recent issue of NATURE, is discussed by the librarian of the National Central Library. He states that the union catalogue housed in the Library and relating to periodicals in British libraries is subject to continual revision, and that the difficulty of obtaining foreign periodicals in war-time has been exaggerated. In reply to these comments, it is pointed out that revision of entries in union catalogues of periodicals is generally very tardy and imperfect, and that the present period will enhance these imperfections. Reasons are given for anticipating further dislocation and interference with supplies, as compared with peace-time.

RESEARCH ITEMS

New Neolithic Site in Ulu Kelantan, Malaya

THE results of the partial excavation of a rock-shelter at Gua Měntěri on the banks of one of the tributaries of the Sungai Nenggiri have been described by H. D. Noone (*J. Fed. Malay States Mus.*, **15**, 4; 1939). The shelter is about 50 yards in length, 20 yards in height, and of an average breadth under cover of 9 or 10 yards. Two trial trenches were dug, but barely 10 per cent of the area available for excavation was touched. Nevertheless, finds were exceedingly numerous. Except where removal was imperative, they were so far as possible covered in again pending the systematic excavation which the importance of the site demands. It affords stratigraphic evidence for the neolithic period, which is urgently needed; and in the human skeletal remains from the burials it will throw light on the at present obscure problem of the population which carried the neolithic culture into Malaya. The grave goods included pots in rows, and disposed in one instance in threes, one inside the other in the inverted position. The eight complete specimens now recovered are unique as evidence of the character of the neolithic pottery, previously known only from sherds, except for a few complete pots from open sites found without associations or stratification. The trial excavations of two trenches revealed three cultural layers, of which the uppermost at a depth extending to 2½ ft. below red clay was rich in relics of a fully developed neolithic, among which three polished axes were found, preceded, it would appear, by an earlier developmental period. This, in turn, was preceded by a cultural layer of an intermediate character marked by the occurrence of numbers of worked flakes of a black stone, which when struck behaves like flint. The earliest cultural level contained palæolithic implements (Hoabinian). In this three intrusive (neolithic) burials with grave furniture were found, the lowest at a depth of five feet below the red clay. Apart from that associated with the burials this lowest level contains no pottery.

A New Drug for Pneumonia Treatment

THE search for new drugs for combating certain infections continues. A few years ago sulphanilamide was introduced and proved of considerable service in the treatment of sepsis due to the streptococcus, and a couple of years ago sulphapyridine (M. and B. 693) was discovered to be of great value for the treatment of pneumonia, cerebro-spinal fever, and other infections caused by the coccoid group of microbes. It is now announced by Science Service of Washington, D.C. that another drug, sulphathiazole, has been developed in the Squibb Institute for Medical Research, New Brunswick, for the treatment of pneumonia. It is stated that it is even more efficacious against this disease than sulphapyridine, that it is safer and has less toxic effect than the latter.

Control of Puerperal Sepsis

AN important memorandum on this subject has been issued by the Ministry of Health (Memo. 226/Med. H.M. Stationery Office. 2*d*. net). Its object is "to explain the nature of puerperal sepsis, how it is spread, and how to identify and group the streptococci responsible". Actually, little is said about puerperal infection in general, the pamphlet being restricted to infections due to the class of microbes known as hæmolytic streptococci, which, however, do not account for more than half the cases of puerperal infection. Details are given of the sources of streptococcal infection, and of the methods of detecting it in patient, midwife or nurse, and of the procedure to be adopted when a source of infection is detected. Finally, a description is given of the laboratory methods required for the isolation and identification of the hæmolytic streptococcus.

Insects of Greenland

STUDENTS of animal distribution will welcome the recent contribution by Kai J. Henriksen entitled "A Revised Index of the Insects of Greenland". Published in *Meddelelser on Grønland* (**119**, No. 10, 111; 1939), it is obtainable from Messrs. C. A. Reitzels of Copenhagen, price Kr. 5.00. It appears that more than twenty years have elapsed since the last list of Greenland insects was published. During that period both English and Danish collecting expeditions have added materially to what is known of the Greenland insect fauna. The Collembola, for example, have been well studied and now number forty-one species. Only a single species of may-fly and no dragonflies have so far been recorded. Among the fifty-four species of Lepidoptera only four are butterflies. Of particular note is the Noctuid moth *Rhyacia occulta* L., the larvæ of which are often pests of the grassland. In two peat bogs at the head of the Ameralik Fjord an entire layer of pupæ of this insect is recorded, and it bears witness to an outbreak of *R. occulta* in bygone times. Coleoptera are poorly represented and number only forty-four species while some of them, notably Cerambycidæ, are introduced forms. Among the Hymenoptera the Parasitica are relatively very numerous, but little idea can be framed as to their hosts. Records of sixty-five species of the Ichneumonidæ alone are given, whereas the only Aculeata recorded are two species of bumble bees. Of the Diptera some two hundred and seventy-five species are listed, Nematocera being the best represented. Mr. Henriksen's memoir concludes with a bibliography of about eighty references, the majority being to writings in the English language.

Hormones and the Garden

THE discovery of growth-promoting compounds in plants brought new opportunities of horticultural propagation. Marked stimulation in the rooting of cuttings of many species can be brought about, but a curious crop of failures has still to be explained. M. A. H. Tincker, with the assistance of C. H. Unwin, has studied the action of a number of such substances upon a wide range of plants which can be propagated by cuttings. Their most recent results (*J. Roy. Hort. Soc.*, **64**, Pt. 12; December 1939) indicate that sixty-one species of those which were tried propagate more readily with treatment, whilst twenty-nine species still defy the propagator. The growth-promoting substances can be mixed with talc and applied satisfactorily in powder form—a great convenience.

Vitamin B_1 (aneurin) alone did not appear to stimulate rooting, but it did increase the percentage of rooted cuttings in a third of the total experiments. The most valuable substances for propagation were found to be (1) indolylbutyric acid, (2) tetrahydronaphthylideneacetic acid, and (3) a mixture of (2) with 3 : 4-dihydro-1-naphthylacetic acid. Some species responded to (1), and others to (2), with equal effect, and the behaviour of (3) approximated closely to (2). The paper gives numerous results of the individual calibre which is urgently needed in this new practice of scientific horticulture.

Sex-chromosomes in Cimex

C. D. DARLINGTON (*J. Gen.*, **39**, 101–136; 1939) has examined the behaviour of the sex-chromosomes during meiosis in Cimex. In the male there are 13 pairs of autosomes, a *Y*-chromosome, together with a variable number of *X*-chromosomes ranging from 2 to 12 according to the species and the culture. At first metaphase, the *X*-chromosomes do not pair but divide as univalents. At the second division, the autosomes form a peripheral ring and the sex-chromosomes congregate in the middle of the equatorial plate. At second anaphase, the *Y*-chromosome passes to one pole and usually all the *X*'s pass to the other. This is believed to be brought about by repulsion resulting from a close approximation in the centre of the equatorial plate. Evidence suggested that the centromeres of the autosomes have polarized centromeres at second metaphase, while the *X*-chromosomes have not. The evolution of the sex-chromosome mechanism in Heteroptera is analysed, and it is shown how the peculiar behaviour of the *X*-chromosomes results from differential precocity.

Effect of X-rays on *Drosophila subobscura*

A. L. M. CHRISTIE (*J. Gen.*, **39**, 47–60; 1939) has compared the effects of X-ray radiation on *D. subobscura* with those on *D. melanogaster*. The frequency of lethal mutations induced by X-rays is about equal in the two species, but many more visible mutants occur in *D. subobscura* at a given X-ray dose. It is noteworthy that *D. subobscura* lies between *D. melanogaster* and *D. funebris* in regard to the type of mutation produced. Twenty-eight mutants are described, and a rough map of the *X*-chromosome, approximately 120 units long, is given.

Mycological Taxonomy

THE *Transactions of the British Mycological Society* of October 1939 (**23**, Pt. 3) contains two papers which offer detailed contributions to the exact recognition of fungal species. J. A. Nannfeldt, of the Institutionen för Systematisk Botanik, Uppsala, describes a second batch of fifty type specimens of British inoperculate Discomycetes. This is part of a critical evaluation of species in this group, and deals with an alphabetical arrangement from Cenangium to Velutaria. The correct name of each species in the light of modern knowledge is indicated, and an adequate list of synonyms appears for each. Miss E. M. Wakefield writes the second contribution, on "Nomina generica conservanda". She sets forth the deliberations of the Society's Nomenclature Committee with regard to such generic names as now appear to have little use, after recent findings have excised well-defined groups. Peziza, for example, a generic name established by Fries in 1822 to include a large group, cannot now be used to express more than a few species. The Committee has made definite recommendations for the retention of thirteen names in the lists published as a supplement to the International Rules, 1935. A new species of fungus, *Phleospora Dodonææ*, is also described by R. M. Nattrass in the same volume. It was found as a parasite upon a hedge of *Dodonæa viscosa* in Cyprus.

Life-Histories of Coprophilous Fungi

DETAILS of the life-histories of coprophilous Pyrenomycetes have been somewhat lacking in the past. Literature dealing with the Sordariaceæ and Chætomiaceæ, which are principally concerned, consists largely of descriptions of perithecia, asci and spores, or systems of classification. W. M. Page has grown, upon artificial media, sixteen species belonging to the genera Sordaria, Podospora, Philocopra, Sporormia and Chætomium, in order to obtain more definite information as to their life-histories (*Trans. Brit. Mycol. Soc.*, **23**, Pt. 3, October 1939). The perithecium originates from a coiled hypha in all but two of the sixteen species. The exceptions, two species of Sporormia, are notable in that the perithecium initial divides in three dimensions, probably an indication of evolutionary superiority. Microconidia were observed in *Podospora anserina* and *P. minuta*; many other details of spores and spore discharge appear in the paper.

Research in Agricultural Meteorology in India

IN addition to the brief summary of the more recent activities of the Agricultural Meteorology Section of the India Meteorological Department that is included in the Department's general report for 1938–39, a more detailed account has recently appeared of the Section's work in 1937–38 in its annual report for the latter period. This report includes a description of an improved portable sensitive galvanometer with thermocouple junctions for measuring plant temperatures, made by the Laboratory Apparatus Works, Poona. One of the thermocouples is kept immersed in water of known temperature inside a thermos flask, and the other is inserted into the stem of the plant. When used in the field the instrument is carried on a metal tripod and is levelled with the aid of a spirit-level. A number of soil evaporimeters were in use in which a 5-in. diameter cylinder of soil is kept with its bottom end in contact with the water in a reservoir at a depth of 6 in., or 1 ft., etc., down to 3 ft., in order to study the evaporation from soil surfaces with subsoil water at these depths. Other instruments included an alarum which could be set to sound when air temperature had fallen below a certain level, so that a farmer who installs the device can take precautionary measures against frost damage on hearing the alarum. It has been found that there is an increasing demand for these, vine and sugar growers being among those who have found it useful. Investigations into the disposal of solar radiation and rainfall at the surface of the ground were continued at the Central Agricultural Meteorological Observatory, and also the exchange of water vapour between soils, plant materials, seeds, etc., on one hand and the atmosphere on the other. It was found that all the last-named surfaces yielded moisture to the atmosphere during the hottest hours of the day and received back moisture at night. On the statistical side, sampling studies on the growth and yield of various crops at Poona and other places were continued.

SALT ABSORPTION OF PLANTS

BY PROF. H. LUNDEGÅRDH,

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IN a communication to NATURE I outlined an electrochemical theory of salt absorption by plant roots[1]. Later, Hoagland and Steward criticized not only the theory itself but also the data on which it was founded[2]. From the article by Hoagland and Steward the general reader might get the impression that the experimental basis of my theory is doubtful. I therefore venture to give a short recapitulation of the work of the Institute of Plant Physiology in Ultuna, Uppsala.

Since 1927 our work has been chiefly devoted to the problems of salt absorption in higher plants. In 1927–32 extensive quantitative investigations[3] on salt absorption showed a wide application of the rules of colloidal chemistry to the process of uptake and transport of cations, and an elaborate study of the antagonistic effects was published in the year 1934 by H. Burström[4]. Also the specific velocity of the anions was demonstrated in earlier papers[5]. The principle of the individual absorption of cations and anions postulates an ion exchange at the surface of the absorbing cell or organ, a well-known fact stated in modern text-books of plant physiology[6]. The existence of such an ion exchange suggested the study of the total ion balance in the boundary between root and medium, including the HCO_3 ions, coming from the expired carbon dioxide. After a preliminary study on this balance[7], it seemed necessary to determine quantitatively the respiration during the ion absorption. These studies soon showed a marked relation between the intensity of root respiration and the amount of absorbed salts[8]. In view of our previous experience in the individual absorption of ions of opposite charge, we tried to correlate the respiration with the uptake of cations and anions. In these experiments one anion, for example, NO_3 or Cl, was combined with a number of cations of different absorption velocity, and also the concentration of the salts was varied. The respiration showed a marked relation to the amount of absorbed anions, and thus the conception 'anion respiration' arose (1933). Apart from the anion respiration the root tissue, as well as all living organs, shows also a fundamental respiration. The total respiration is the sum of the fundamental and the anion respiration[9].

Parallel to the work of Lundegårdh and Burström, Steward and Hoagland and collaborators showed that 'aerobic metabolism' is essential to salt absorption. But they were not able to find either quantitative relations or an individual absorption mechanism of anions. The cause of these negative results of Hoagland and Steward is twofold. They limited themselves to a very restricted combination of cations and anions; then their choice of material and experimental technique was inappropriate. In studying quantitatively a physiological process it is very important to choose an organ which is exclusively designed to effect this process. The root system of grass plants is an intensive working absorption machine, which pumps salts into the lower parts (that is, the region of root hairs) and transports them into the upper parts. The bleeding sap which issues from the top of a cut root system contains salts in a much higher concentration than the solution from which these salts are pumped[10]. Hoagland and Steward used either slices of very slowly absorbing storage tissue, or ignored roots which were submerged in the solution. In the former case the ion absorption is too small to render possible an accurate determination of the coupled respiration process, because this will be covered by the variations of a considerable fundamental respiration. In the latter case the root pieces will pump in salts from the solution at the lower end and pump them out again at the top, and the amount stored up in the tissue will for this reason give an incorrect picture of the absorption intensity. Recently, van Eijk[11], at the University of Amsterdam, repeated the experiments of Lundegårdh and Burström on roots of a plant of a type quite different from wheat, namely, *Aster tripolium*. Van Eijk confirmed the "Lundegårdh principle of salt respiration". He presented, furthermore, a detailed criticism of Steward's experiments and draws the following conclusion (in translation): "Steward's criticism of Lundegårdh's investigations cannot be sustained, because it is built upon experiments, the method of which is insufficient to demonstrate the anion respiration or on experiments with subjects which *a priori* must cause negative results"[12].

I have repeatedly tried to explain that in the case of the roots of a number of plants the absorption mechanism will function fairly well, if respiration energy is supplied only when anions are absorbed[13]. The protoplasmic colloids and also the free surface of the root cells have negative electrical charge and thus attract cations. This absorption potential will lead to an accumulation of cations in the protoplasm. But this accumulation stops when the absorption surfaces are saturated. If now anions are simultaneously absorbed by means of an energy-expending respiration process, these anions will, when they come into the cells, remove cations from the absorption surfaces and cause an accumulation of neutral salts. This theory implies also that anions, for example, of organic acids, are produced within the cell itself. In this case the cation absorption will proceed, even if no anions are absorbed from the outside. But the metabolic activity through which organic acids are produced should not be confused with the anion respiration process which enables inorganic anions to enter the cell. This is a very important distinction. Burström has shown that it is possible to distinguish experimentally between the process by which NO_3 ions are absorbed in the root and the chemical mechanism of NO_3 reduction[14]. I showed recently that manganese is a catalyst for fundamental respiration processes, but fails to influence the anion respiration and anion absorption[15]. Burström discovered that manganese is essential for the reduction of NO_3, but has no influence on the NO_3

absorption process[16]. Earlier investigations by Lundegårdh and Burström[17] demonstrated a remarkable difference in the sensitivity of the fundamental respiration and of the anion respiration to cyanide and metallic poisons. Hoagland and Steward seem to have overlooked these results, which prove the possibility of dividing up the 'aerobic metabolism' into at least two distinct groups of processes :

(1) the fundamental respiration complex, which is characterized by its insensitivity to cyanide and the catalytic action of manganese, and

(2) the anion respiration, which is very sensitive to cyanide, but independent of manganese.

Very important is Burström's result that nitrate reduction persisted in crushed root material, whereas the absorption of NO_3 from the solution takes place only if the living organization is intact[18]. This observation conforms with my theory of ion absorption, which postulates the existence of an electrically charged absorption surface and an internal respiration mechanism, which transports the ions to the interior of the cell or organ[19]. The theory assumes a polarity (that is, a one-sided movement of substances) which, of course, will be destroyed if the living substance is crushed.

The complex of fundamental respiration is to be considered as the sum of a number of exothermic chemical processes, which build up cell substance, for example, protein synthesis and growth material of any kind. Some ions, for example NO_3, no doubt participate in both respiration systems : the anion respiration during the uptake, and the fundamental respiration during the reduction and proteinization process. If the cation NH_4 produces an acceleration of the total respiration of the root, as Hoagland and Stewart claim[20], this might be due to an increase in the fundamental respiration complex, because protein synthesis involves a partial breakdown of carbohydrates. Cations which do not interfere with organic chemical processes within the cell, for example, alkali metals and alkaline earth metals, are to a limited extent absorbed from bicarbonates without any increase in the respiration[21].

The coefficient $k = \frac{Ra \text{ (anion respiration)}}{A \text{ (anion absorption)}}$ is fairly constant, if A is varied by means of variations in the concentration of one single salt. If the effect of salts with the same anion but different cations is studied, k changes somewhat with the type of cation. As a rule k increases with the absorption power of the cation[22]. The circumstance that the quotient $\frac{A\ (=\text{ absorbed anions})}{M(=\text{ absorbed cations})}$ also increases with k is an expression of the fact that k is a function of the work which the living organ has to perform in the absorption process[23]. Work can also be expressed in terms of electro-chemistry, and this was the reason why I started a series of observations of the boundary potential between the root and the solution. The results of these investigations have been fully described in two papers[24], and the studies are being continued. Hoagland and Steward also criticize these results.

Hoagland and Steward claim that the potential measurements are performed on "ill-defined" surfaces. I do not know whether they consider the boundary between root epidermis and nutrient solution to be nebulous and unfit for producing an electrical double layer. Speaking in well-known terms of physical chemistry, the existence of electrical potential differences, not only between the root surface and the solution, but also between cell sap and protoplasm, between nucleus and protoplasm, etc., is self-evident. Bio-electrical currents arise everywhere as a consequence of such boundary potentials, if a circuit is closed, and countless measurements of such bio-currents have been made. In an organ the cells are coupled wall by wall and the opposite charges therefore to a large extent neutralize one another. For this reason observed potentials arise, in the majority of the cases, in the boundary between the cell or organ and the electrode. In my experiments the problem was settled by the fact that a sudden change in the electrode solution caused an instantaneous change in the boundary potential, the height of which corresponded with what was electro-chemically to be expected. The boundary between the tissue of the root tip and the solution is consequently well defined, and its behaviour corresponds with well-known laws of physical chemistry.

From a thermo-dynamical point of view, the existence of a boundary potential at the surface of the root must act as a regulator upon the ion absorption (exchange) from the surrounding solution. A number of earlier investigations on animal tissue and also on roots[25] show a distinct relation between respiration and potential. Unpublished results from this laboratory confirm the existence of such a relation and the fact, postulated in my letter to NATURE, that a fraction of the root respiration (that is, anion respiration) causes an increase of the positive charge (a lowering of the negative charge) of the root surface, thus facilitating the absorption of anions.

Hoagland and Stewart claim that my theory of ion absorption means an "over-simplification of a very complicated problem". The experimental work of this Institute shows, on the contrary, that the absorption of inorganic ions is far more complicated than earlier investigators, among them Hoagland and Steward, believed.

[1] Lundegårdh, H., NATURE, **143**, 203 (1939).
[2] Hoagland, D. R., and Steward, F. C., NATURE, **143**, 1031 (1939).
[3] Lundegårdh, H., "Die Nährstoffaufnahme der Pflanze" (Jena, 1932).
[4] Burström, H., *Svensk botan. Tidskr.*, **28**, 157 (1934).
[5] Lundegårdh, H., and Moravek, Vl., *Biochem. Z.*, **151**, 296 (1924).
[6] Fitting, Sierp, Harder, Firbas, *Lehrb. Bot.*, **20**, 181 (1939).
[7] Lundegårdh, H., and Burström, H., *Planta*, **18**, 683 (1933).
[8] Lundegårdh, H., and Burström, H., *Biochem. Z.*, **261**, 235 (1933).
[9] Lundegårdh, H., and Burström, H., *Biochem. Z.*, **277**, 223 (1935).
[10] Lundegårdh, H., *Biochem. Z.*, **290**, 104 (1937).
[11] Van Eijk, M., *Rec. trav. botan. nĕerland.*, **36**, 559 (1939).
[12] *loc. cit.*, p. 655.
[13] Lundegårdh, H., *Naturwiss.*, **23**, 313 (1935).
[14] Burström, H., *Planta*, **29**, 291 (1939 *a*).
[15] Lundegårdh, H., *Planta*, **29**, 419 (1939).
[16] Burström, H., *loc. cit.* (1939 *a*) ; *Planta*, **30**, 129 (1939 *b*).
[17] *loc. cit* (1935).
[18] Burström, H., *loc. cit.* (1939 *a*).
[19] Lundegårdh, *loc. cit.* (1935).
[20] *loc. cit.* (1939).
[21] Lundegårdh, *loc. cit.* (1937).
[22] *loc. cit.* (1937).
[23] Lundegårdh and Burström, *loc. cit.*, p. 250 (1933).
[24] Lundegårdh, H., *Biochem. Z.*, **298**, 51 (1938) ; **300**, 167 (1939).
[25] Rosene, H. F., and Lund, E. J., *Plant Physiol.*, **10**, 27 (1935).

BY PROF. D. R. HOAGLAND, UNIVERSITY OF CALIFORNIA
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Our earlier article directed the attention of the general reader to two independent series of investigations which have been in progress in different laboratories for several years. The combined investigations are extensive and deal with a variety of plant materials and environmental conditions. These apparently divergent investigations yield a consistent general picture of the process of salt uptake in plants, and we are not persuaded by Prof. Lundegårdh's arguments that this picture can be dismissed by the general reader. Our view is that salt accumulation involves vital processes in a more complex and intimate manner than would be suggested by Prof. Lundegårdh's discussion with its reference to principles expressed "in modern text-books of plant physiology" and "well-known terms of physical chemistry".

Prof. Lundegårdh's rejoinder mainly recapitulates his own earlier work. It will be recalled that we had raised the following general points.

(1) Any view of the metabolic processes concerned with salt uptake which has as its dominant feature carbon dioxide production, and especially a limited phase of carbon dioxide production conditioned only by anion uptake, is too restricted. Other vital processes are also concerned, perhaps more fundamentally. Pre-eminent are metabolic properties which are characteristic of cells still able to grow; but which are still difficult of quantitative expression.

(2) There is not, in our view, the sharp distinction in the relation of metabolism to the uptake of cations and of anions, described by Prof. Lundegårdh.

(3) The effects of salts on respiration—undoubted alike for roots and a variety of storage organs—are not related specifically to anion absorption; cations also exert an influence, which is the predominant one for some tissues, and the effects of differential absorption of cation and anion introduce additional factors.

(4) The storage tissue experiments deal with cells uniform in origin, subject to rigid control, in which the capacity for further growth is known. Root systems can never provide such uniform material; but in the experiments of Hoagland and Broyer special methods yielded root material which was replicated with accuracy well within the requirements of the investigation described. By the special control of nutrition the experimental barley plants yielded tissues with a great capacity for salt uptake, apparently much greater than that possessed by the wheat plants used by Lundegårdh.

(5) Neither respiration nor salt uptake occurs uniformly throughout the root system. In calculating an arithmetical relation between respiration and anion absorption Lundegårdh takes no cognizance of this fact, nor of the complications caused by interaction of root and shoot.

(6) Lundegårdh's references to bio-electric phenomena do not elucidate the problem. The surfaces involved were not precisely defined and in any event the origin of such bio-electrical potentials is still controversial.

We may now note those parts of Prof. Lundegårdh's second article which refer to these points.

Lundegårdh states that we did not find the quantitative relations demanded by the concept of anion respiration because:

(*a*) The choice of treatments was too restricted.

(*b*) The process of salt uptake must be studied in an "organ exclusively designed to effect this process" and therefore experiments on cells of storage roots and stems are not admissible.

(*c*) The work of Hoagland and associates on excised roots is subject to the assumed complication that salts absorbed may exude from the single cut surface back into the external solution, so that the amount in the tissue is not a correct measure of that which is absorbed.

We are unable to accept these arguments. To restrict experimental attack on problems of salt uptake to any particular organ, for example, roots of grasses, is an unjustifiable and arbitrary conception. Salt uptake is one of the most general properties of living cells during their growth, and general conclusions must embrace the results of experiments on a wide range of cells and tissues. Our views were based on experiments on roots of barley and potato, a variety of storage roots, stems and modified leaves, growing leaves of dicotyledons and monocotyledons, as well as submerged aquatics and green algæ. While the most intensive investigations have demanded a restricted choice of materials, the general picture we have presented embraces work with all.

Lundegårdh implies that in storage tissues the anion absorption is too small to reveal the anion respiration effect. However, we clearly stated that in experiments that cover a wide range of salts and salt concentrations the *entire metabolism* of the tissue (not merely respiration) responded to the salt treatment. The ion absorption *was* large enough to produce marked effects, which are different in *kind* from those described by Lundegårdh.

Lundegårdh cites no proof that submerged, excised roots continue to exude salt. In any event, Hoagland and Broyer have made numerous studies on exudates of barley roots and find that the salt present in such exudates during the brief duration of the experiments is equivalent only to a very small fraction of the total salt absorbed by an active ("low-salt, high-sugar") root system. Comparisons have also been made between the salt removed from solution by intact plants and by submerged, excised, root systems. With plants having a high capacity for salt absorption, and for the short periods of the experiments, the excised roots and corresponding entire plants absorbed salt in quantities of similar magnitude. The ion uptake, for example, of potassium and easily absorbed anions was very large, and so far as we can find a basis for comparison, was more rapid than that reported by Lundegårdh or, indeed, by any other investigators of salt absorption in plants. As in the case of the storage tissues, we are certain that the roots absorbed salt in amounts and at rates such as to produce striking metabolic effects, although

certain aspects of metabolism may be more prominent in one tissue than in the other.

We have not found anything in Lundegårdh's rejoinder to warrant discarding our view that the implications for the problem of salt uptake of bio-electric measurements are still obscure—we only wish it were otherwise. Amongst those who favour this line of work there cannot be said to be agreement concerning the nature or origin of the phenomena they investigate. Lundegårdh's re-statement still does not convey to us a clear picture of the boundaries which he regards as the seat of the phenomena he measures; that is, whether this membrane is one of cells, for example, piliferous layer (epidermis of Lundegårdh), root cortex, or endodermis separating an external and internal intercellular fluid, or is a protoplasmic boundary membrane, across which the phenomena of ion accumulation in cells actually occur. Such phrases as "root tip" relative to electrode measurements require much more precise definition before they convey any anatomical meaning.

To return to the constant '*k*' of anion respiration. It is said to be "fairly constant" for an anion present only as a given salt (although in the experiments with barley roots this function would not be constant even with this restriction). With different cations the value of '*k*' is now said to "change somewhat", and it varies also with the ratio of absorbed anions to cations. So versatile a "constant" seems to us to lack utility.

Our purpose in this and our former communication is to suggest to the general reader the complexity of the problem of salt absorption by living cells, and also that the theory of Prof. Lundegårdh has not yet been established and generally accepted by plant physiologists. With regard to the quoted work of van Eijk on the salt marsh composite *Aster tripolium*, we note that it is rather the principle of a salt effect on respiration which van Eijk confirms (with which we are not in disagreement) and not the reality of the special anion effect, which even by van Eijk seems to be regarded as an open question. Van Eijk's values for the quantity "K" do not show that this has a constant value specific for each anion.

Finality cannot be obtained by further exchange of views in the columns of NATURE. Although we hope that the present discussion may serve a useful purpose, its continuance in this journal could not be justified.

STATISTICS AND ENGINEERING PRACTICE

DR. B. P. DUDDING and W. J. Jennett, of the G.E.C. Research Laboratories at Wembley, have contributed a paper on "Statistics" to the Institution of Electrical Engineers which was published on January 5 and should prove useful in engineering applications. Although there was no spoken discussion, the authors have made some minor changes so that it can be read as a contribution to a general written discussion which will be concluded not later than February 5.

The theory of statistics as a distinct branch of science did not begin to flourish until the last quarter of the nineteenth century; in England, the work of Galton and Karl Pearson laid the foundations of the applications of the theory to many fields of science. Research workers in biological sciences and in agricultural industry were the first to turn these more recent advances to practical use. Great interest was stimulated by a series of lectures given by Dr. Shewhart at University College, London, in 1932. Later, the British Standards Institution formed a committee charged with the following terms of reference:

(1) To report on the application and use of statistical methods in standardization and specification of quality; (2) to draw up a short report which would serve to awaken interest in the application of statistical methods on the part of manufacturers and others concerned with problems of standardization and specification; (3) to consider what encouragement is necessary for the development of research on improved statistical methods and their application to industry; and (4) to consider what steps should be taken to provide for co-operation with bodies in the United States of America and elsewhere instituted for similar objects.

Out of this activity also grew the formation of the Industrial and Agricultural Research Section of the Royal Statistical Society. The meetings of this Section have provided opportunities for technicians employed in industry to meet statisticians and for statisticians to meet and discuss with technical people the difficulties which arise in trying to apply statistical methods to the examination of industrial data. Many institutions have been interested in this development. At the present time, there are few industrial products which are not expected to conform with some standard of quality. Measures are taken to ensure that finished products will conform with quality standards demanded by consumers.

The main object of Messrs. Dudding and Jennett was to emphasize the essential statistical nature of many technical problems and the part that chance plays in many technical decisions, and to demonstrate the need for a technique which will give assistance in making deductions from test data.

The following technical improvements and economies accrue to those industrialists who cultivate the statistical outlook and apply statistical methods to the scrutiny of their data. The errors of judgment arising from ambiguities due to the effect of chance, which lead to incorrect action, are reduced. Development work involving reasonably large-scale production can be planned most economically and the results rightly appraised. The efficiencies of the specifications used can be improved, and simple and efficient systematic methods of presenting data requiring daily scrutiny can be readily devised.

The authors explain fully the academic method of considering the frequency distribution of observations by the Gaussian curve, and the use of mean and standard deviations is explained. The importance of the methods given for carrying out specifications which involve sampling is clearly stated.

Numerical examples are included which will help those beginning the study of variance. An example has been given where an experienced engineer lacking statistical knowledge, and the statistician lacking practical knowledge, would probably have come to the same erroneous conclusion. Correct diagnosis of the difficulty in the factory was only possible by a combination of the attributes of the two.

SEVENTY YEARS AGO

NATURE, vol. 1, January 20, 1870

Kant's Views on Space

PROF. T. H. HUXLEY concludes a letter on this subject with . . . "there can be no doubt that that thorough and acute student of Kant, Dr. Ingleby, was perfectly right when he said that Kant would have repudiated the affirmation that 'space is a form of thought'. For in these sentences [quoted from Kant's writings], and in many others which might be cited, Kant expressly lays down the doctrine that thought is the work of understanding, intuition of the sense ; and that space, like time, is an intuition. The only 'forms of thought', in Kant's sense, are the categories."

Projected Channel Railways

THE second of a series of three articles on this topic was published. The first article discussed the cultural advantages for Great Britain of closer connexion with the continent of Europe, and proceeded to demolish a fantastic scheme for a railway bridge across the English Channel. The second article dealt with a proposed Channel Tunnel and included a map of the route from the engineers' report issued by the promoters. "We are of opinion that it is not an unreasonable proposition, to drive a tunnel under the Channel, but that in some measure it must be a venture. If we are to undertake such a venture to gain a magnificent prize, of immense value to the English and French nations, we must be prepared to meet all ordinary eventualities. . . . The first step towards accomplishing the object would be to obtain a geological section across the Channel . . . from actual test of the materials which compose the bed of the Channel."

Meteorological Blockade

SIR WILLIAM THOMSON, F.R.S. [afterwards Lord Kelvin] discusses Dr. Balfour Stewart's proposal for a cordon of meteorological stations around a district to keep an exact account of the quantity of water vapour entering and leaving the space over the district in question. "This appears to me a most valuable proposal, which, if well carried out, must have a very important influence, tending to raise meteorology from its present empirical condition to the rank of a science . . . the same system of account-keeping ought to be applied to electricity . . . among the many unknown quantities involved, the two departments of the blockade combined will give means for eliminating some and estimating others."

WE notice that an individual was examined on Tuesday at Worship Street on the charge of sweating sovereigns. The details of the case, which are of considerable importance to the public, will be watched with interest. It appears that the coins are dissolved by acid, aided by a battery, and that the loss in some cases equals about two shillings in the sovereign.

IT was announced by Mr. Lockyer at the meeting of the Royal Astronomical Society on Friday last, that the great refractor of 25 inches aperture, constructed by the Messrs. Cooke, of York, is so near completion that it will be erected in the observatory prepared for it at Gateshead early next month.

APPOINTMENTS VACANT

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

ASSISTANT LECTURER IN ELECTRICAL ENGINEERING AND PHYSICS at the Technical College, Coventry—The Director of Education, Council House, Coventry (January 26).

HEADMASTER for the Pentre Junior Technical School—The Director of Education, Council Offices, Pentre, Rhondda (January 27).

TEMPORARY INSTRUCTOR LIEUTENANTS in the Royal Navy—The Director, Education Department, Admiralty, Whitehall, S.W.1 (January 31).

GRADUATE ASSISTANT to teach ENGINEERING Subjects, PHYSICS and MATHEMATICS—The Principal, Hendon Technical Institute, The Burroughs, N.W.4 (January 31).

ENGINEERING WORKSHOPS INSTRUCTOR to take Engineering Drawing and Allied Subjects (Elementary Mathematics and Mechanics)—The Principal, Hendon Technical Institute, The Burroughs, N.W.4 (January 31).

LECTURER (Grade II) IN DENTAL PROSTHESIS—The Secretary and Registrar, University, Bristol (February 10).

DIRECTOR OF RESEARCH of the Linen Industry Research Association —The Secretary, The Research Institute, Lambeg, Co. Antrim (March 1).

JUNIOR ASSISTANT CHEMISTS—The Secretary, Linen Industry Research Institute, Lambeg, Co. Antrim.

ENGINEER for the Public Works Department of the Government of Hong Kong—The Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/9006).

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Imperial Bureau of Animal Breeding and Genetics. Animal Breeding in the Light of Genetics. (Seventh International Genetical Congress, Section D.) Pp. 78. (Edinburgh and London : Oliver and Boyd.) 3*s*. [2812

Department of Scientific and Industrial Research. Report of the Forest Products Research Board, with the Report of the Director of Forest Products Research, for the Year 1938. Pp. iv+84+4 plates. (London : H.M. Stationery Office.) 1*s*. 6*d*. net. [2912

International Journal of Agrarian Affairs. Vol. 1, No. 1 : The Problem of Surplus Agricultural Population. Pp. 96. (London : Oxford University Press.) 3*s*. 6*d*. net. [21

Thirtieth Report of the Commissioners of His Majesty's Customs and Excise for the Year ended 31st March 1939 : being the 83rd Report relating to the Customs and the 82nd Report relating to the Excise. (Cmd. 6098.) Pp. 205. (London : H.M. Stationery Office.) 3*s*. net. [21

University of Durham. Abstracts of Theses for Doctorates presented by Candidates who have received the Degrees in Congregation during the Academical Year 1938–39. Pp. 22. (Durham : The University.) [31

Other Countries

U.S. Department of Agriculture. Technical Bulletin No. 690 : The Acidic Properties of Peat and Muck. By Irvin C. Feustel. Pp. 42. (Washington, D.C. : Government Printing Office.) 10 cents. [2812

Bulletin of the American Museum of Natural History. Vol. 76, Art. 8 : Body-Forms of the Black Marlin (*Makaira nigricans marlina*) and Striped Marlin (*Makaira mitsukurii*) of New Zealand and Australia. By William K. Gregory and G. Miles Conrad. Pp. 443–456+plates 3–6. (New York : American Museum of Natural History.) [2812

Chinese Medical Association. Special Report Series No. 12 : Nutritional Studies in Shanghai. By H. C. Hou, P. G. Mar, T. G. Ni and B. E. Read. Pp. iv+92. (Shanghai : Chinese Medical Association.) 2 dollars ; 4*s*. [2912

Madras Government Museum. Guide to the Archæological Galleries : An Introduction to South Indian Temple Architecture and Sculpture. By Dr. F. H. Gravely, C. Sivaramamurti and other Curators. Pp. viii+48+4 plates. 8 annas. Illustrations of Indian Sculpture, mostly Southern : for Use with the Guide to the Archæological Galleries. By Dr. F. H. Gravely and C. Sivaramamurti. Pp. iv+46 plates. 1.8 rupees. (Madras : Government Press.) [21

Journal of the Indian Institute of Science. Vol. 22A, Part 19 : Synthetical Investigations in the Thujone Series, Part 8 : Synthesis of *Iso*-Thujone. By P. C. Guha and A. Kuppusami. Pp. 249–254. 10 annas. Vol. 22A, Part 20 : Synthetical Investigations in the Camphane Series. Part 5 : Synthesis of Manasse's Ketonic Acid, $C_{10}H_{16}O_3$, from Camphorquinone : 2 : 2 : 3-Trimethyl-*cyclo*hexane-4-one-Carboxylic Acid. By P. C. Guha and Debabrata Das Gupta. Pp. 255–262. 12 annas. (Bangalore : Indian Institute of Science.) [21

Government of India : Meteorological Department. Magnetic, Meteorological, Atmospheric, Electric and Seismographic Observations made at the Government Observatories, Bombay and Alibag, in the Year 1937 under the direction of Dr. K. R. Ramanathan. Reduced and tabulated under the direction of Dr. K. R. Ramanathan and Dr. S. R. Savur. Pp. A76+B44+C4+D14+5 plates. (Delhi : Manager of Publications.) 14.14 rupees ; 23*s*. [21

OFFICIAL ANNOUNCEMENTS

UNIVERSITY OF BRISTOL

ENTRANCE SCHOLARSHIPS

Examinations for the two following Scholarships, each of the value of £100 per annum, will be held in the University on May 6, 1940, and following days.

1. A Dulverton Scholarship tenable in the Faculty of Science.
2. A George Alfred Wills Scholarship tenable in Modern Languages.

The Marian Clarke Scholarship, value £25 per annum, will be awarded in September 1940 to a *woman* student entering the Honours School of English, Modern History, French or German.

Further particulars of each of the above may be obtained on application to the undersigned.

WINIFRED SHAPLAND,
Secretary and Registrar.

UNIVERSITY OF LONDON

THOMAS SMYTHE HUGHES MEDICAL RESEARCH FUND

Applications are invited from members of the University for grants from the Thomas Smythe Hughes Fund for assisting medical research. Application forms (which must be returned by March 31, 1940) and further particulars may be obtained from the Academic Registrar, 42 Gyles Park, Stanmore, Middlesex.
January 1940.

UNIVERSITY OF LONDON

Applications are invited from members of the University for grants from the Central Research Fund for assisting specific projects of research and for the provision of special material and apparatus. Application forms (which must be returned by March 31, 1940) and further particulars may be obtained from the Academic Registrar, 42 Gyles Park, Stanmore, Middlesex.
January 1940.

UNIVERSITY OF LONDON

DIXON FUND

Applications are invited for grants from the Dixon Fund for assisting scientific investigations. Application forms (which must be returned by March 31, 1940) and further particulars may be obtained from the Academic Registrar, 42 Gyles Park, Stanmore, Middlesex.
January 1940.

AIR MINISTRY

METEOROLOGICAL OFFICE

APPLICATIONS are invited for APPOINTMENT as TEMPORARY FORECASTERS, Grade II (Male), in the Meteorological Office. Candidates must be between 25 and 35 years of age.

Candidates must have reached their 25th birthday but not their 35th birthday on January 1, 1940. Candidates must possess a Science Degree, preferably with physics or applied mathematics or meteorology. The possession of an Honours Degree will be an advantage.

Remuneration will be by a fixed salary of £260 per annum. After a period of training entrants who have shown exceptional merit will be considered for promotion to the post of Temporary Forecaster, Grade I, at a fixed salary of £315 per annum.

Candidates should apply for an application form by postcard to the Under-Secretary of State, S.2.B. (Met.), Department Q.A., Air Ministry, Adastral House, Kingsway, W.C.2.

INSTRUCTOR OFFICERS, ROYAL NAVY

APPLICATIONS are invited for commissions as TEMPORARY INSTRUCTOR LIEUTENANTS in the ROYAL NAVY for hostilities only. These officers will be required for service in H.M. Ships and in Naval Establishments and must be prepared to join the Royal Naval College, Greenwich, on May 1, 1940. The duties include the instruction of Naval Officers and the meteorological work of the Fleet.

Candidates must have attained the age of 25 and be under 30 years of age on May 1, 1940, and must be physically fit. They must possess an Honours degree in Engineering (Mechanical or Electrical), Physics (with Mathematics as a subsidiary subject), or Mathematics. Some teaching experience is desirable.

Application forms and copies of the regulations may be obtained from the Director, Education Department, Admiralty, London, S.W.1.

Completed forms of application must be returned not later than January 31, 1940.

UNIVERSITY OF ABERDEEN

APPOINTMENT OF A UNIVERSITY ASSISTANT IN BOTANY

Salary £250 12s. to £300 per annum, according to experience and qualifications.

Qualifications in Agricultural Botany will be a recommendation.

Applications, together with a full statement of qualifications and the name of at least three referees, should be sent not later than January 20, 1940, to the Secretary to the University, from whom further particulars may be obtained.

The University, Aberdeen. H. J. BUTCHART, *Secretary*.

LINEN INDUSTRY RESEARCH ASSOCIATION

Applications are invited for two vacancies for Junior Assistant Chemists. Salary on the scale £250—£15—£360, with F.S.S.U. benefits. Subject to one year's probation. Preference will be given to honours graduates having some experience of textile research. Application forms may be obtained from the Secretary, Linen Industry Research Institute, Lambeg, Co. Antrim, N. Ireland.

THE LINEN INDUSTRY RESEARCH ASSOCIATION

Applications are invited for appointment as Director of Research of the Linen Industry Research Association. This post will carry a salary of the order of £1,200, with superannuation provision under the F.S.S.U. Scheme, and will afford attractive opportunities for a suitable candidate.

The Candidate should possess recognized scientific qualifications and preferably considerable research experience. He should also possess a broad outlook on the application of research to industrial problems and be of a type able to establish useful contacts with industry.

Applications for the post should be submitted not later than March 1, 1940, addressed to the Secretary, The Research Institute, Lambeg, Co. Antrim, Northern Ireland, from whom further particulars can be obtained on application.

The International Tin Research and Development

Council invites applications for the post of Research Assistant, to undertake work on the casting of bronzes. Candidates should have a degree in metallurgy and some research or works experience. Salary £300—(×£25)—£400. Applications should be received by the Secretary, The International Tin Research and Development Council, Fraser Road, Greenford, Middlesex, not later than January 27, 1940.

Vacancies exist for Valve Designers in the Laboratory

of a well-known firm of wireless valve manufacturers. Applicants must have had considerable personal experience in the design of receiving and/or transmitting valves, and should possess academic qualifications in physics or electrical engineering. Applications should be made by letter, giving full details of experience and salary required, to Box 691, T. G. Scott & Son, Ltd., 63, Ludgate Hill, London, E.C.4.

A vacancy exists for a Senior Research Assistant in

the Laboratory of a well-known firm of wireless valve manufacturers. The subject for research is connected with secondary emission phenomena, and applicants must have had considerable experience in this or some nearly related subject. Good academic qualifications should be held, and full details should be given, including salary required, by letter, to Box 692, T. G. Scott & Son, Ltd., 63, Ludgate Hill, London, E.C.4.

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