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The Civil Population and Air Attack

SINCE the issue of the circular to local authorities in Great Britain by the Air Raids Precautions Department in July 1935 urging them to co-operate in schemes of passive defence, public attention has been continuously engaged with this subject, but despite the growing activities of the Department it cannot be said that public opinion is at all happy upon the question. It is increasingly aware of the concern with which informed scientific and technical opinions regards the proposed measures, and the decision of the Government to transfer the shell-filling and other explosives supply departments of Woolwich Arsenal to four centres in the west and north of the country, which are regarded as less vulnerable to air attack, tends to increase rather than to dispel alarm.

While many local authorities have accepted the suggestions of the Government in regard to the organization of air raid precautions and defence, and many large firms are giving the matter active consideration, other local authorities have only accepted the suggestions so far as they relate to the training of fire brigades or police, while a few have refused to co-operate. At first sight, this latter attitude appears somewhat indefensible. The precautions professedly are purely humane in their intention and effect. The five handbooks already issued by the Department outline comprehensive schemes dealing with protection against gas, either in the way of first-aid services, the establishment of the requisite preliminary organization in large commercial or industrial firms and the like, precautions for merchant shipping and methods of decontamination of materials. It is common sense to take every reasonable precaution against so appalling a danger, however remote the probability may be. When the danger is one that can be aggravated so seriously by panic, the support of measures likely to promote order and discipline in the event of attack may reasonably be urged as a public duty.

While this is so, and while it is obvious that effective safety measures cannot be improvised at a moment's notice, a body of opinion, strongly supported by some scientific workers apparently qualified to express views on this subject, has offered important criticism or objection to the proposals on at least four grounds. These objections are summarized in a series of reports which from time to time since August 1935 have been distributed by the National Peace Council, and the present position has been summarized in No. 27 of these reports, by Dr. A. F. W. Hughes, issued in December last.

In the first place, the plans of the Air Raid Precautions Department are regarded as inadequate both in degree and in kind to afford protection for the people from air attack. The main measures of defence advocated are those against gas attack, and the most important criticism is that the danger from gas attack is far less than from attack by high explosive and incendiary bombs, from which there is no protection whatever except properly constructed shelters either underground or with a heavily reinforced roof. The main defence suggested by the Department is that of a gas-proof room with windows and chimney blocked, and to be used for no other purpose. It is obvious that only a minority of the population will be able to set aside a room specially for this purpose. Of the remainder, many live in crowded areas, sometimes in houses insufficiently protected against the weather. Although officials of the Department have publicly admitted the inadequacy

of the ordinary house to provide any shelter at all, in October last, Commander Franks, of the Department, was still advising those who could reach their homes to take shelter in them. Moreover, although expert opinion to some extent appears to believe in the possibility of creating bomb-proof buildings as well as gas-proof structures, the need of research in this field has been admitted freely, notably by the Parliamentary Secretary to the Ministry of Health, who stated in July last that an influential committee had been set up to advise on the Air Raid Precautions Handbook "Structure Precautions against Bombs and Gas" which is in preparation. Experiments are still required to establish data in regard to the effect of various types of bombs and gas, and also the resisting power of the miscellaneous materials used in a modern building. Even the possibilities of air-conditioning as a defence against gas have as yet scarcely been explored.

These facts in themselves are sufficiently disturbing. The efficiency of the gas mask has also met severe expert criticism. Apart altogether from the psychological difficulty of inducing unskilled workers to wear them—a difficulty with which the industrial chemist is only too familiar—or the attendant discomfort, there is the practical problem of devising a mask effective against any gas which the enemy might possibly use. Without such knowledge, use of a gas mask may be quite ineffective and even engender a false confidence. On the other hand, while that very confidence, whether well founded or not, may help to sustain morale and diminish casualties by avoiding or diminishing panic, the fact should not be overlooked that air raid drill and practice with gas masks may have an effect on the health of the population quite opposite to that intended. The use of the mask may, in fact, engender hysteria and nervous strain that may more than outweigh all the advantage gained against panic.

The second main ground of criticism of the proposals is that they are an essential part of war preparation and have as their avowed object not directly the saving of life or the prevention of suffering, but the strategic necessity of maintaining the public morale and so decreasing the danger in war time of a craving for peace. There is little room for doubt that Government policy in Germany and in Italy is fairly open to this charge, but so far in Great Britain there is little evidence to disentangle this criticism from opposition to the Government defence policy really based on political grounds. At least it can be urged that those who take this view should show that the drawbacks to the gas mask proposals, for example, outweigh its advantages on psychological, apart from technical grounds. There is scarcely any evidence that the whole outlook of the people of Great Britain is other than fundamentally pacific, and those who bring this charge against the Government policy would have a much stronger case if they also attacked that section of the Press which consistently fosters a war mentality and pillories all constructive effort for peace.

None the less, it must be admitted that the third objection to the precautions policy of the Government that, whatever their intention, the precautions cannot fail to create a war mentality which is in itself the most mischievous danger to peace, undoubtedly holds some truth. The nation, however reluctantly, has accepted the Government's defence policy, but is still far from the frame of mind which regards war as inevitable. It would be foolish, however, to ignore the tendency of the whole tenor of recent events in Europe to encourage the mental outlook which will accept conflict as a welcome release from the strain of suspense. It is only too easy to slip insidiously and unconsciously from mere repugnance to war to acquiescence in it on the principle of knowing the worst rather than remain in suspence.

What is equally untoward is the check which the intensification of preparations for war has given to almost all effort designed to deal with the fundamental problem of the elimination of the causes of war. The important discussions which have taken place in the daily Press regarding the future of the mandates system, raw materials, population and the German colonial claims, are only a few examples of directions in which impartial investigation or research is required to provide a satisfactory basis for settlement or to demonstrate the speciousness of merely partisan or propagandist arguments. Despite Sir Samuel Hoare's statement at Geneva in August 1935 regarding an impartial inquiry into raw materials and colonial questions, no steps have apparently been taken to implement the inquiry. The whole spirit of the present defence measures has apparently paralysed such effort. No single action of the Government, however, could do more to disarm the foregoing criticism of its air defence proposals than an emphatic demonstration in some such way of its willingness to make constructive contributions to the elimination

of the causes of war by the initiation of these or similar inquiries which might diminish international friction.

Positive action of this type would also offer a weighty reply to the fourth main ground of serious objection to the air raid precautions in which most scientific workers are agreed, that the precautions conceal the truth that there is no possible protection of civilian population from air attack other than the abolition of bombing from the air. Those who realize the limitations of a policy of evacuation or even of the replanning and rebuilding of great cities with an eye to defence against attack by air, as in the Middle Ages they were built against attack under different defence conditions, carry a heavy responsibility if they fail to inform public opinion of those limitations.

Only so can we secure that widespread and intelligent public support for proposals such as the control of national air forces, the organization of an international air force or of effective collective security upon which alone the future safety of civilization appears to depend. Nor can we reasonably doubt that, if the public once realized how limited is the protection available even for those who can afford it, there would be forthcoming that large volume of informed public opinion which, while realizing the inevitability at the present moment of pressing on with measures for national defence, would insist that simultaneously no effort was spared to explore every possibility of international understanding and co-operation in the search for the causes of war itself.

Papuan Pygmies and Art

(1) Walkabout:
a Journey in Lands between the Pacific and Indian Oceans. By Lord Moyne. Pp. xxvi + 366 + 97 plates. (London and Toronto: William Heinemann, Ltd., 1936.) 18*s*. net.

(2) Art and Life in New Guinea
By Dr. Raymond Firth. Pp. 126. (London: The Studio, Ltd.; New York: The Studio Publications, Inc., 1936.) 10*s*. 6*d*. net.

(1) THOSE interested in Pacific affairs may recall the unusual and stimulating collection of ethnographical specimens, predominantly from New Guinea, exhibited by Lord Moyne in his London house last summer. His volume, "Walkabout" (Pacific 'pidgin' for travel beyond the tribal territory), records the experiences of the expedition upon which this fine series of objects was collected and also tells us something of the animals brought back to the Zoological Gardens at Regent's Park, London, and of the difficulties of getting them there. But while the collecting of animals and ethnographical specimens was one of the major objects of the expedition, its chief aim seems to have been to study a group of relatively light-skinned pygmies who were said to inhabit the foothills on the north-eastern slopes of the Bismarck Range in Mandated Territory.

The volume sets out in vivid fashion how far the party were successful, and the misfortunes (they came near being something worse) endured in carrying out the programme, in which they succeeded to the extent of bringing home a magnificent series of photographs of pygmies taken by Lady Broughton. These photographs and their discussion constitute the backbone of the book, and the discovery of the Aiome pygmies is no doubt the most important result of the voyage. These pygmies differ entirely from the darker riverain natives, as they do from those of the Aiome foothills, who are still darker than the River people. Twelve males measured by Lord Moyne had an average stature of 54½ in. (extremes 52½ in. and 58 in.), while three women varied from 50½ in. to 53 in. The photographs show that they vary greatly in facial characters, nevertheless certain generalizations can be made:

"Their upper lips were fleshy, projecting and sometimes everted, with rather pendulous lower lips and receding chins. Brow-ridges were not noticeable. The noses generally were straight and broad, the roots being clearly marked. The ends of the nostrils were set square and not diagonally, the bulbs being made to stand out by a bird's quill or as many as four fine sticks cut from the fronds of a sago-palm and worn right through the septum."

Like other New Guinea pygmies, they are skilful gardeners, and it seems impossible to bring their culture into close alliance with any of the Indonesian pygmy groups with which we are acquainted. Who then are these New Guinea pygmies? Are they local groups of 'Papuans' of very low stature, or are they part of a vanishing

pygmy negroid stock, whose other representatives are the Aeta of the Philippines and the Semang of Malaya? Where Dr. Haddon, who writes the introduction, leaves us in doubt no one will wish to dogmatize, but the reviewer may record his impression that with a single exception (Plate LIII) the faces of the pygmies here reproduced might equally well be those of natives he knew years ago in the area formerly called British New Guinea, now the Territory of Papua.

So much for the Aiome pygmies, but the book might almost be regarded as a traveller's manual to Pygmydom, for Lord Moyne and his party also visited the Andamanese and the Semang, and again Lady Broughton's camera produced most admirable results.

An appendix by Dr. Cave gives an account of the crania collected, prefaced by a general statement as to the races of mankind. These are correctly given according to current classification, but is it not likely to mislead the layman to tabulate Mediterraneans, Alpines and Nordics as if they were primary divisions of mankind in the same sense as are the Mongoloids, Negroids and Australoids? If Dr. Cave will not have the term Caucasian, surely it should have been indicated that the first three 'races' mentioned belong to a single greater unit (or subspecies) comparable with Negroids and Mongoloids—the White Race.

(2) Dr. Firth's pleasant volume is one of those treats which the proprietors of *The Studio* provide for us from time to time. It consists of about one hundred photographs of objects and typical scenes from New Guinea, the former predominating. Among the representations of village life are a number from the negatives presented by Captain F. R. Barton, a former Governor of British New Guinea, to the Royal Anthropological Institute. To those who, like the present writer, know something of this magnificent series, it will be a treat to see it at last emerging from the disuse into which it had fallen. The life scenes are accompanied by an adequate commentary by Dr. Firth. The reviewer would particularly like to emphasize his agreement with the author with regard to the futility of trying to bring into line surrealism and such objects of native workmanship as are figured in this volume. C. G. S.

Geography and European Society

Environment and Nation:
Geographical Factors in the Cultural and Political History of Europe. By Prof. Griffith Taylor. Pp. 571. (Toronto: University of Toronto Press; London: Oxford University Press, 1936.) 17*s*. net.

PROF. GRIFFITH TAYLOR holds an honourable place in the society of geographical investigators, and in his research—especially that part concerned with the interrelations of climate and human settlement—he has demonstrated the power of his observant eye. His certainty of touch is most dependable when he is engaged in the study of Australasia, a region with which his name will always be intimately associated. An earlier volume—"Environment and Race"—discussed, in relation to environmental conditions during successive epochs, the evolution of some of the main groups of mankind outside Europe, and it is, therefore, not unexpectedly that we find the present volume devoted to the European communities by whom the idea of nationality was first conceived.

In these days, there are few who claim to understand the intricacies of the political and social fabric of Europe without appreciation of the conditions of physical and human geography which have prevailed during the evolution of the nations. Prof. Taylor attempts this study in historical geography, or geography in retrospect, and finds it—as many other students have done—a particularly difficult subject to interpret. The essential requirement is to know how to employ the records furnished by the historian so as to associate the historical events and trends with the circumstances of geographical environment. On one hand is the temptation towards 'geographical determinism', a conception of history as being determined by geographical laws; on the other, is the danger of indiscriminating use of the historian's materials and the neglect of geographical factors. A very valuable contribution which the historical geographer can make is the reconstruction of the climatic and vegetational environment at successive periods, for it is only by the light of such knowledge that the trends in the prehistory and early history of Europe are made intelligible.

No doubt the author is fully aware of these requirements, but his arguments suffer by being clogged with historical detail. Instances of this are over-abundant and include lengthy reference to ancient Greece and Rome in which there is much military history and singularly little

concerning the social and economic geography of the Mediterranean region in past times. The complexity and antiquity of civilization in Europe impose an enormous burden of reading on him who undertakes the study, and it would have been surprising if the author had been able to keep abreast of the literature in so many different fields, including archæology. Recent research in the prehistoric civilizations of Britain and Ireland, in particular, has received little attention. In the case of the smaller country, there is no recognition of its place and significance in the Bronze Age of western Europe.

Some day the genius will arrive who will satisfy our need for an adequate statement of the part that geography has played in the shaping of European society. As a whole, the volume now before us falls short in achievement of the ambition which inspired the author when he began his task, although in one or two chapters, particularly one devoted to Russia, there are instances of satisfactory fulfilment. Throughout, the author seems to be reminding himself that nationality is a product of 'place' rather than of 'race', but repeatedly he wanders into historical and ethnological descriptions, leaving the geographical factors unexplained and sometimes ignored. Least satisfactory are the chapters devoted to the nation-states of France and Britain in which, by unnecessarily lengthy reference to invasions and annexations, he distracts attention from the coalescence or welding together of regions, each with its own 'personality', out of which statehood and nationality evolved. It is a matter for notice, though not indicated by the author, that in each country mentioned above the establishment of the State preceded the development of national consciousness, whilst in the case of Germany the idea of nationality was widespread long before its political expression was fully achieved.

In matters of detail there is the opportunity for much careful revision, in readiness for a second edition, and it is essential that an adequate bibliography should be added. W. F.

World Power Statistics

Statistical Year-Book of the World Power Conference

No. 1: 1933 and 1934. Edited, with an Introduction and Explanatory Text, by Frederick Brown. Pp. 111. (London: World Power Conference, 1936.) 20*s*. net.

COMPILATION of a volume containing comparable statistics of resources, production, stocks, imports and consumption of power and power sources of all countries of the world would appear to be a superhuman task, bearing in mind the present lack of international classification of power types and widely different methods of collecting and recording data employed by countries and public bodies throughout the world. The International Executive Council of the World Power Conference has for a number of years past sponsored the systematic compilation of inventories of power resources by national committees and by Government and other organizations, and has so far as possible ensured their return in comparable form by the circulation of definitions of each power type. This action on the part of the Council has now made possible the issue of a year-book relative to the years 1933 and 1934.

It is admitted in the introduction that the volume is capable of improvement in subsequent editions, and that the work of collection of statistics has by no means reached finality. The criticism might also be levied that the wealth of annotation, sub-division and definition (admittedly appended solely in the interest of strict accuracy) is cumbersome to the reader who strives in his own mind to form a concise idea of the approximate world resources of a given fuel, but who is continually thwarted by observations such as that made in the case of coal. . . . "The largest areas for which no estimates are presented are in Africa, Asia, and Central and South America; it is known that coal reserves exist in many countries in these areas but, . . . exploitation of these resources has hardly begun, and their magnitude has not been even approximately estimated". Nevertheless, in spite of manifest drawbacks, the book probably embodies the most comprehensive collection of power studies as yet published.

Power types are divided into five major classes —solid fuels, including coals, brown coal, lignite, peat and wood; liquid fuels, sub-divided into petroleum, benzoles, alcohols; gaseous fuels (natural gas), and water-power and electricity. In each case a note is given of the scope and meaning of the statistics. This is followed by a table of Continental and world totals, and finally by standard definitions applicable to the particular section. The tables themselves give resources of the power type, listed under continents

and countries, and annual statistics of production, imports, exports and consumption for the years 1933 and 1934 wherever available.

It is to be hoped that this volume will be followed by other editions which will justify more fully the tremendous amount of time and energy put forward by its promoters. It would also be desirable, if possible, to reduce the price of later editions, as twenty shillings is excessive for a year-book of this character.

Micro- and Macro-Analysis

(1) Semi-Micro Qualitative Analysis

By Prof. Carl J. Engelder, Tobias H. Dunkelberger and Dr. William J. Schiller. Pp. x+265. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1936.) 13*s*. 6*d*. net.

(2) Semimicro-Methods for the Elementary Analysis of Organic Compounds

By Prof. Dr. Eduard Sucharda and Boguslaw Bobranski. Authorised translation by Dr. George W. Ferguson. Pp. vii+52. (London : A. Gallenkamp and Co., Ltd., 1936.) 6*s*. net.

(3) A Textbook of Elementary Quantitative Analysis

By Prof. Carl J. Engelder. Second edition. Pp. xiv+270. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1936.) 13*s*. 6*d*. net.

(1) FOR many years, analytical chemistry had maintained a fairly static state ; dependable methods of detecting and estimating the more commonly used elements had been worked out, and these were adhered to in a more or less rigid manner. During the past two decades, however, there has been a remarkable revival of interest, new methods have been adopted and a nearer approach made to the ultimate ideal of one specific procedure for each cation or anion. This movement has been due partly to the use in industry of a larger number of the chemical elements, especially the so-called rarer elements, partly to the discovery of increasingly sensitive reagents and partly to the desire of the analyst to know more and more about less and less. The two latter causes have conspired to give birth to microchemistry, a subject which has advanced so rapidly that it will undoubtedly play a large part in future schemes of analysis. For that reason, the authors of the work under review have deemed it wise that students should have practical acquaintance with some of the technique of micro-analysis. They have therefore developed a scheme whereby drop-reaction methods are applied to the ordinary system of qualitative analysis, and for which 1–2 c.c. of solution containing some 20 mgm. of material suffices for the usual group separations and confirmatory tests.

The book is divided into four sections, the first of which deals with the theoretical principles underlying qualitative analysis. This is written in an interesting manner and covers a remarkably wide field. In the second part there is set forth the reactions of the cations appearing in the various analytical groups, and included here are many 'spot' tests employing organic reagents. A similar treatment is then applied to the commoner anions, while the last section deals with the systematic analysis of mixtures.

The work provides an excellent introduction to drop-systems of detection and will be found useful both to students and to the more advanced worker. Its value is further enhanced by numerous references to the literature of qualitative micro-analysis.

(2) Micro-methods of organic analysis are now well established and are gradually displacing the macro systems. Nevertheless, they suffer from one disadvantage in that they require a special balance which, in turn, needs a suitable place for its erection. Many workers have therefore sought to develop semi-micro or centigram methods for which an ordinary balance accurate to 0·1 milligram can be used. In this book, Prof. Sucharda and Dr. Bobranski outline such a scheme for the estimation of carbon and hydrogen, nitrogen and the halogens, using 20–30 mgm. of material. In addition, there is also described a semi-micro ebullioscopic determination of molecular weights.

The technique of these elementary analyses is based almost entirely on that of Pregl, although in the carbon-hydrogen determination there is one notable refinement. In order to ensure a constant excess of oxygen during combustion, use is made of an automatic regulator whereby the size of the flame causing the vaporization of the material is controlled by the pressure inside the combustion tube. Consequently there is no need to count bubbles or read a manometer ; indeed the presence of the analyst is superfluous during this part of the operation.

Halogen compounds are burnt in oxygen with the aid of platinum as catalyst, but, in the case of chlorine or bromine, the halogen is absorbed in heated barium carbonate. Iodine is taken up

in sodium sulphite, but, as the halides formed in each case are titrated argentiometrically, excess of sulphite must be removed as the barium salt.

This monograph has been excellently translated from the original German version, and, although small, it contains adequate details of the procedures employed. These methods should provide a good opportunity for acquiring the technique of micro-organic analysis without incurring the expense of a micro-balance.

(3) Most text-books of elementary quantitative analysis are nothing more than a heterogeneous collection of estimations which the student is expected to carry out, often without knowing the reasons underlying the various processes. The present book, however, does not suffer from this defect, for theory and practice are blended most judiciously.

The manual opens with a section on such fundamental principles as the law of mass action, the use of the balance and the errors and precision of quantitative methods. It then treats of volumetric analysis, this section covering half the book and containing an excellent chapter on the theory of neutralization and the use and selection of indicators. The gravimetric part of the work deals with the usual common precipitations, while there is also a short section on electro-analysis. The text includes numerous problems, and the student who solves them all and carries out the various estimations will have received a sound grounding in quantitative analysis.

The value of the book is best illustrated by the fact that a second edition is called for so soon; this differs but little from the original one and that mainly in the arrangement of the text.

G. R. D.

Training of Engineers

Advanced Laboratory Practice in Electricity and Magnetism

By Dr. E. M. Terry. Revised by Prof. H. B. Wahlin. Third edition. Pp. xiv+318. (New York and London: McGraw-Hill Book Co., Inc., 1936.) 18*s*.

THE layout of this book is so curious that a few words on the purpose of laboratory work for budding engineers must precede our criticism.

Assuming that the purpose of an academic and educational course of training is to make a student think accurately and consistently in a given field of activity, with some overflow of these faculties for living socially with other men, it appears that the time considered adequate for acquiring these attainments is too short to permit contacts with more than a small section of the chosen field. It may or may not be desirable to use little beyond laboratory work in such training, particularly for electrical engineers, but since in laboratory work economy severely restricts the materials and apparatus available for student use, and he cannot spend all his time wandering around works and other commercial examples of modern technique, it is clear that the function of the laboratory must be restricted to illustrate practically but effectively a selection of useful fundamental principles which inculcate faith in the wider field described in lectures and consolidated in exercises and design work. It is clearly the utilization of the most effective means within a given set of conditions, remembering that a student is most teachable when studying fundamental ideas illustrated by applications in which he is interested.

Returning to the book under notice, we find a large number of elementary experiments which are more suited to second year students than third year students as stated, assuming that they take final examinations at the end of the third year, which is not stated. We also find a considerable number of advanced electronic experiments which are more suited to an advanced physics course than an engineering course. We gather that the course is for communication or high-frequency engineers, but experience shows that these require a fair knowledge of the so-called power side, and there is none of this.

While the radio section is good, there is insufficient body in the middle grade of experiment, and the reader must conclude that a student may be left with a superficial idea of the practice in modern electrical communication. For example, the most used bridges in this field, the series-resonant bridge and the capacity and conductance bridge, and the most useful method of impedance measurement, up to very high frequencies, the hybrid-coil set, are not mentioned. In taking this course one would like to feel that every student has taken a certain number of the most important fundamental experiments and then devoted his time to something which is more extended, but selected so as to make a special appeal to him; but this is not suggested. Perhaps the choice is left to the able demonstrators who are always required for an advanced course. L. E. C. H.

Fondamenti della meccanica atomica

Per Enrico Persico. (Trattato generale di fisica a cura del Consiglio Nazionale delle Ricerche.) Pp. iii+510. (Bologna : Nicola Zanichelli, 1936.) 80 lire.

In the development of a comparatively new subject, such as quantum mechanics, advances are made by a few brilliant pioneers, each working on his own lines. At this stage it is very difficult for a student of average attainments to grasp the subject as a whole. We owe a deep debt of gratitude to Dr. Persico for undertaking the useful task of presenting, in a single volume of reasonable size, a unified account of all aspects of the subject.

The book is divided into three parts. The first, which is very easy reading, describes the fundamental experimental results, and the simple Bohr theory of the hydrogen atom. The second part opens with a mathematical discussion of orthogonal functions, and then develops Schrödinger's wave equation. The applications include the harmonic oscillator, the hydrogen atom, and other problems of a single particle. A good example of the author's skill in correlating his material is the way in which an approximate treatment of the wave equation leads on to the Sommerfeld conditions of the older quantum theory and their application to elliptic orbits. This order violates the historical development, but it makes things much easier for the student.

The third part is the most difficult. It opens with a discussion of functional and Hilbertian space, linear operators and matrices. It then explains Dirac's ideas of observables. After further developments of the matrix method, we pass to the theory of perturbations. Another chapter deals with relativity, spin, and Dirac's linear wave equation, and the final chapter with Pauli's principle. The book concludes with a bibliography and an index.

There are a few places where more advanced students would desire a fuller treatment, but the only serious defect of the book is that it is in Italian. Will some publisher consider the possibility of an English translation ? H. T. H. P.

Croydon Natural History and Scientific Society

Regional Survey Atlas of Croydon and District. Pp. 19+12 plates+Locator template. (Croydon : Roffey and Clark, Ltd. ; London : Thomas Murby and Co., 1936.) 12*s.* 6*d.*

For several decades, the Croydon and District Natural History Society has been to the fore in advocating the importance of regional survey. In the view of Mr. C. C. Fagg, such a survey need never be complete but can continue to record facts on outline base maps and the maps listed and classified according to a scheme which, in its decimal system, recalls the Dewey system for books. A start has been made with the publication of some of the material collected ; a substantial binder has been issued together with the classification scheme, specimens of the base maps (one covering a limited area on the one-inch scale, the other a larger area on the half-inch scale, both being reproductions of the Ordnance Survey maps in grey), a geological map and an outline on transparent paper, map of rivers, rainfall map and map of Roman roads. There are valuable notes on each map and a half-tone reproduction of Say's "Plan of Croydon" (1785).

This is a promising start, though regrets must be felt that so much of this material is available in maps of the Geological and Ordnance Surveys. Issues of new maps, to be distributed at a price varying with the cost, are promised from time to time. A glance at the classification scheme suggests that difficulties may arise—thus 82 includes land (tenure, ownership, utilization, value)—and that modifications may be needed. L. D. S.

Easy Methods for the Construction of Magic Squares

By Major J. C. Burnett. Pp. 77. (London : Rider and Co., 1936.) 2*s.* 6*d.* net.

It is rather difficult to describe this little book. It is in no sense a systematic discussion of the construction of magic squares. Rather it consists of a series of examples to show how, by the method of 'complementary differences', a variety of problems relating to these squares may be solved ; and it attempts no general theoretical discussion. Starting with the construction of an associated magic square of the fifth order, that is, one in which the sum of two numbers placed symmetrically with regard to the centre of the square is constant, the author proceeds to discuss bordered squares, magic rectangles and the like, in each case by particular examples. The language of the book is described as non-technical. This is a fair description, in the sense that the book lacks the precision of statement usually expected in mathematical works. For example, the use of the verb "to be" in the definition "Reversions are when the Squares are merely turned round . . ." is surely an archaism ; and there are several other places where, though the author's intentions are clear, his explanations do not conform to modern grammatical standards. J. A. Todd.

An Elementary Chemistry

By A. H. B. Bishop and G. H. Locket. Pp. 398. (Oxford : Clarendon Press ; London : Oxford University Press, 1936.) 4*s.* 6*d.*

This is a text-book written by teachers who have aimed at making the subject interesting and also are aware of the usual difficulties encountered by young pupils. It includes details of a number of instructive experiments which can be performed in the classroom or laboratory, and the many little hints given in these descriptions show that the authors appreciate the conditions under which the experiments will be successful. All teachers will be well advised to have a copy of this book, if for no other reason than the help they are likely to obtain from the descriptions of the experiments. Emphasis is laid on everyday aspects of chemistry and there are some excellent plates of industrial apparatus, etc. The text is clear and well arranged, and there is a good selection of examination questions. The treatment throughout is from the modern point of view and the arrangement of topics will be found to work well in actual teaching.

The Origin of Fahrenheit's Thermometric Scale

By Dr. J. Newton Friend

THE scientific world has recently paid tribute to the bicentenary of the death of the renowned German instrument maker, Daniel Gabriel Fahrenheit[1], who was born in Danzig in 1686 and died at The Hague on September 16, 1736.

Ever since the general acceptance of his thermometric scale, there has been much discussion as to why Fahrenheit chose such an apparently inconvenient numerical relationship as 32° and 212° for the freezing and boiling points of water respectively. Published opinions have differed widely. Martine, a contemporary of Fahrenheit, believed that, having once fixed his zero, Fahrenheit chose his scale in a purely haphazard manner, as explained later on. On the other hand, an entirely different view is put forward in Chambers' "Encyclopædia"[2], where we read :

"Fahrenheit took as his zero the lowest temperature then obtainable (from a mixture of salt and ice) and called the temperature of the human body 8°. Each degree was subdivided into 12 parts ; and subsequently these twelfths were taken as degrees. This made the temperature of the body 96° ; and it was found that the freezing point of water was 32°."

These illustrations will suffice.

Fresh light has been thrown on the problem by the recent discovery in the Military Medical Academy at Leningrad of certain letters sent by Fahrenheit to Boerhaave during the period 1718–29. These letters were written in Dutch at Amsterdam, and a literal translation of one of them into German, dated April 17, 1729, is given by the Cohens (*loc. cit.*)[1], which enables us to settle the question fairly satisfactorily.

It may be said at once that Fahrenheit did not choose 32° and 212° for the freezing and boiling points of water ; they were mere incidents on his scale, which was chosen independently of them and was based upon two fixed points, namely, a zero obtained by immersing his thermometer in a mixture of ice and sal ammoniac, and an upper point at blood heat, which Fahrenheit took as 96°.

The purpose of the present article is to attempt to explain :

(i) Why the above mentioned temperatures were chosen as bases of Fahrenheit's scale in preference to the freezing and boiling points of water ; and

(ii) why the upper fixed point was designated as 96°.

In order to answer these questions a knowledge of the early history of thermometry is necessary. A brief résumé is all that can be attempted in these columns.

The term thermometer appears to have been first used by Father Leurechon (1591–1670), a French Jesuit, in his work entitled "Récréation Mathematique", dated 1624. The credit of inventing thermometers with a liquid indicator (actually spirits of wine) hermetically sealed in a glass tube is usually given to Ferdinand II (1610–70), about 1650 ; he was Grand Duke of Tuscany, a liberal patron of science and founder of the Accademia del Cimento at Florence. Prior to these, air thermoscopes or baro-thermoscopes had been used for comparing relative changes in temperature. These were (probably) invented either by Santorio (1561–1656), professor of medicine at Padua and colleague of Galileo, or by Galileo (1564–1642) himself, about 1592. The utility of these thermoscopes was severely limited by their susceptibility to changes in atmospheric pressure. As no standard temperature scale was recognized, it was at first impossible, even with the Ferdinand or Florentine thermometers, to collate the results of different investigators. This very serious defect was soon realized, and steps were taken to find a remedy.

The Liquid Indicator

It was regarded by some as sufficient to select a single fixed point at an easily reproducible temperature and regard that as the zero or null point. Other temperatures were measured by noting the percentage or other fractional change in volume of the liquid indicator once the null point had been marked off on the thermometer.

Clearly the nature of the liquid medium was a matter of supreme importance, for, if the results of different investigators were to be collated, either the same liquid indicator must be used by all, or one possessed of an identical coefficient of expansion. Halley (1656–1742) directed attention to this, having observed that all liquids do not expand by similar amounts with rise of temperature[3]. Further, the exact volume of the liquid in the bulb of the thermometer must be known in order that the fractional volume change may be calculated and the temperature evaluated.

Boyle (1627–91) proposed *water*. He recommended taking a vessel of water and noting the volume of the liquid at the boiling point. On cooling to a lower temperature, the latter could be registered in terms of the contraction of the

water as parts per 10,000 of the boiling volume. But this suggestion did not find favour despite the abundance of water and the ease with which it could be obtained in a pure condition. Water was regarded as an unsuitable liquid indicator, for not only was its coefficient of expansion small as Halley pointed out[4], but also its freezing point was too high for many meteorological purposes, and it was for this kind of work that thermometers were largely required. Its irregularity of expansion with rise of temperature did not much matter; it would scarcely be noticed, for the general experimental error was high.

Newton[5] (1642–1727) used *linseed oil*, noting its volume at the temperature of melting ice and, like Boyle, expressing its change in volume as parts per 10,000. Martine[6] quaintly refers to his experiments as follows:

"Sir Isaac Newton thought the settling [of] the degrees of heat and cold well worth his notice; and as he carried everything he meddled [*sic*] with beyond what anybody had done before him, and generally with a greater than ordinary exactness and precision, so he laid down a method of adjusting thermometers in a more definite way than had been done hitherto."

But although linseed oil has a low freezing point and a large range of liquidity, its use in thermometry did not become general, despite Newton's fame as an investigator and the fact that the oil could be used at temperatures far above the boiling point of water. This was probably due to the fact, to which Martine directs attention, that, in consequence of its high viscosity, the oil drains very slowly, particularly at the lower temperatures, down the sides of the tube bearing the scale; the thermometer thus takes a long time to adjust itself to new conditions.

Ferdinand (*vide supra*) ordered his thermometers to be made with *spirit*; Boyle was quick to appreciate their merits and introduced them into England. Referring to them, Martine says they "came immediately to be of universal use among the virtuosi in all the several countries, wherever polite learning and philosophy were cultivated". The scale divisions were approximately one fiftieth of the volume of the bulb. Sagredo[7] used 360 divisions, like the graduation of a circle; hence the term degree, as applied to temperature.

The low freezing point and viscosity of spirit were excellent features, but a really serious difficulty lay in the fact that the coefficient of expansion was found to vary greatly with the quantity of admixed water. Réaumur, as we shall presently see, made use of this property when devising his scale some years later.

Fahrenheit favoured the use of *mercury* as well as of spirit; indeed he was the first to bring the mercurial thermometer into general use.

Martine, as has already been mentioned, believed that Fahrenheit chose his scale in a purely haphazard manner, using mercury as indicator. He records that Fahrenheit took a volume of mercury measuring 11,124 parts when cooled in ice and sal ammoniac; 11,156 parts in melting ice—a rise of 32 parts or degrees; and 11,336 parts in boiling water—a rise of 212 degrees *in toto*; whence his scale. Martine[8] then comments on the extremely arbitrary character of the scale, adding, "I confess there might have been a more convenient one fixed upon at first". We agree.

Martine quotes as his authority Hermann Boerhaave (1686–1738), professor of medicine and chemistry at Leyden, from whose work entitled "Elementa Chemiae"[9] the above accounts were taken. There is evidently a misunderstanding here for, in view of Fahrenheit's letter to Boerhaave discussed below, it does not seem at all possible that this could have been the origin of his scale. It is more probable that, if Fahrenheit did carry out this experiment, the particular volume of mercury was deliberately chosen because it would give the necessary expansion to fit in with his own already existing scale.

Selection of Fixed Points

Some investigators, Martine included, advocated the use of a thermometric scale based upon two fixed points instead of one only. Any suitable liquid could then be used as indicator, and the necessity no longer existed for determining with great accuracy the volume of the bulb of the thermometer. All that one had to do, and this was comparatively easy, was to note the levels at the two fixed points and divide the distance between them into as many parts or degrees as was held convenient. Newton and Ole Rœmer (see below) appear to have been the first to devise such scales prior to 1703.

Numerous suggestions were made for the selection of fixed points. Boyle[10] recommended the freezing point of oil of aniseed (17°–20° C.) as zero, because it was not necessary to wait for frosty weather before it solidified. Halley thought a cave might be selected where summer and winter temperatures are alike; one such cave was known to Boyle, and Mariotte[11] claimed that the cave under the Royal Observatory at Paris was also isothermal. Newton chose the freezing point of water as his zero.

Boyle[12] was aware that an intense cold could be produced by mixing ice and salt. Ole Rœmer (1644–1710), the Danish astronomer famous for his measurement of the velocity of light from a study of the movements of Jupiter's satellites,

used this mixture or a similar one (ice and sal ammoniac, see later) in obtaining his zero, which was regarded as the lowest temperature then attainable in the laboratory. Some years later, Fahrenheit adopted the same zero, and has hitherto, but incorrectly, been regarded as its originator.

Boyle's suggestion is ruled out because oil of aniseed is a natural product and as such does not possess a fixed composition; its melting point is thus liable to vary. For geographical reasons, Halley's idea is impracticable, as a particular cave could not be visited by everyone desirous of checking his thermometer.

Newton's idea appears to be the simplest and most convenient. Why, then, was it not generally adopted?

The reason seems to be that scientific investigators believed the freezing point of water was not constant, but varied with the latitude, Halley and others asserting that, the farther north we go, the more cold is required to freeze the water—to use the then current phraseology.

Martine[13] refers to this, and appears to have been the first to show that such is not the case. He rightly attributes the observed differences in the freezing point of water either to inaccurate observation or to the use of imperfect thermometers. He says that he marked the mercury level on a thermometer at Edinburgh, when immersed in snow and water, whilst a friend did the same with another thermometer in London. They then exchanged instruments and tested them, finding them to agree perfectly. Evidently the difference in latitude between the two cities had not affected the freezing point. Later experiments as far south as Paris and Dijon yielded similar results.

For his upper fixed point Newton chose blood heat; this was regarded as absolutely constant for a healthy person. He designated this temperature as 12°, probably because the number is easily subdivided and remembered, as there are 12 inches to the foot; the decimal system was not in general use in scientific work. As we have seen, his 0° was obtained in melting ice.

In "Adversaria", which was printed in 1910, the MS. having been mislaid for about 200 years[14], Rœmer gives an account of the construction by him of a standard thermometer in 1702–3. The scale of this thermometer was based upon *two* fixed points, the upper one being the boiling point of water, which he designated as 60. In checking his thermometers he used this temperature and, for convenience, possibly also for greater accuracy, the melting point of snow or crushed ice. This latter temperature, however, was not his zero, but fell on his scale at $7\frac{1}{2}$ degrees. According to Fahrenheit, Rœmer also used blood heat in checking his thermometers, presumably when intended for meteorological use, as it was not necessary for these to be graduated to so high a temperature as the boiling point of water. In his letter to Boerhaave dated 1729, to which reference has already been made, Fahrenheit states that he met Rœmer in Copenhagen in 1708 and saw him testing some thermometers by placing them first in ice and water and afterwards into water at blood heat. The scales on the instruments were divided into $22\frac{1}{2}$ parts, beginning at 0. When placed in iced water the reading was $7\frac{1}{2}$; at blood heat, $22\frac{1}{2}$. How the zero was obtained is not definitely stated either in "Adversaria" or in Fahrenheit's letter, but simple calculation shows that it corresponds roughly to the temperature of a mixture of salt and ice. This is supported by the fact that Fahrenheit then goes on to say that he himself later adopted the same temperature scale but with this small difference, namely, that he divided each of Rœmer's divisions into quarters, presumably for ease of reading. Evidently, therefore, Fahrenheit adopted the same zero, and this, he had stated[15] in 1724, was obtained "by the commixture of ice, water and sal ammoniac, or even sea salt". From the fact that he quotes sal ammoniac and sea salt as alternatives we gather that Fahrenheit supposed they yielded the same temperature with ice. We now know that their cryohydric points are $-15°$ C. (or $+5°$ F.) and $-22°$ C. (or $-8°$ F.) respectively. Nevertheless, Fahrenheit did realize that there was a difficulty in reaching the true zero, for he naïvely remarks that "if into this mixture the thermometer be put, it descends to 0. This experiment succeeds better in winter than in summer"!

We wonder what the toleration of his thermometers would amount to. Martine mentions[16] that he had occasion to test some Dutch mercurial thermometers, but found them in error by one or two degrees.

Halley[17] recommended, for the upper fixed point, the boiling point of spirit of wine,

> "only it must be observed, that the spirit of wine used to this purpose, be highly Rectified or Dephlegmed for otherwise the differing goodness of the spirit will occasion it to boil sooner or later, and thereby pervert the designed exactness".

Several workers recommended the boiling point of water as the upper fixed point, using the freezing point as zero. Martine favoured this idea and it was acted upon by René de Réaumur (1683–1757), the French scientist, who found that the best spirits of wine of his day expanded by $87\frac{1}{2}$ parts per 1,000 when warmed from melting ice to boiling water[18]. Equal parts of his spirit and water gave an expansion of $67\frac{1}{2}$. He therefore for simplicity chose such a mixture as expanded by

80 parts. Hence the Réaumur scale runs from 0° to 80° between those two temperatures. The choice was not accidental, as we frequently read, but by design.

In 1736 Celsius (1701–44), in contrast to previous workers, favoured the decimal system and divided the same interval into 100, thus giving us the Centigrade thermometer. At first he denoted the freezing point by 100 and the boiling point by 0, but this scale was afterwards inverted.

It was known to Martine[19], to Fahrenheit and possibly also to Boyle that the boiling point of water varies with the pressure. This, however, was not regarded as a serious drawback to its use as a fixed point because, as Martine states,

"in ordinary changes of the weather, the difference is not very great. And farther, we may avoid all errors that might arise from anything of that sort, if we make our observations on the heat of boiling water, and adjust this term of heat at a middle state of the atmosphere in places near the level of the sea, when the quicksilver in the barometer stands at about 30 inches, or a very little under it. And the same caution will be necessary in judging the heat of boiling spirit of wine, or of the boiling heat of any other liquid."

The Fahrenheit Scale

We have seen that Fahrenheit, on his own admission, based his scale on that of Rœmer. This confirms the conclusion to which Kirstine Meyer[14] had already come in 1910, after examining the scales on some early Fahrenheit thermometers and collating various statements in contemporary literature.

If we ask what were the features of Rœmer's scale that attracted him and led him to reject the freezing and boiling points of water as his zero and upper fixed point respectively, the answer is undoubtedly to be found in the fact that the majority of his thermometers were intended for meteorological purposes.

The freezing point of water is relatively high, and if taken as zero involves the repeated use of negative values for winter temperatures. By using the then lowest attainable temperature as zero—the "absolute zero" of those days—all the meteorological readings would be positive. Fahrenheit probably objected to the conception of a negative temperature, just as we do to-day in regard to our own absolute scale.

As regards the upper fixed point, the temperature of boiling water was rejected as being unnecessarily high for meteorological purposes and inconveniently high for spirit thermometers. Fahrenheit states[20] that he was accustomed to use the same fixed points for all his instruments, whether spirit or mercury, when intended for meteorological purposes.

Fahrenheit went on to say, in his letter to Boerhaave, that in 1717 he felt Rœmer's scale with its fractions to be both inconvenient and inelegant; so instead of 22½° divided into quarters, that is, 90, he decided to take 96° as blood heat. Retaining the same zero, the melting point of ice became 32°, instead of 7½° divided into quarters, or 30. This scale he continued to use and was using at the time the letter was written (that is, in 1729); he added that he had been confirmed in his choice because he found it to agree, by pure coincidence, with the scale marked on the thermometer hanging in the Paris Observatory.

Fahrenheit gave no reason for regarding the number 96 as more convenient than 90. Probably it was due to the fact that 96 is divisible not merely by 3 but also by multiples of 2 and hence by 12. The decimal system was not then in general use in scientific work, otherwise Fahrenheit would no doubt have fixed blood heat at 100°. In that case the freezing and boiling points of water would have been represented by numbers even more awkward and disconnected, namely, 33·3° and 221° respectively. So let us be thankful.

Although we retain a Fahrenheit scale to-day, it is not quite the same as that which Fahrenheit used. The lower and upper fixed points adopted are those deliberately rejected by Fahrenheit, ice being taken to melt at 32° and water to boil under standard conditions at 212°.

In conclusion, I gladly express my indebtedness to Mr. H. W. Robinson, librarian of the Royal Society, to the staff of the Birmingham Public Library and last, but by no means least, to my friend Mr. F. W. Clifford, librarian of the Chemical Society, for their kind assistance whilst I have been examining the early documents referred to in this article.

[1] See Cohen, E., and Cohen-De Meester, W. A. T., *Kon. Akad. Wet. Verhand.* (Eerste Sectie), **16**, No. 2, pp. 1–37. Amsterdam, 1936. See NATURE, **138**, 428 (1936).

[2] New Edition, by Patrick and Geddie, **10** (1927), under "Thermometer". A similar view is put forward by Higgins, *J. Roy. Soc. Arts*, **74**, 946 (1926).

[3] Halley, *Phil. Trans.*, Lowthorp's Abridged Edn., **2**, 33.

[4] Halley, *loc. cit.*, **2**, 34.

[5] Newton, *Phil. Trans.*, 824 (1701). The paper, which is anonymous, is entitled "Scala graduum Caloris", and appears in Latin. See also Brewster, "Life of Sir Isaac Newton", **2**, 362–8 (1855).

[6] Martine, "Essays on the Construction and Graduation of Thermometers". (New edition, Edinburgh, 1792.) The first essay, from which these and succeeding quotations are taken, is dated 1738.

[7] Sagredo. See "The Times Century Dictionary" under "Thermometer".

[8] Martine, *loc. cit.*, p. 30.

[9] Two volumes, dated 1732. See **1**, 174, also 162–165.

[10] Boyle, "An Experimental History of Cold", 39 (1665).

[11] *Phil. Trans.*, Lowthorp's Abridged Edn., **2**, 36.

[12] Boyle, *loc. cit.*, 156.

[13] Martine, *loc. cit.*, p. 15.

[14] See Kirstine Meyer, NATURE, **82**, 296 (1910); also "Adversaria" by Thyra and K. Meyer (Köbenhavn, 1910), reviewed NATURE, **86**, 4 (1911).

[15] Fahrenheit, *Phil. Trans.*, **33**, 78 (1724). Printed in Latin. This quotation is from *Phil. Trans.*, Hutton's Abridged Edn., **7**, 22–24.

[16] Martine, *loc. cit.*

[17] *Phil. Trans.*, Lowthorp's Abridged Edn., **2**, 35.

[18] Réaumur, *Mem. Acad. Roy.*, 452 (1730).

[19] Martine, *loc. cit.*, 10.

[20] Fahrenheit, *Phil. Trans.*, **33**, 78 (1724).

The Ancestry of Insects*

By Dr. A. D. Imms, F.R.S.

THE insects are unknown in their original or primitive manifestations and consequently their ancestry is wrapped in obscurity. The subject can only be approached by the co-ordination of whatever evidence may be gleaned from three principal courts of appeal—comparative morphology, embryology and palæontology. Of these, palæontology has, so far, remained almost like a closed book : no annectant forms bearing directly upon the problem have been disclosed in the strata of any geological period. Without this necessary record of the past, the links in the evolutionary chain are deductions based mainly upon morphology and development. For a considerable time past, the two most plausible theories of insect descent have been those which involved either the Crustacea or Symphyla as ancestors. The Crustacean theory, which is based no external structure, is losing ground, while that involving the Symphyla has remained in much the same status that it acquired in the days of Packard.

The most important evidence bearing upon insect ancestry that has come to hand during the last thirty years or more was Silvestri's[1] discovery, in 1903, of the remarkable thysanuran *Anajapyx* ; since that date, no revelation of comparable significance has been made. While this discovery added weight to the symphylan theory, Packard's conclusion of 1898[2] still holds good to-day. This writer stated that *Scolopendrella* is the only extant arthropod, which, with the sole exception of being progoneate, fulfils the conditions required of an ancestor of the Thysanura and, through them, of the winged insects. In 1930, Tillyard[3] brought forward a theory which claimed that the Insecta were derived from remote hypothetical nauplioid ancestors ("Protaptera") : they arose separately from the Symphyla and other Myriapoda which, he maintained, had a similar origin. The symphylan theory was rejected by this author owing to the old crux of the segmental location of the gonopore.

The contention of the present communication is that the symphylan theory is substantiated by a larger body of evidence than any other explanation of insect descent. In considering this theory, it needs to be stressed that it is generally accepted to-day that among the Thysanura are found the most generalized of all insects : *Lepisma* and its allies are the forerunners of the Pterygota, while *Anajapyx* and *Campodea* are more nearly related to the ancestral insects. The old phylogenetic importance of *Campodea* has now been largely eclipsed by *Anajapyx* with its greater display of symphylan characters. Since *Anajapyx* provides an essential link in the present theory, these characters need to be recounted. They include simple multi-articulate antennæ : styli and eversible sacs on most of the abdominal segments : cerci bearing the orifices of large posterior glands : mouth-parts built on an essentially similar plan : an identical leg-segmentation with single-jointed tarsi : a simple digestive canal with homologous salivary glands and the same fundamental type of excretory organs. A second link in the chain is provided by embryology. The lower insects pass through a developmental phase revealing fourteen postcephalic segments, each bearing limb rudiments. This phase can only be interpreted as a relic of a former polypodous condition. On turning to the Symphyla, it will be noted that they reveal, in their adult structure, close resemblance in metamerism as evidenced by the appendages : namely, twelve pairs of legs, the thirteenth pair transformed into sensory processes and the fourteenth pair, as in insects, represented by cerci. Thus it seems very possible that the Insecta recapitulate what may be regarded as a symphylan stage in their development.

In the derivation of the Insecta from symphylan ancestors, it would appear that three main evolutionary changes were involved. (1) The development of a segmental tracheal system. (2) Concentration of the locomotory function in the first three postcephalic segments, with the consequent reduction of the appendages of the remaining segments (other than cerci) to a vestigial condition. (3) The development of posterior gonoducts opening between the tenth and eleventh postcephalic segments, together with the atrophy of the original ducts. (1) and (2) require little comment since they are evidenced in the development of the lower insects and in the adult structure of the Thysanura. In connexion with (3), it is noteworthy that a shifting backwards of the genital apertures during development is a common feature among many orders of insects. Furthermore, new (or secondary) genital passages and

* The present article is an abbreviation of one bearing the same title (*Trans. Soc. Brit. Entom.*, 1 ; 1936) the main features of which formed the subject of a presidential address given to the Society for British Entomology, at a congress held in Cambridge on June 26–29, 1936.

orifices have been acquired among Lepidoptera, Strepsiptera and in the Hemipterous family Cimicidæ. The postulation of a change from a progoneate to an opisthogoneate condition refers, therefore, to the evolution of a class wherein diverse modifications of the genital conduits are a prominent feature. The Insecta are peculiar in that the egg-follicles are disposed in a linear series forming ovarioles, while at the apex of each ovariole is an end-chamber (or germarium) containing the undifferentiated germ cells. In other arthropods no such arrangement into ovarioles prevails and the germarium is located parietally. It will be evident that structural modifications of the gonads must have been involved during the evolution of the Insecta, and, it is claimed, that these changes occurred in association with the development of posterior gonoducts.

So far, the Protura and Collembola have been omitted from discussion: they are side developments off the main line of insect descent. The Protura show a predominance of hexapod features, suggesting that the early evolution of this group was with the rest of the Insecta. Afterwards they diverged as a specialized side branch but retained the primitive trait of anamorphosis. The Collembola display both myriapodan and insectan characters. Owing, possibly, to the paucity of yolk, which has induced holoblastic segmentation, development became arrested and only nine trunk segments formed. In the absence of ovarioles and retention of the parietal germarium, together with the general simplicity of the gonads, the Collembola betray close resemblances to the Symphyla. The possibility that traces of a former progoneate ancestry are revealed in Collembola, as mentioned by Claypole[4], needs further investigation; evidence of such ancestry also requires exploration among other Apterygota.

Re-examination of the symphylan theory seems, therefore, to establish it as the only adequate explanation of insect descent. In view of the many fundamental similarities between the Symphyla and Thysanura, it is claimed that these two groups arose from a common stock, not very different from living forms of Symphyla. Theories involving separate origins for the two groups in question, on the grounds of disparity in the segmental locations of the gonopores, have to fall back upon the improbable hypothesis of convergence to account for their community of structure. If the propositions now advanced serve to focus attention upon aspects of the problem hitherto neglected, they will have fulfilled their purpose.

[1] *Ann. della Scuola Sup. di Agric. in Portici*, **5** (1903); *ibid.*, **6** (1905).
[2] Packard, "Text-book of Entomology", 22 (1898).
[3] *Pap. Roy. Soc. Tasm.*, 1930; and NATURE, **126** (1930); this theory was partially recast in *Amer. J. Sci.*, **30**, 438 (1935).
[4] *J. Morph.*, **14**, 239 (1898).

The Recent Floods in the United States*

By Dr. C. E. P. Brooks

THE Mississippi and its tributaries together drain about half the area of the United States. The Mississippi itself runs through the centre of the country, the Missouri rises in the Rocky Mountains and the Ohio in the Allegheny Mountains. The upper courses of the Mississippi and Missouri lie in relatively dry regions, where moreover the winter precipitation is mainly in the form of snow. The Ohio, on the other hand, runs through a region of comparatively heavy rainfall, and is much more liable to flooding.

During the last few months of 1936, the rainfall in the valley of the Ohio and the Mississippi above Memphis had been abnormally heavy, the total for the months September–December being nearly one and a half times the normal. Thus at the beginning of January, the ground was waterlogged and there was already minor flooding in some of the tributaries of the Ohio. In January a type of pressure distribution developed which was very favourable to prolonged heavy rain (Fig. 1). Pressure was high off the east coast of the United States, and decreased steadily westwards. This was associated with a current of warm moist air blowing from the Caribbean Sea and the Gulf of Mexico across the eastern half of the United States. Above this warm and very moist south-easterly wind was an upper current from the west, which was relatively cool. The air was therefore highly unstable. Farther north, over the Great Lakes and southern Canada, pressure decreased northward, and the westerly current descended to ground-level. The encounter of the warm moist south-east wind with this great barrier of colder air from the west gave all the conditions necessary for heavy and prolonged rain, which was localized by a series of depressions travelling from south-west to north-east along or near the line of the Ohio Valley.

* Paper read before the Royal Meteorological Society on February 17.

The rainfall was abnormally heavy, exceeding four times the January normal between Cincinnati and Cairo, the totals for the three weeks January 6–26 reaching 12 inches at Cincinnati and 16 inches at Louisville farther down the Ohio*. The latter river rose steadily along its whole length, the rise being hastened by the abnormally high temperatures, which prevented any accumulation of snow or ice. The main stream of the Ohio was in flood on January 10, and by January 19 the floods were general. From that date conditions rapidly became disastrous. The official "flood stage" at Cincinnati is a level of 52 feet, and the highest level on record was 71·1 feet, which occurred on February 14, 1884. This record was passed on January 23, and on January 26 the level stood at 80 feet. Previous records were exceeded at all stations on the Ohio below Parkersburg, and on the Mississippi from Cairo to at least Memphis.

The crest of the flood reached Cairo, at the junction of the Ohio and Mississippi, early in February, the highest level being about 60 feet. This is nearly four feet higher than the highest crest of the great flood of 1927, which itself constituted a record. The defences of Cairo have, however, been greatly strengthened during the past ten years, and although the city was isolated and abandoned by most of the inhabitants, it did not suffer so severely as in 1927. It lay precariously in a hollow surrounded by water up to the level of the house-tops, and some damage was caused by water forcing its way through an underlying bed of sand and coming up in sudden 'sand-boils'. Farther down the Mississippi, the chief danger areas are along the tributaries entering the main river below the Ohio. These cannot be completely protected by levees, and the water floods back up them, and over the surrounding country. As a measure of precaution, thousands of people were evacuated from their homes along these tributaries in Arkansas, Louisiana and Mississippi.

By about February 5, the cities of the Ohio Valley were able to resume normal activities and the level had begun to fall at Cairo. The flood crest was now making its way slowly down the main Mississippi; but the levees were being strengthened at all danger spots, and the engineers were confident that they would hold. On February 9 the river at Memphis reached a level of 48·7 feet, more than two feet higher than in 1927, without breaking its banks. On February 10 the level at Helena, Arkansas, was about three feet above the previous record. After that date, however, the levels began to fall steadily and no further danger was anticipated.

The flood of 1937 differed from that of 1927 mainly in the area of greatest damage, which was limited to the Ohio valley instead of extending widely over the whole Mississippi below Cairo. In 1927 the Ohio valley was much less affected than in some earlier floods, especially those of 1883 and 1907. The Ohio valley is narrower and steeper than that of the lower Mississippi, and the Ohio floods both set in and pass away comparatively rapidly. This is shown by the speed of the flood crest, which normally exceeds 50 miles a day on the Ohio from Cincinnati to Cairo, compared with about 23 miles a day along the Mississippi from Cairo to Helena. The crest of the 1937 flood appears to have travelled even more rapidly, 80–90 miles a day, and this flood was therefore a relatively sudden affair, lasting less than a month. The floods of 1927 continued for two months at Cincinnati, but four or five months at Memphis and Helena.

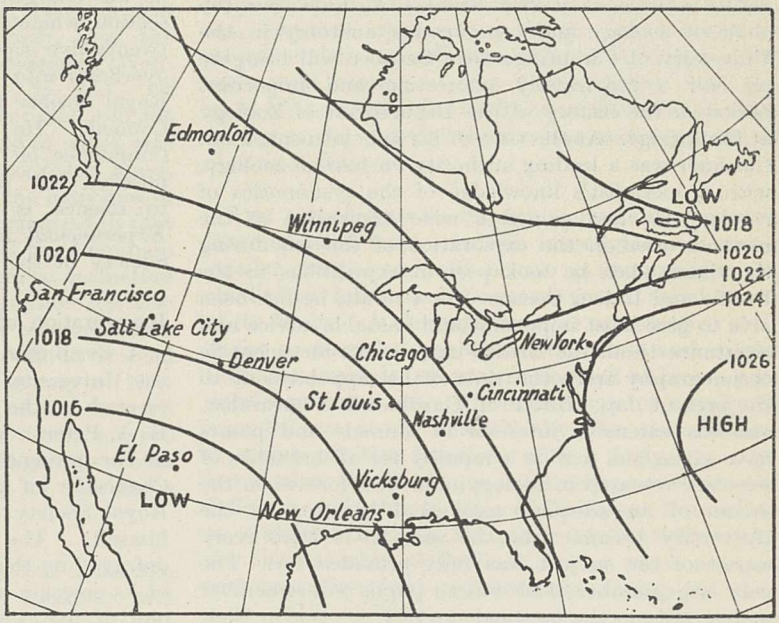

Fig. 1.

DISTRIBUTION OF PRESSURE OVER THE UNITED STATES IN JANUARY.

The great cities of the lower Ohio valley suffered severely during the recent flood. In Cincinnati and Louisville the level of the water reached to the tops of many of the houses. The supply of drinking water broke down and there was grave risk of typhoid, which actually broke out in Louisville. Petrol floating on the water became

* See map in NATURE, Feb. 6, 1937, p. 227.

ignited, and there were several outbreaks of fire. About a million people were homeless, and though the loss of life was probably not more than five hundred, the material damage amounted to hundreds of millions of pounds.

The meteorologists at least have not been found wanting, and it is fitting to conclude this brief account with a reference to the work of the United States Weather Bureau. The forecasts of the times and heights of flood stages were of incalculable assistance throughout to the patrols and rescue organizations. Without these warnings, the loss of property, and still more of life, would have been enormously greater.

News and Views

Prof. J. Stanley Gardiner, F.R.S.

THE retirement of Prof. Stanley Gardiner from the chair of zoology and comparative anatomy in the University of Cambridge next October will bring to an end a remarkably interesting and important period in the history of the Department of Zoology at Cambridge. At the time of his appointment, Prof. Gardiner was a leading authority on marine zoology, with a specialist's knowledge of the systematics of corals. He had gained a wide knowledge of the methods used in the exploration of the sea during the times when he took part in expeditions to the Pacific and Indian Oceans. As a result, he has been able to give most important and valuable advice and assistance to all the British expeditions for scientific oceanography from the time of his appointment to the present day. But Prof. Gardiner is a naturalist, and his extensive interests in animals and plants have given him a wide sympathy for all branches of scientific research in zoology, and therefore when the dream of an adequate zoological institute in the University became true, he saw to it that every aspect of the subject was fully provided for. The very large number of his former pupils will remember with gratitude the personal interest he took in their work, and the kindly advice and help he gave them at the outset of their careers.

Dr. J. Gray, F.R.S.

Prof. Stanley Gardiner will be succeeded by Dr. James Gray, who was one of his pupils when he became professor in 1909. Dr. Gray has had a varied career. He was demonstrator of zoology before the Great War, carrying out research on fertilization of echinoderm eggs. Then he saw war service from August 1914 until the peace, serving in France and Palestine, attaining the rank of captain and being awarded the *M.C.* Returning to Cambridge, he became Balfour student, commencing a long line of research on ciliary movement, in which he and his pupils are still interested. Lecturer and reader in turn, by a natural evolution he passed onwards to a comprehensive study of the physiology of animal locomotion, being especially interested in fish. In 1928, he was visiting professor at Columbia University. His share in the rebuilding of the whole Zoological Department at Cambridge was great, and in particular he was charged with the design of the experimental section, which contains, besides a teaching laboratory, twenty-five separate research rooms and at present overflows into the whole building. Elected to the Royal Society in 1929, he is now a member of the Council. He is also a member of the Advisory Committee on Fisheries of the Development Commission, but perhaps his greatest public service to science is in the editing of the *Journal of Experimental Biology*, which is associated with the Society of the same name.

Inauguration of an Ultra-centrifuge at Oxford

A SVEDBERG ultra-centrifuge, generously lent to the University of Oxford by the Royal Society and erected in the Department of Biochemistry (Prof. R. A. Peters), was formally set going on February 27 in the presence of a large company by the Vice-Chancellor of the University, the president of the Royal Society and Prof. The Svedberg of Uppsala himself. The cost of the complete instrument, defrayed by the Royal Society, was £2,000. The cost of its erection has been met by the University. It is one of five similar instruments, the third outside Sweden—two are at Uppsala, one in London at the Lister Institute of Preventive Medicine, and another in the United States. It is designed for the determination of the rate of sedimentation of particles of very high molecular weights. The rotor, of a nickel-chromium steel found after many trials to stand the great strain put upon it, is supported by bearings of Babbitt's metal and driven by two small oil turbines, one at each end of the shaft, which give a smooth and easily regulated run. The rotor moves in an atmosphere of hydrogen of about 25 mm. pressure. Rotation speeds, determined electrically, up to 65,000 revolutions per minute (equal to about 300,000 times gravity) can be safely attained. The solution to be centrifuged is contained as a thin column in a cell with quartz windows carried, and suitably balanced, on the rotor. The height of the column, which is about 7 cm. from the centre of rotation, does not generally exceed 27 mm. The position of the moving boundary of the particles sedimented during a run of the ultra-centrifuge is determined from photographs obtained at suitable

intervals with a camera with a lens of very great focal length, the source of light being a mercury lamp. The ultra-centrifuge, which will be available for any research worker in the University, is, under the direction of Prof. R. A. Peters, in the charge of J. St. L. Philpot, Balliol College. He will employ it in a general investigation of enzymes as proteins, and particularly to see how the alteration by chemical reaction of certain groupings on the enzyme affects the stability of the particle itself.

Scientific Research in New Zealand

THE tenth annual report of the New Zealand Department of Scientific and Industrial Research covers the year 1935–36, and in addition to the Minister's statement and the Secretary's report, includes reports of the various research committees as well as of the Dominion Laboratory, the Geological Survey Branch, Meteorological Branch, and the Dominion, Apia, and Magnetic Observatories (Wellington: Government Printer, 1936. 2*s*. 3*d*.). Of the expenditure of £91,344 during the year, £46,306 was on research investigations, £11,225 of which was for industries and £21,360 in the Consolidated Fund. Plant research plays a large part in the activities of the Department, and has now been organized so that each Division is situated in the part of the Dominion most affected by its activities. General co-ordination of the work on animal health and nutrition has also been effected, and it is hoped that a comprehensive scheme of attack on these problems will be evolved during the year. A systematic soil survey of New Zealand is in progress and a survey of the tung oil industry will shortly be undertaken. Soil surveys form an important part of the investigations which are being made in the development of the citrus industry.

THE first organization to be established under the Department was the Dairy Research Institute, and this has already attacked with success certain major problems in the manufacture of butter and cheese. Strains of starter bacteria which afford the best type of Cheddar cheese have been isolated, and much information on the action of bacteria in the ripening of cheese has been accumulated. Valuable research by the Wheat Research Institute has resulted in the breeding of a new hybrid which avoids the necessity of importing strong wheats for blending purposes. An outstanding feature of the fruit research in the year has been the proving of a successful method of controlling corky-pit disease of apples by the application of boron compounds. Steps are being taken to establish research associations for various industries on the lines of those in Great Britain and also to establish a general bureau of technical information for industry. Recently the Government has taken over the responsibility for the development of industrial standards. The work of the Meteorological Office has been considerably affected by the inauguration of regular air services in New Zealand, and the system of weather observation and reporting is being considerably increased.

League of Nations and Nutrition

AT a meeting of the Expert Committee on Nutrition set up by the Committee of the League of Nations, held on December 8–10, 1936, under the chairmanship of Prof. H. Laugier, methods and results obtained as an outcome of the report on the physiological bases of the subject and a programme of research outlined, were compared and a plan of action established. Agreement was reached as to the technical methods to be applied, and a plan of future studies for co-ordination by the Health Organization was drawn up. Three methods are recommended for assessing the state of nutrition of children of pre-school age and school age and of adolescents. The first method is essentially suitable for practical work, such as the determination of the state of nutrition of large numbers of children, and for this purpose the preparation of record cards giving particulars of age, sex, physical appearance, weight and height is recommended, as well as a clinical examination of each child bearing on the colour of the skin, the state of the teeth, the condition of the subcutaneous fat layer, the state of the muscles and any signs of abnormal fatigue.

THE second type of inquiry is intended for more thorough and more scientific investigation covering smaller groups, and will include an inquiry into the child's food intake and the economic and social status of its family. A thorough medical examination and, so far as possible, special measurements and special tests, for example, on protein content of blood, pre-deficiency tests, etc. The third type of inquiry is intended to study scientifically the disturbances to which all the functions of the body are subjected when the diet is quantitatively or qualitatively deficient. A further meeting of the Expert Committee on Nutrition held on December 11–12, 1936, under the chairmanship of Prof. E. Gorter was concerned with nutritive food requirements during the first years of life. These requirements were defined as regards calories, proteins, vitamins and iron, indicating to what extent milk, cereals, vegetables, eggs, meat and broth should be used to provide a suitable diet for infants, and remarks on the quality and preparation of food were also made.

Science and Social Problems

A RECENT broadsheet issued by Political and Economic Planning (PEP) directs attention to the welcome evidence afforded by the malnutrition controversy of the recognition that science can make important and indispensable contributions to the solution of social problems. The present broadsheet merits attention not merely as presenting a concise summary of experiments and studies bearing on the known facts of nutrition, but also for a helpful discussion of the main points of controversy or misunderstanding. This is particularly true of its efforts to disperse some of the confusion caused by the use of the word 'malnutrition' in several different senses. Available evidence shows that even in the lowest income groups, shortage of calories cannot affect

more than a small number of persons. On the other hand, shortage of protective food elements affects many millions, and the effective absorption as well as the actual consumption of essential food elements requires consideration. Since this is affected, for example, by exercise and fresh air, these may also be ancillary factors in nutrition. The most serious and widespread form of malnutrition at the present time in Great Britain is probably the deficiency of calcium among children and adolescents, but there is also insufficient consumption of fresh fruit, vegetables and fats, although in the present state of knowledge the deficiency cannot be measured. The most pressing nutritional needs are, however, clearly indicated, and Government and industry carry a heavy responsibility for taking the necessary steps to meet these needs. Not the least valuable feature of this admirable broadsheet is a list of reports and books on nutrition.

Roman Leicester

LEICESTER has saved her Roman remains. At a meeting of the City Council held on February 23, it was decided that the site of the Roman Forum, recently discovered in the course of the excavations carried out by Miss Kathleen Kenyon (see NATURE, **138**, 356, 432) should be preserved as an open space for all time. As the site is centrally situated and had been chosen for the erection of municipal baths, it will be widely appreciated that the citizens of Leicester by this decision have shown a generous public spirit in their attitude towards the claims of the past and a consciousness of their obligation to the nation at large and to posterity, which is worthy of all praise. Of this monument, unique in Britain, the excavations have now proceeded to a point which reveals two sides of the Forum with one of the flanking streets; while it has been shown that the famous "Jewry Wall", one of the largest pieces of Roman work in England, was part of the west wall of the basilica. In later times this became a place of Christian worship, and in the early medieval period the Jewry Wall itself was utilized as the west end of a church. Tiles and bricks from the Forum were used in the construction of the adjacent late Saxon church of St. Nicholas, itself one of the notable monuments of Leicester. It has been pointed out that in declaring that this area shall remain in perpetuity an open space, the Council preserves in the heart of the city "the veritable birth-place of her commerce, her self-government, and her religion"; but in fact it does even more. For Miss Kenyon in the course of her excavations has discovered traces of pre-Roman settlement, which may well go back to the original British village founded on the banks of the Soar. The City of Leicester is to be congratulated on a decision which will earn the gratitude of all who are interested in the preservation of such relics of the past.

An Experiment in Science Teaching

IN discussing some time ago certain aspects of university science teaching (NATURE, **129**, 773–5; 1932), doubts were expressed of the present-day necessity for, or desirability of, extensive spoon-feeding lecture and laboratory courses in universities. In proposing some changes, a plea was made for incorporating into science teaching some instruction in scientific method. An interesting development on these lines is being carried out by Prof. A. J. Riker in the University of Wisconsin in a laboratory class in plant pathology. Instead of using the same set of exercises repeated by each member of the class, the routine laboratory manipulations are acquired in carrying out simple investigations. Most members of the class work on different subjects, and compare the results freely. When a piece of work has been completed, a time is arranged and the student gives a short account and demonstration, after which the results are discussed by the other members of the class.

To facilitate the supervision, Prof. and Mrs. Riker have published in a limited edition "An Introduction to Research on Plant Diseases" (Madison, Wis.: Prof. A. J. Riker, College of Agriculture, University of Wisconsin, 1936. 2.65 dollars), giving a short account, with references to selected original papers, of the methods usually needed. Some of the chapters serve to guide the student in making his own systematic search of the literature before starting experimental work in the laboratory, in formulating his problem and his proposed plan of work clearly and in preparing an adequate report of the results. The more a method of teaching departs from a formalized routine, the more does its effect depend upon the actual supervisor, who must judge how much and how little help may be given to each individual. Much experience and analysis are then necessary before a supervisor may be able to help others to apply his new methods. Not infrequently in pioneer work the 'right' course of action may be adopted for what others may regard as a 'wrong' reason or rationalization. Since, however, there is little doubt that the methods of scientific workers could help in dealing with some of the major problems troubling present-day civilization, any attempts at developing educational methods so as to foster scientificaction deserve encouragement and close study.

Institute of Chemistry

AT the fifty-ninth annual general meeting of the Institute of Chemistry, held on March 1, the president, Dr. R. H. Pickard, stated that the membership now includes a roll of nearly 6,800 members and 800 registered students. This year, on October 2, the Institute will attain the sixtieth anniversary of its original incorporation. The ideals of its founders have been steadily pursued. Chemistry, Dr. Pickard said, has established its place among the learned professions, and its practitioners are to be found in industry and commerce, in the Government and other public services. Chemists, by the very nature of their calling, have been for the most part of a retiring and modest disposition. Happily, there are also among them not a few who have developed a measure of business acumen. That is a matter of very great significance and importance. Everything

possible should be done to encourage in the profession a continuous supply of men of that type. There are, in the profession, young men, many as yet little known, who have courage and initiative to come forward with new work, to read papers, and to make useful and sensible contributions to discussions. To be able to express themselves clearly and with assurance on matters on which they can claim to know something is a valuable asset in itself. He would suggest to the younger members that much could be done to acquire this ability by good reading, by cultivating the habit of mixing with men of other professions, and by taking an active interest, not only in the proceedings of the societies devoted to their science, but also in the world of affairs generally. The supply of men and women for administrative posts is a difficult problem. There is another side of the question, however, namely, that in attaining an administrative post with the responsibility that it entails, there is a danger of the chemist losing touch with his science, so that it becomes more and more difficult for him to encourage the workers in the laboratories. Dr. Pickard was re-elected president of the Institute for the ensuing year.

Smoke Reducing Grates for Domestic Use

IN NATURE of January 23, an article on the prevention of smoke and dust emission referred to the difficulty experienced in burning raw coal smokelessly in the conventional open grate, and stated that investigations are now in progress having as their object the removal of this source of atmospheric pollution. The fundamental cause of smoke production from a domestic fire is the low temperature obtaining in the space above the fuel bed, combined with the cooling of the hot products of combustion by excess air entering the face of the grate. This normally gives rise to partial combustion of the hydrocarbon distillation products and the evolution of materials rich in carbon, but at certain periods, notably on kindling and on refuelling, the tarry matter may pass into the atmosphere unchanged.

To overcome these defects, a number of grate designs have been advanced, and the more important may be divided roughly into four classes. In the first, preheated air is supplied to the space above the fuel, increasing the temperature and promoting the early combustion of the volatile matter. This method can only be partially successful, as both the air supply and its temperature will be lowest just before adding a fresh charge. The second class, which is used in many multiple purpose grates, employs a draught which carries the distillates downwards through the hot fuel, giving conditions more suitable for their combustion. In these two, the smoke from the ignition charge is little altered. Gas is used in the third class as an auxiliary to burn the smoke. A novel example of this type was demonstrated recently by the Coal Utilisation Council, British Industries House, Marble Arch, London, W.1. The final class consists of more complicated devices in which the heat from the fire partially carbonizes raw coal contained in a suitable receptacle, the distillation products passing through the burning fuel where they are consumed. Dr. Arnot's smoke consuming grate (1855) was the forerunner of this type, but more recently a gravity feed from a hopper behind the fireback brings it more into line with modern ideas.

Control of the Grid System in Great Britain

IN a paper, read to the Institution of Electrical Engineers on February 10, Mr. J. D. Peattie describes the control rooms provided by the Central Electricity Board for controlling the generating stations supplying electricity to the grid and for supervising the operation of the transmission lines. The whole of Great Britain with the exception of northern Scotland is now divided into nine schemes. These are grouped into seven systems which are controlled from seven centres, at Glasgow, Newcastle, Leeds, Manchester, Birmingham, Bristol and London respectively. For short distances, continuous metallic circuits are provided, but for longer distances the Post Office channels pass through repeating stations and alternating current signals only are transmitted. The telephones and automatic indicating apparatus are always combined in one equipment suitable for use in conjunction with the channels hired from the Post Office. The vital line of communication is that connecting the control engineer on duty and the operator at the distant station.

IN general, the control engineer has access to, and a prior claim from his desk on, the outgoing channels. By means of automatic indicating apparatus he knows the position of the circuit breakers, the routine instruction signals and the readings of the load. In most cases the transmitting and receiving equipment for the signals are developments of apparatus used in automatic telephony. As a check on the frequency and time control carried out by the operators at the generating stations, meters connected to the local supply are installed in each control room. Differential dials are provided showing the difference between the time given by a high-grade standard clock and the system time given by the synchronous motor clocks. The standard clock is checked daily against the Greenwich radio time signal. Differential dials are also provided showing the difference between the time given by the standard clock and the system time given by a synchronous motor clock.

Recent Acquisitions at the Natural History Museum

AMONG recent acquisitions in the Department of Zoology are the mounted head of a Mexican bighorn sheep presented by Mr. John Lawson, the head of a Newfoundland caribou presented by Mr. W. Lawson, and the head of a woodland caribou presented by Captain D. A. Lawson. The study collection has been enriched by an Argali sheep skin from Samarkand, the gift of Mr. Douglas Carruthers, and a tiger skin and skull from Perak presented by the Zoological Society. Miss Emma Hutchinson of Grantfield, Leominster, Herefordshire, has presented to the Museum the collection, contained in four cabinets, of British Lepidoptera made at Leominster by her

mother and other members of the family, mostly between 1860 and 1900, though Miss Hutchinson has added to it odd specimens and notes up to 1936. The specimens number some 10,000, and included with them are Miss Hutchinson's note-books in which all the records are kept. Among donations to the Geological Department is one from Mr. C. T. A. Gaster, who collected the material during many years of intensive study of the chalk of the South Downs. This collection includes 10,000 Polyzoa, 3,200 Echinoderms, 700 Sponges, 360 Annelids, 85 Mollusca, and 450 Brachiopods, and forms a valuable source of information on the succession of faunas in the Chalk. The Mineral Department has acquired by gift from Dame Maria Ogilvie Gordon, a carefully labelled series of rocks and minerals which were collected by her in the Monzoni district, Val di Fassa, Italy. She first visited this region in 1891 when on Baron von Richthofen's geological excursion. Since then she has carefully studied the structure of the western Dolomites and has made a geological map of the whole area. The present gift is a first selection of all the original material studied. Prof. S. J. Shand, of Stellenbosch University, has given a fine series of igneous rocks from localities in South Africa, South-West Africa, and Kenya Colony.

COLONEL R. H. INGHAM CLARK has placed on permanent loan in the Botanical Department of the Museum a large collection of gums. Two enormous pieces of Kauri gum, one the largest ever discovered in New Zealand, are in the collection; and one sample of Demerara Animi is the largest example known. The collection was shown at the Paris Exhibition of 1878. Since then it has been added to mainly by F. W. Fell Clark. Many of the gums are no longer obtainable, the demand having considerably decreased from a commercial point of view, and the 'workings' have reached a point where there is too much water to make the mining of gum a commercial proposition. A collection of about 1,100 Phanerogams and 50 Cryptogams from around Kangersdlugssuck at the southern end of Knud Rasmussens Land, East Greenland, has been received from Dr. H. G. Wager (British East Greenland Expedition). The importance of the collection is that it was made from inland nunataks, which has only once previously been achieved. Dr. Wolfgang von Hagen has presented seventy-three Phanerogams and nine Cryptogams from the Galapagos Islands. The Department has also received the first consignment of 420 plants collected on the Swedish Expedition to South Africa and Southern Rhodesia (1930–31) by Thore C. E. Fries, T. Norlindh and H. Weimarck.

British Science Guild

A BRIEF review of the formation and activities of the British Science Guild, including a list of subjects investigated by its committees, details of the Norman Lockyer and Alexander Pedler Lectures, the Research and Development Lectures and other lectures arranged by the Guild has recently been issued as a final statement to members. Some notes on the Parliamentary Science Committee, which has been constituted a separate body and is not included in the scheme of incorporation with the British Association, are also given. The statement gives a list of the officers and members of Council at the time of incorporation with the British Association, together with the final income and expenditure account and capital account.

An Astronomical Handbook for 1937

IN addition to the standard astronomical ephemerides, such as the "Nautical Almanac", there are published each year a few handbooks which supply, for the non-technical inquirer, astronomical tabular matter and information that is generally wanted concerning the aspects of the heavens. The 1937 edition of Flammarion's "Annuaire Astronomique" (Paris: Ernest Flammarion, 1937. 14 francs) has for some years reached the status of a modest text-book, and is an excellent example of what a non-technical ephemeris should be. An important feature of this compilation, which runs into 450 pages, is the large number of tables and diagrams, many of them conveying at a glance some fact of astronomical or of geophysical interest. This annual handbook, which is carefully revised each year so as to include the latest observations of note, should be of real use to those requiring an elementary guide to the study of the heavens.

Institution of Chemical Engineers: Medal Awards

AT the fifteenth annual corporate meeting of the Institution of Chemical Engineers, held on February 26, the following medal awards were made: Osborne Reynolds Medal to Viscount Leverhulme in recognition of his work in the interests of chemical engineering during the year 1936, especially as president of the Chemical Engineering Congress; Moulton Medal to Dr. D. M. Newitt for the paper on "The Design of Vessels to withstand High Internal Pressures" as the most valuable paper among those read before the Institution during the year (1936); Junior Moulton Medal and prize of books to Mr. Roy F. Hayman for the paper on "Corrosion", read before the Graduates and Students Section in 1936; William Macnab Medal to Mr. G. U. Hopton, for meritorious work in the Associate-Membership Examination, 1936. At this meeting Dr. William Cullen was elected president of the Institution for the year 1937.

Fitzwilliam Museum, Cambridge: New Director

MR. L. C. G. CLARKE, curator of the Museum of Archæology and Ethnology, Cambridge, has been appointed director of the Fitzwilliam Museum, Cambridge, in succession to Sir Sydney Cockerell. Mr. Clarke was appointed curator of the Museum of Archæology and Ethnology in 1922, succeeding Baron Anatole von Hügel. He has travelled extensively in Central and South America, and in Abyssinia and other parts of Africa; and he has

conducted archæological excavations in New Mexico and Hungary. In addition to being recognized as an authority on the material cultures and art of the peoples of South America, he is well known as a connoisseur in art.

International Management Congress

PRELIMINARY notice has just been received of the seventh International Management Congress, which will take place in Washington during September 1938. This will be the first of the series to be held in the United States, and it will provide the most favourable opportunity which is likely to occur for many years of seeing examples of the application of American management methods to business undertakings. Two main themes are proposed for the Congress: (*a*) recent developments in scientific management; (*b*) economic and social aspects of scientific management. The papers which are accepted will be classified under one of the following six heads: administration, production, distribution, personnel, agriculture, the home. It is proposed to preface the discussions by an authoritative review of the history of scientific management up to the time of the London Congress, which will be based on reports previously prepared by each of the national committees. The organization of the British participation in the Congress is in the hands of the newly formed British Management Council, the Secretary of which is Mr. U. Baliol Scott, Armour House, E.C.1.

Scholarships in Electrical Engineering

APPLICATIONS, which must be received not later than April 15, are invited for the following scholarships awarded by the Institution of Electrical Engineers. Inquiries for full particulars and nomination forms (specifically mentioning the name of the scholarship) should be addressed to the Secretary of the Institution, Savoy Place, London, W.C.2. *Duddell Scholarship* (value £150 per annum, tenable for three years), open to British subjects under nineteen years of age on July 1, 1937, who wish to take up a whole-time day course in electrical engineering. *Ferranti Scholarship* (value £250 per annum, tenable for two years), open to British subjects under twenty-six years of age on July 1, 1937, who are students or graduates of the Institution of two years standing and desire to carry out whole-time research or post-graduate work of an electrical engineering nature. *Swan Memorial Scholarship* (value £120, for one year), open to British subjects under twenty-seven years of age on July 1, 1937, who desire to carry out whole-time research or post-graduate work of an electrical engineering nature. *Silvanus Thompson Scholarship* (value £100 per annum and tuition fees, tenable for two years), and *William Beedie Esson Scholarship* (value £120 per annum, tenable for two years, renewable in approved cases for a third year), for works employees, open to British subjects less than twenty-two years of age on July 1, 1937, for wholetime instruction in electrical engineering at an approved university or technical college.

New Fellows of the Royal Society of Edinburgh

AT the ordinary meeting of the Royal Society of Edinburgh, held on March 1, the following ordinary fellows were elected: Dr. A. J. G. Barnett, lecturer in chemistry, Education Department, Nigeria; Mr. Biswas Kalipada, curator of the Herbarium, Royal Botanic Garden, Calcutta; Dr. J. J. Black, manufacturing chemist, Edinburgh; Prof. Max Born, Tait professor of natural philosophy, University of Edinburgh; Mr. G. B. Brook, chief chemist, British Aluminium Co., Ltd., London; Mr. A. G. R. Brown, manager and actuary, Life Association of Scotland, Edinburgh; Mr. C. J. Cousland, Edinburgh; Dr. W. S. McR. Craig, Medical Officer, Ministry of Health, Whitehall, London; Dr. S. C. Dhar, head of Mathematics Department, College of Science, Nagpur, C.P., India; Dr. H. P. Donald, research assistant, Institute of Animal Genetics, University of Edinburgh; Prof. D. M. Dunlop, Christison professor of therapeutics, University of Edinburgh; Prof. R. C. Garry, Department of Physiology, University College (University of St. Andrews), Dundee; Dr. A. R. Gilchrist, assistant physician, Royal Infirmary, Edinburgh, and lecturer in therapeutics, University of Edinburgh; Dr. G. Green, lecturer in applied physics, University of Glasgow; Mr. W. A. F. Hepburn, director of education, Ayrshire Education Authority; Prof. P. R. Kirby, professor of music and musical history, University of the Witwatersrand, Johannesburg, South Africa; Dr. P. C. Koller, cytologist, Institute of Animal Genetics, University of Edinburgh; Mr. W. O. Leitch, civil engineer, Edinburgh; Dr. H. W. Melville, fellow of Trinity College, Cambridge; Mr. James Miller, Stirling; Lieut.-Colonel J. Morison; Mr. Roy Nasmith, United States Consul in Edinburgh; Mr. T. T. Paterson, fellow of Trinity College, Cambridge; Dr. J. D. Pollock, Edinburgh; Dr. B. N. Prasad, lecturer in pharmacology, P. W. Medical College, Bankipore, P.O., Bihar, India; Mr. F. I. G. Rawlins, scientific adviser to the Trustees of the National Gallery, London; Dr. M. Ritchie, assistant lecturer in chemistry, University of Sheffield; Mr. J. W. Robertson, headmaster, Central School, Aberdeen; The Hon. Lord Robertson, a senator of the College of Justice, Edinburgh; Dr. W. R. Russell, assistant physician to the Royal Infirmary and to the Deaconess Hospital, Edinburgh; Dr. J. K. Slater, assistant physician, Royal Infirmary and physician to the Deaconess Hospital, Edinburgh; Dr. A. M. Smith, lecturer in agricultural chemistry, University of Edinburgh; Mr. H. G. Smith, assistant, Department of Natural History, University of Aberdeen; Dr. H. M. Steven, divisional officer, Forestry Commission, Aberdeen; The Right Hon. the Earl of Suffolk and Berkshire, Eskbank, Midlothian; Mr. J. G. Tait, scholar of Peterhouse College, Cambridge and formerly principal, Central College, Bangalore, India; Dr. H. Tod, biochemist, West House, Edinburgh; Mr. M. McK. Turnbull, lecturer in banking, University of Edinburgh; Prof. E. M. Wright, Department of Mathematics, University of Aberdeen; Mr. A. W. Young, Writer to the Signet, Edinburgh.

Announcements

WE regret to announce the death, which occurred on February 27, at the age of seventy-one years, of Mr. W. Taylor, O.B.E., F.R.S., past president of the Institution of Mechanical Engineers, director of Messrs. Taylor, Taylor and Hobson, Ltd., optical instrument manufacturers, Leicester.

MR. R. H. BECKETT, director of public instruction, Bombay Presidency, in 1930–34, has been appointed registrar of the Indian Institute of Science, Bangalore. The appointment follows on the publication of the report of the second quinquennial reviewing committee of the Institute under the chairmanship of Sir James Irvine (see NATURE, Dec. 5, 1936). Mr. Beckett was a student of the Imperial College of Science, and entered the Indian Educational Service in 1906. He was appointed principal of the College of Science, Nagpur, in 1908, and became officiating director of public instruction and secretary for education to the Government of the Central Provinces in 1924. Mr. Beckett was made C.I.E. in 1928 and C.S.I. in 1934.

ACCORDING to *Science and Culture* (**2**, No. 8; Feb. 1937), Rao Bahadur K. N. Dikshit has been appointed director general of archæology in India in succession to Mr. J. F. Blakiston. Rao Bahadur Dikshit was appointed superintendent of the eastern circle in 1920; in 1930 he was appointed deputy director general for exploration and in 1935 deputy director general of archæology. He has successfully carried out archæological excavations at Mohenjodaro, Paharpur, Mahasthan, Rangamati and a number of other places.

THE Grant Fellows in Planning at the Edinburgh School of Art recently displayed the results of two years' research in an exhibition under the aegis of the Royal Scottish Societies of Artists in Water Colour. The exhibition has now been brought to London and is to be opened at the Housing Centre, 13 Suffolk Street, Pall Mall, S.W.1, at 4 p.m. on March 10 by the Right. Hon. Arthur Greenwood.

THE Rudolf Virchow Medal has been awarded to Prof. Hans F. K. Günther by the Berlin Society of Ethnology, Anthropology and Primeval History.

DR. HUGH S. CUMMING, surgeon-general, United States Public Health Service, has been awarded the Marcellus Hartley Gold Medal for eminence in the application of science to public welfare.

PROF. P. UHLENHUTH has been awarded the Cothenius Medal of the German Academy of Natural Philosophers for his researches on immunity and infectious diseases.

DR. FRANK G. BOURDREAU, chief of the League of Nation's service of epidemiological intelligence and public health statistics, has been appointed executive director of the Milbank Memorial Fund in succession to the late Edgar Sydenstricker.

THE American Congress of Therapeutics has awarded the "Gold Key of Merit" and the title of honorary member to Dr. Stefan Jellinek, professor at the University of Vienna, for his work in electropathology and his important contributions to the scientific development of physical therapeutics.

A MINISTRY OF HEALTH has recently been established in Paraguay by a presidential decree, under the direction of Dr. Pedro Duarli Ortellado.

THE General Education Board of the Rockefeller Foundation has given the University of Chicago three million dollars for the development of the Medical School and the improvement of the University generally.

THE Hungarian Society of Public Health, one of the oldest public health associations in the world, recently celebrated the fiftieth anniversary of its foundation, when the Archduke Josef Franz delivered the opening speech under the presidency of Dr. Daranyi.

IN spite of the vigorous campaign carried on throughout the country, the birth-rate in Italy fell from 23·1 per 1,000 in 1935 to 22·2 per 1,000 in 1936. The excess of births over deaths in 1936 was 372,577 (8·7 per 1,000) as compared with 401,833 (9·4 per 1,000) in 1935.

THE International Homœopathic League will hold a congress in Berlin on August 8–15. Further information can be obtained from the Office of the Congress, Tauentzienstrasse 7, Berlin, W.50.

THE third International Congress of Radiology will be held in Palmer House, Chicago, on September 13–17. The official languages will be English, French and German. The subscription is 20 dollars. Information regarding communications can be obtained from the president, Dr. Arthur M. Christie, 1835 Eye Street, Washington, D.C., and all other information from the General Secretary, 2561 North Clark Street, Chicago.

THE Child Guidance Council has arranged a vacation course on child psychology to be held on March 31–April 9 at Berridge House, Fortune Green Road, London, N.W. The programme will include lectures on normal emotional growth and its bearing on good mental health (Dr. J. R. Rees, Dr. Henry Wilson, Dr. Grace Calver), clinical experience in dealing with behaviour difficulties (Dr. William Moodie, Dr. R. MacCalman, Dr. Hamilton Pearson), and intellectual development and its relation to problems of learning (Miss L. G. Fildes, Mrs. Susan Isaacs, Miss M. MacTaggart and Miss C. Simmons). Further information can be obtained from the Secretary, Woburn House, Upper Woburn Place, W.C.1.

Letters to the Editor

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

The Constant of Gravitation

WITH regard to Prof. P. A. M. Dirac's recent letter to NATURE[1], I have shown, in various contexts[2] that the relation between γ, the 'constant' of gravitation, and t, the epoch, is given by

$$\gamma = c^3 t/M_0, \qquad (1)$$

where M_0 is the *apparent* mass of the fictitious homogeneous universe. (The *actual* mass must be infinite.) With $t = 2 \times 10^9$ years, this gave $M_0 = 2{\cdot}4 \times 10^{55}$ grams = mass of $1{\cdot}5 \times 10^{79}$ protons. Two points of interest (amongst others) emerge from the treatments I have given. First, (1) is a purely macroscopic formula, having no connexion with atomicity. It is derived from purely kinematic considerations, involving no appeal to any empirical dynamical laws, still less to atomic laws. In papers already communicated for publication, I have extended the application of (1) to all local gravitational situations and derived the inverse square law of gravitation in relativistic form in flat space, again without recourse to empirical appeals, by kinematic methods.

Secondly, the actual meaning of M_0 is that it is the mass which would occupy the sphere of radius ct with matter of density ρ_0, the density at the observer, and so

$$M_0 = \frac{4}{3}\pi(ct)^3\rho_0 = \frac{4}{3}\pi m_0 B, \qquad (2)$$

where B is a constant depending on the mode of counting of fundamental particles (for example, as spiral nebulæ or smaller particles) and m_0 is the mass-number assigned to a fundamental particle. It has been shown[3] that the mass-number assigned to *any* particle may be regarded as a constant of integration. M_0 is therefore a constant. Thus there is no inference as to the creation of matter, inside stars or anywhere else. It is clear in fact that the considerations leading to (1) could never lead to any such inference, for the complete inverse square law of local gravitation (of which (1) is an intrinsic part) emerges from arguments depending on the use of Boltzmann's equation, which is a kinematic consequence of the conservation of particle numbers for any given system. We have thus $\gamma \propto t$.

When we transform the scale of time-measurement from kinematic time t to the dynamical time τ corresponding to the present epoch t_0 by the formula

$$\tau = t_0 \log(t/t_0) + t_0, \qquad (3)$$

and adjust the measures of all derived quantities accordingly[4], γ reduces to a constant γ_0, and is given by $\gamma = \gamma_0 (t/t_0)$. The usually adopted constancy of γ_0 is thus connected with our habitual use of a dynamical scale of time.

Relation (3) is not, of course, a transformation of co-ordinates but a re-graduation of the fundamental observers' clocks. The associated transformation of co-ordinates is readily found. It then appears[5] that this transformation leads to the relation $ds = e^{(\tau - t_0)/t_0}\, d\sigma$, where $d\sigma^2 = d\tau^2 - c^{-2}d\varepsilon^2$ and $d\varepsilon^2$ is the metric of the static, infinitely extending hyperbolic space into which the interior of $r = ct$ transforms. The epoch co-ordinate τ of *any* event is an invariant, the same by whatever fundamental observer it is measured, and it enjoys all the properties of a world-wide Newtonian time; and $d\sigma$ may be taken as the interval between two events with the same justification as ds. These results confirm Dirac's remarks at the end of his letter.

Note added in proof, Feb. 26. Complete agreement between Dirac's results and kinematic cosmology can be obtained, and his proportionalities $M \propto t^2$, $\gamma \propto t^{-1}$, replaced by $M = \text{const.} = M_0$, $\gamma \propto t$, if we take the 'electrostatic' constant γ' in the inverse square law to be proportional to t; γ' is, of course, usually taken as unity. This is formally the same as taking $e^2 \propto t$. The t-dynamics then gives the radius of the Bohr atom as proportional to t, and a material rod is 'rigid' on the τ-scale. Electrostatic forces then become to some extent analogous to gravitational forces, and might be discussed kinematically by examining the properties of an expanding sphere of mingled positive and negative particles.

E. A. MILNE.

Oxford.
Feb. 23.

[1] NATURE, **139**, 323 (Feb. 20, 1937).
[2] "Relativity, Gravitation and World-Structure' (1935), pp. 103–4. See also pp. 130, 145, 187. These results depended on $G(1) = -1$, but the deeper result $G(\xi) \equiv -1$ has since been obtained. See also *Proc. Roy. Soc.*, A, **154**, 43; **155**, 75 (1936).
[3] *Proc. Roy. Soc.*, A, **154**, 31 (1936).
[4] *Proc. Roy. Soc.*, A, **158**, 333, 340 (1937).
[5] *Proc. Roy. Soc.*, in press. (The invariance of τ was obtained independently by Leontowski.)

Scotopic Luminosity Curve and the Absorption Spectrum of Visual Purple

ALTHOUGH it is generally accepted that visual purple plays an essential part in the process of scotopic vision, attempts[1] at relating the *human* scotopic luminosity curve (for equal energy spectrum) with the extinction (absorption) coefficient curve of *amphibian* or *mammalian* visual purple have shown a difference in the wave-length position of the maxima. Hecht and Williams[2], using a 'constant stimulus' method, found that the maximum of this luminosity curve was at 510 mμ. This was a mean value for forty-eight young observers, and there was little variation. Abney and Watson[3], using a threshold intensity method, found that the maximum of the luminosity was at 505 mμ for three monochromats.

Most experimenters have found maxima for the extinction coefficient of visual purple solutions between 500 mμ and 504 mμ. König[4] found a maximum at 500 mμ for human visual purple. Recently, Lythgoe[5], using an improved technique[6] and carefully purified specimens, has found the maximum for *Rana esculenta* to lie at 502 mμ. His measurements were made against a blank of the solvent, a solution of digitonin (colourless).

Hecht and Williams explain the difference in the position of the maximum of luminosity and of extinction by supposing that in the eye the visual purple is dissolved in a substance of high refractive index, when according to Kundt's rule, the absorption

spectrum would be displaced towards the red with respect to an aqueous solution of visual purple. Kundt's rule is untrustworthy, and in any event, before a comparison can be made, it is essential to consider the physical (dimensional) relation between the two factors, luminosity and light absorption.

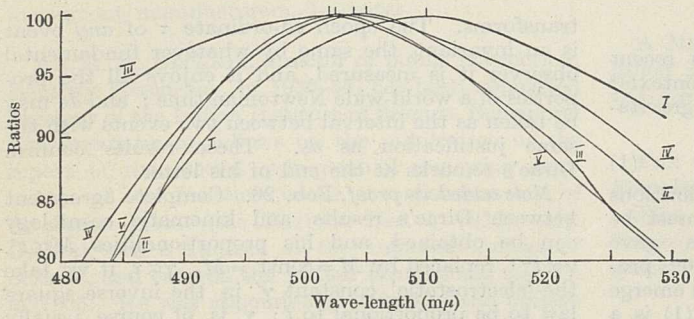

Fig. 1.

SCOTOPIC LUMINOSITY CURVES. ENERGY BASIS, I, HECHT AND WILLIAMS, AND II, ABNEY AND WATSON; QUANTUM BASIS, IV, HECHT AND WILLIAMS, AND V, ABNEY AND WATSON. CURVE III SHOWS THE EXTINCTION COEFFICIENT OF VISUAL PURPLE, LYTHGOE.

Evidence continues to accumulate indicating that the primary part of the physico-physiological process in scotopic vision is photochemical[7]. Thus the relative luminosity, R_λ, should be represented not on the basis of an equal *energy* spectrum but on that of an equal *quantum intensity* spectrum. This may be effected by multiplying the figures for the relative scotopic luminosity (energy basis) by the value of the quantum at the wave-length in question. This has the effect of shifting the maxima from 510 mμ and 505 mμ to 504 mμ and 502 mμ respectively, as shown on a large scale in Fig. 1. Thus reduction to the quantum basis discloses that the curve of the extinction coefficient of visual purple and the curve of relative scotopic luminosity have effectively coincident maxima. This supports the contention that the primary process in scotopic vision is the absorption of light *quanta* by visual purple.

In order to extend the relation between the two curves it is necessary to consider the following points. According to the above definition of the relative luminosity, equality of the stimuli produced by light of two different wave-lengths implies equality of the values of $R_\lambda I_\lambda$, where I_λ is the intensity of light in quanta per second at the wave-length λ, given by the instrument used. If almost any simple photo-chemical mechanism were assumed, the stimulus would be a function of the intensity of light *absorbed*, I_a, at each wave-length, that is, equality of stimulus arises from an equality of I_a. The value of R_λ would, therefore, be proportional to I_a/I_λ, which in turn is given by

$$I_a/I_\lambda = 1 - e^{\alpha c} \quad . \quad . \quad . \quad (1)$$

where c is the areal concentration in chromophore groups[7] per sq. cm. and α the extinction coefficient per chromophoric group. αc is simply 2·3 times the usual optical density ($\log_{10} I_0/I_T$). If, therefore, we know the optical density of visual purple in the dark-adapted eye for wave-length 502 mμ, we can calculate the relative intensities of the light absorbed at the other wave-lengths.

Unfortunately, there are no trustworthy measurements of this density. König[4] extracted visual purple from a human eye in an amount sufficient to cover the retina to an optical density of 0·018 (λ = 500 mμ). This value is probably much too low owing to decomposition before extraction and incomplete recovery of the visual purple. In the course of our experiments with visual purple solutions carried out in conjunction with Dr. R. J. Lythgoe, we have calculated that at complete dark adaptation the optical density in a frog's eye (*Rana esculenta*) at the maximum is not less than 0·1. For the purposes of argument a value of 0·1 will be assumed for the dark-adapted human eye, but should this value be incorrect by as much as a factor of two, the argument below is not appreciably affected.

The densities for other wave-lengths have been obtained by combining the relative extinction coefficient curve with the above value for the density at 502 mμ (that is, solving for c equation (1), in arbitraryunits). The fraction of the incident light which is absorbed, I_a/I_λ, has been calculated relative to the value at 502 mμ (where it has been taken as 100 units), and the results plotted as shown in Fig. 2.

It will be seen that on the red side of the maximum the 'light absorbed' curve agrees well with the luminosity curve of Abney and Watson and in part with that of Hecht. If the value for the density of the visual purple in the eye is an acceptable one, the contention that the primary process in scotopic vision is photochemical is strengthened by this agreement.

On the blue side, the luminosity curve lies well below the 'light absorbed' curve. This would be expected for a number of reasons, only a few of which need be mentioned here. It is well known that yellow substances are present to a considerable extent in the retina. These are probably visually insensitive, but will affect the luminosity curve by absorbing the light below a wave-length of about 500 mμ, thus reducing the amount absorbed by the visual purple in this region. This probably accounts for most of the difference in the curves. Yellow substances in the eye lens may sometimes have an important effect.

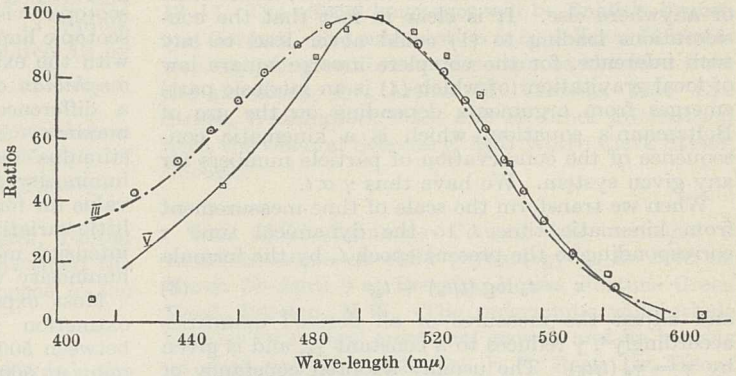

Fig. 2.

CURVES III AND V AS IN FIG. 1. SQUARES, AS CURVE IV, FIG. 1. CIRCLES, LIGHT ABSORBED BY VISUAL PURPLE (CALCULATED).

If in place of the absorption curve as shown, one uses the curve from which has been subtracted the absorption of the bleached solution (as is usually done), the difference in the blue is much reduced. Such a 'correction' is, however, meaningless, as visual purple bleaches to a yellow substance, and the resultant curve depends largely on the yield and stability of this substance. The yellow products of visual purple may themselves be partly responsible for the low luminosity in the blue. The curve obtained by Dr. Lythgoe may include absorption due to a small amount of residual impurities, but is much more trustworthy than the 'corrected' curves.

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Jan. 26.

[1] See for example Houstoun's "Vision and Colour Vision", p. 89 (Longmans Green and Co., London, 1932).
[2] Hecht, S., and Williams, R.E., *J. Gen. Physiol.*, **5**, 1 (1922).
[3] Abney, W. de W., and Watson, W., *Phil. Trans.*, A, **216**, 91 (1916).
[4] König, A., *Sitz. Berlin Akad.*, **2**, 577 (1894).
[5] Lythgoe, R. J., private communication.
[6] Bayliss, L. E., Lythgoe, R. J., and Tansley, K., *Proc. Roy. Soc.*, B, **120**, 95 (1936).
[7] See, for example, Dartnall, H. J. A., Goodeve, C. F., and Lythgoe, R. J., *Proc. Roy. Soc.*, A, **156**, 158 (1936); Goodeve, C. F., *Proc. Roy. Soc.*, A, **155**, 664 (1936).

Sharpness of the Magnetic Curie Point

EXPERIMENTS carried out in recent years on nickel and iron have led to the view that the spontaneous magnetization does not disappear suddenly at the Curie point, but that there is a definite 'tail' to the magnetization-temperature curve. The specific heat measurements of Ahrens[1], and more particularly the work on very pure nickel by Grew[2], establish beyond doubt that the energy (E) associated with the ferromagnetic state does not vanish suddenly at the Curie point, although there is probably a sharp discontinuity in the (d^2E/dT^2, T) curve at this temperature. The measurement of the energy, either through the specific heat or the magneto-caloric effect, appears to us to be the only sound method of estimating the degree of spontaneous magnetization.

Recently, Svensson[3] has measured the resistance of nickel near its Curie temperature and finds a discontinuity in the temperature coefficient taking place within a temperature range so small as 0·1° C. One of us (H. H. P.) has recently repeated and verified this result, and has also shown that from the Curie point (357° C.) up to a temperature of 1,000° C., the resistance-temperature curve is concave to the temperature axis with a very marked curvature for some 30° or more above the Curie point. We wish here to suggest a means of reconciling the results of the experiments on the change of magnetic energy with those on the change of resistance.

The magnetic state is determined by the degree of order among the electron spins, the disappearance of the ferromagnetism being associated with the break-up of the Weiss domains. Now the magnetic energy must depend on the interactions between spins at close range or, in other words, on short-distance order. On the other hand, since the mean free path of an electron in nickel at its Curie point is of the order of 20 times the interatomic distance, the resistance will depend on long-range order. If at a definite temperature (Curie point), order suddenly ceases to extend over domains of more than about 8,000 atoms, a kink in the resistance-temperature curve will be obtained; but owing to the presence of smaller ordered domains the magnetic energy will not have vanished completely.

The effect of the subsequent break-up of these smaller domains is to produce the 'tail' of the magnetization-temperature curve, and a marked curvature in the resistance-temperature curve in the region immediately above the Curie point.

The continued concavity of the resistance curve towards the temperature axis up to 1,000° C. is due to quite another cause; it occurs also for paramagnetic metals, and has already been explained by one of us[4].

It may be noted that Stoner[5] has used a similar idea of small ordered domains persisting above the Curie temperature to explain certain apparent anomalies in the magneto-caloric effect.

N. F. MOTT.
H. H. POTTER.

H. H. Wills Physical Laboratory,
University, Bristol.
Feb. 5.

[1] Ahrens, *Ann. Phys.*, (5), **21**, 169 (1934).
[2] Grew, *Proc. Roy. Soc.*, A, **145**, 509 (1934).
[3] Svensson, *Ann. Phys.*, (5), **22**, 97 (1935).
[4] Mott, *Proc. Roy. Soc.*, A, **153**, 699 (1936); A, **156**, 368 (1936).
[5] Stoner, *Phil. Trans.*, A, **235**, 165 (1936).

Constitution of the Keratin Molecule

FROM a study of the elastic properties of wool fibres in solutions of varying hydrogen ion concentration, Speakman[1] has argued that the long peptide chains of wool are bridged by salt linkages formed from the acid side chains of aspartic and glutamic acids, and the basic side chains of arginine, lysine and histidine. In addition, chemical equivalence between the *free* acid and basic side chains was deduced from the form of the curve relating the ease of fibre extension to the *p*H of the medium. Such is the salt linkage theory, for which support was later found in the titration curves of wool[2] and feather keratins[3], as well as in deductions concerning the influence of the salt linkages on the reactivity of the disulphide bond in strained animal fibres[4]. Unfortunately, however, the amounts of aspartic and glutamic acids isolated from wool and goose feather by Abderhalden[5] are insufficient to account for the basic side chains as well as amide nitrogen. The difficulties of protein analysis are so great that the salt linkage theory is not called into question by Abderhalden's results, but it was felt desirable to augment the supporting evidence already available by direct proof based on new determinations of the dicarboxylic acids in wool and seagull quill, which may be regarded as typical keratins.

Using modifications of Foreman's[6] and Jones and Moeller's[7] procedures, which will be described elsewhere, the following data, corrected for nitrogen loss at different stages of the investigation, were obtained for Cotswold wool.

Acid	Amount isolated expressed as: per cent on weight of wool	mgm.N/gm. of wool
Glutamic acid	15·27	14·54
Aspartic acid	7·27	7·65
	Total N =	22·19

When uncorrected for loss of nitrogen, the total dicarboxylic acid nitrogen was 20·75 mgm./gm., so

that correction, being small, is justified. The amide nitrogen content of the wool was found to be 13·7 mgm./gm., leaving dicarboxylic acid equivalent to 8·49 mgm./gm. available for combination with the basic side chains. Taking Vickery and Block's[8] determinations of the basic amino acids in wool, the excess dicarboxylic acid required for combination according to the salt linkage theory is 8·55 mgm.N/gm. Vickery and Block's results are probably low, but even if the maximum combining capacity of wool for hydrochloric acid is taken as a measure of the basic amino acid content, the amount of dicarboxylic acid needed for combination is only 11·2 mgm.N/gm. In other words, we have succeeded in isolating 22·19 out of the maximum possible requirement of 13·7 + 11·2 = 24·9 mgm./gm. of dicarboxylic acid nitrogen.

The methods employed in the preceding investigation were evolved during a preliminary attempt to determine the dicarboxylic acid content of seagull quill. According to the salt linkage theory, the quill should contain 20·6 mgm./gm. of dicarboxylic acid nitrogen, comprising 14·9 mgm./gm. for amide nitrogen and 5·7 mgm/gm. for basic side chains as deduced from the acid combining capacity. In the case of goose feather, however, Abderhalden[5] succeeded in isolating only 2·3 per cent of glutamic acid and 1·1 per cent of aspartic acid, together equivalent to 3·4 mgm.N/gm. When corrected for nitrogen loss as before, the quantities isolated in the present investigation were as follows:

Acid	Amount isolated expressed as: per cent on weight of feather	mgm.N/gm. of feather
Glutamic acid	9·72	9·26
Aspartic acid	6·57	6·92
Not identified	—	0·96
		17·14

The amounts of aspartic and glutamic acids are an improvement on Abderhalden's values, and the agreement between the nitrogen content of the isolated dicarboxylic acids and the requirement of the salt linkage theory is sufficient to establish its validity for feather, as well as for wool, if due account is taken of the preliminary character of the feather investigation.

J. B. SPEAKMAN.
F. TOWNEND.

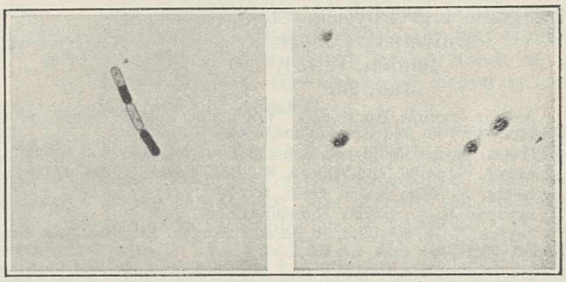
Textile Chemistry Laboratory,
University, Leeds.
Feb. 10.

[1] Speakman and Hirst, NATURE, **128**, 1073 (Dec. 26, 1931); *Trans. Faraday Soc.*, **29**, 148 (1933).
[2] Speakman and Stott, *Trans. Faraday Soc.*, **30**, 539 (1934).
[3] Speakman and Townend, *Trans. Faraday Soc.*, **32**, 897 (1936).
[4] Speakman, *J. Soc. Dyers and Colourists*, **52**, 423 (1936).
[5] Abderhalden, *Z. physiol. Chem.*, **52**, 348 (1907).
[6] Foreman, *Biochem. J.*, **8**, 463 (1914).
[7] Jones and Moeller, *J. Biol. Chem.*, **79**, 429 (1928).
[8] Vickery and Block, *J. Biol. Chem.*, **86**, 107 (1930).

Chromatin Arrangements in Spore-forming Bacilli

WE have recently made a cytological study of several species of spore-forming bacilli, using the vital staining method of Nakanishi as modified by Stoughton[1]. This has resulted in two observations which help to explain (1) the confusion of ideas as to the changes in cell structure accompanying spore-formation, and (2) the role of the spore in the cycle of development of the bacillus.

(1) In young cultures (purified by plating, followed by single cell isolation), prior to the appearance of spores, many cells show a sharp lateral division into two sections depending upon a difference in affinity for the stain (for example, neutral red chloride). One section (usually rather less than half the cell) is deeply stained, the other section very lightly and in many cases apparently not at all. This appearance (shown by the top cell in the photomicrograph reproduced as Fig. 1, *a*) has been found to be typical in the case of six spore-formers—two isolated from silage, one from soil, one found as a contaminant in a medium and two stock cultures (*B. subtilis* and *B. megatherium*)—otherwise easily distinguishable on physiological grounds.



a *b*

Fig. 1.

Observations on cultures of a slightly more advanced age indicate that the cell containing the two sections undergoes fission in the usual way, giving rise to one cell capable of staining deeply and one which has little or no affinity for stain (as shown by the two lower cells in Fig. 1). Further observations in the case of three of the above cultures have led us to the conclusion that the two kinds of cells thus produced differ in their subsequent cytological development, resulting in each case in a cell containing an endospore but with a different structure extraneous to the spore. These alternative methods of forming endospores shown by the same species of organism may possibly explain to some extent the divergence in descriptions of the process of spore-formation by different authors.

(2) As is well known, the fully formed bacterial spore, examined by ordinary methods, appears as a refractile body resistant to the entry of stains, and it has been generally assumed that it is in fact homogeneous and represents a resistant resting stage in the life of the bacillus. So far as we are aware, there is no record of experimental evidence to refute this view, and the only suggestion found in the literature is one by Mellon (quoted by Hadley[2]) that the bacterial spore may be a 'cover' for nuclear reorganizations.

In the case of two of the above species of spore-formers, both isolated from silage, structures visible by vital staining methods have been followed at frequent intervals until the cultures were several weeks old. This has disclosed the fact that endospores, though certainly refractile for some time after formation and subsequent release from the enclosing cells, may later take up the stain and reveal a deeply staining granular structure. This shows rearrangement into several definite forms over a considerable period of time. In some spores showing an internal structure the stain is absorbed quickly, in others the structure appears more slowly after leaving the spores in contact with

the stain. One such appearance is shown in the photomicrograph reproduced as Fig. 1, *b*.

These appearances suggest that, in some instances at least, the bacterial spore certainly has a function other than that of a resistant resting stage, namely, that it provides an opportunity for rearrangement of chromatin material.

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University, Reading.
Feb. 4.

[1] Stoughton, R. H., *Proc. Roy. Soc.*, B, **105**, 469 (1929–30).
[2] Hadley, P. J., *Infectious Dis.*, **40**, 1 (1927).

Development *in vitro* of the Mammalian Gonad

IN recent experiments the entire mammalian gonad has been successfully cultivated *in vitro* and the explants continued to differentiate during cultivation.

The ovary and testis from young and embryonic rats and mice were grown by the watch-glass method on the surface of a clot composed of equal parts of fowl plasma and fowl embryo extract. For each culture, one gonad was fixed as a control.

A typical maturation division figure was observed in an explanted ovary from a four-day (post-embryonic) rat after 9 days' cultivation (Fig. 1). The appearance of the figure was preceded by an actual growth of the ovum.

Small, normal Graafian follicles differentiated *in vitro* in the ovaries of two 19-day rat embryos and of three new-born mice, although the controls showed that at the time of explantation the germinal tissue was in the form of sex cords and contained no Graafian follicles. Some of these follicles remained healthy after twenty-two days *in vitro*. Many residual ova survived *in vitro* for an equally long time. After a month *in vitro*, the organ degenerated.

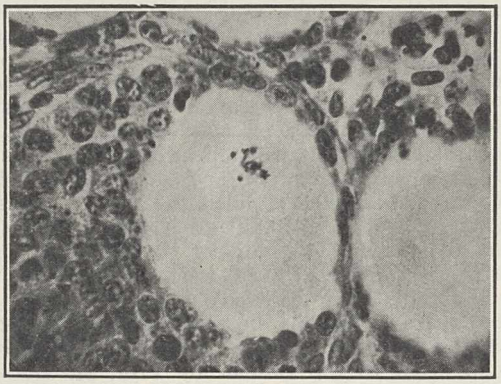

Fig. 1.

OVARY FROM A FOUR-DAY (POST-EMBRYONIC) RAT AFTER 9 DAYS' CULTIVATION *in vitro*. (ALLEN'S MODIFICATION OF BOUIN'S FLUID; MAYER'S HAEMATOXYLIN. × 640.)

The testis also grew and differentiated *in vitro*. In the explanted testis of a new-born mouse, spermatocytes in the typical pachytene phase of the meiotic prophase had developed *in vitro* after 11 days' cultivation (Fig. 2), although only spermatogonia were present at the time of explantation. Similar spermatocytes were also observed in the explanted testis of a 17-day mouse embryo after 16 days *in vitro*.

So far, spermatogenesis *in vitro* has always stopped at the pachytene stage of meiosis, although female germ cells growing under the same conditions seem to pass through this phase without difficulty. This point requires further investigation.

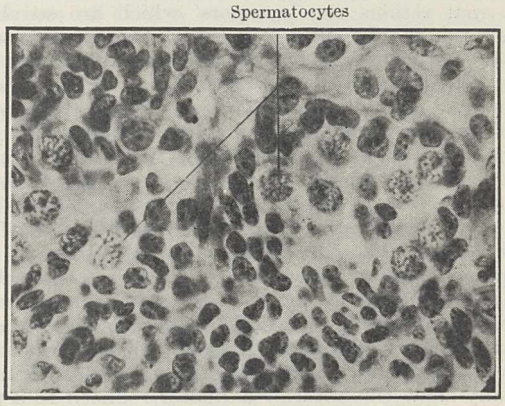

Fig. 2.

TESTIS OF A NEW-BORN MOUSE AFTER 11 DAYS' CULTIVATION *in vitro*. TYPICAL SPERMATOCYTES SHOWING CHROMATIN FIGURES OF THE EARLY MEIOTIC PROPHASE HAVE DIFFERENTIATED *in vitro*. (ALLEN'S MODIF CATION OF BOUIN'S FLUID; MAYER'S HAEMATOXYLIN. × 640.)

Many seminiferous tubules maintained their original form for as long as 17 days' cultivation, but the germ cells mostly degenerated by the twentieth day *in vitro*.

The results so far obtained have provided a new experimental approach to several problems of sex physiology.

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Feb. 2.

Metamorphosis of the Larva of *Ostrea edulis*

ALTHOUGH we now have a complete description of the fully-developed larva[1] of the European oyster (*Ostrea edulis*), we have as yet no account of the metamorphosis which takes place when the larva attaches itself and becomes the settled spat. The smallest spat yet described is that figured by Yonge[2]. The shell of this individual measured 1·2 mm., whereas the shells of fully-developed larvæ before settlement average only 0·30 mm. There is therefore a considerable gap which requires to be bridged by the description of smaller spat.

I have been able to obtain a number of such early stages attached to glass slides, and, with the addition of further material during the coming season, it may be possible to prepare a complete description of the metamorphosis. The material already collected shows the evolution of the posterior adductor as the one shell muscle, and the development of the gills. The fully-developed oyster larva, as described by Erdmann[1], possesses anterior and posterior adductor muscles about equal in size and symmetrically placed with regard to the hinge. At this stage the rudiments of six gill filaments on the left side are shown by Erdmann. The earliest settled spat that I have yet

examined, which possesses the larval shell (prodissoconch) only, without any fringing growth (dissoconch), has seven gill filaments on this side. In this spat the anterior adductor already shows reduction and, with the increase in size of the posterior adductor, the ratio between the two is already 3 : 2 in favour of the latter.

During the first eighteen hours after settlement, the spat retains the 'eyespots' which are so characteristic of the fully-developed larva, and such 'eyed' spat usually have eight gill filaments on the left side with a suggestion of the ninth. The 'eyespots' disappear within twenty-four hours of settlement, and at forty-eight hours a fringe (dissoconch) has been added to the larval shell. The spat at about forty-eight hours after settlement measures about 0·35 mm. and possesses ten gill filaments on the left side, while still showing distinct vestiges of the foot and velum. The fate of these larval organs in the American oyster (*Ostrea virginica*) has been described by Stafford[3], but we have no information concerning their fate in *Ostrea edulis*. The eleventh, twelfth and thirteenth gill filaments appear on the left side before the spat is ninety hours old, and such spat usually show the anterior adductor reduced to a few fibres at the edge of the shell, or absent altogether. The posterior adductor has increased in size and its point of attachment has moved ventrally until it lies almost outside the prodissoconch attached to the dissoconch, the definitive shell of the adult. Such ninety hours old spat may be 0·6 mm. in diameter, that is, with a shell twice the diameter of that of the larva. The foot and velum are completely absorbed and there are 13 gill filaments on the left and 7 on the right. The smallest spat described by Yonge[2] had 20 filaments on the left and 13 on the right and its shell measured 1·2 mm. It is probable that it had been attached for five or six days.

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[1] Erdmann, *Wiss. Meersunters. abt. Helgoland*, **19**, No. 6 (1933).
[2] Yonge, *J. Mar. Biol. Assoc.* (n.s.), **14** (1926).
[3] Stafford, "The Canadian Oyster" (1913).

Light and Breeding Seasons

IT has recently been shown by Marshall and Bowden[1] that not only duration but also intensity of illumination can affect the onset of a breeding season, and that ultra-violet as well as visible light is effective. These discoveries have an important bearing on seasonal phenomena in the tropics.

On the equator itself the length of day is always the same, and in the equatorial regions the seasonal change is small. (As my brother, Mr. S. J. Baker, points out, the difference in minutes between the longest and shortest day in the tropics may be found by multiplying the latitude in degrees by 7·2. The result is always correct within two minutes between 20° N. and 20° S.) Despite a constant or almost constant length of day, not very many equatorial birds are known to breed all the year round. One may suppose that the control is by intensity of illumination (visible and ultra-violet).

It is an interesting fact that, of those species of birds in Ceylon the breedng seasons of which are known, no fewer than eleven definitely have two breeding seasons annually, and at least sixteen other species probably behave in the same way. The length of day, of course, only rises to a maximum and sinks to a minimum once annually, but the intensity of illumination probably has two maxima in the year, at about the times when the sun passes overhead. Although these are often times of heavy rainfall, yet the mornings and early afternoons tend to be sunny. In South America in nearly the same latitude as Ceylon, it has been shown that there are two periods of maximum intensity of ultra-violet light in the year, in May and October (Chavarria and Gomezvega[2]). Similarly, Harrisson and I[3] have shown that in the tropics of the southern hemisphere the amount of ultra-violet light sinks to a low figure when the sun is near the Tropic of Cancer.

Those birds of Ceylon which have two breeding seasons commonly breed at about the times when one must suppose that the intensity of illumination is near its maxima. To take only one example, the Ceylon blackbird, *Turdus merula kinnisii*, breeds in March–April and again in September[4].

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Feb. 5.

[1] Marshall, F. H. A., and Bowden, F. P., *J. Exp. Biol.*, **13**, 383 (1936).
[2] Chavarria, A. P., and Gomezvega, P., *Amer. J. Hyg.*, **20**, 508 (1934).
[3] Baker, J. R., and Harrisson, T. H., *J. Linn. Soc.* (*Zool.*), **39**, 433 (1936).
[4] Wait, W. E., "Manual of the Birds of Ceylon" (London : Dulau, 1931).

Extent of the Ranikot Sea

WITH reference to my preliminary note[1] on the results of work by Mr. Pinfold and myself on the Eocene beds of the Punjab Salt Range, we have now determined the fact that, of the six sections of the local Eocene, the lower three (Dhak Pass Beds, Khairabad Limestone and Patala Shales) are all of Upper Ranikot age ; the Patala Shales representing later Ranikot elements than have yet been found elsewhere. The three upper sections (Nammal Shales, Sakesar Limestone and Bhadrar Beds) are of Lower to Middle Laki age, the unconformity between Ranikot and Laki being rather less on the Salt Range than elsewhere. Our paper on this subject, giving full palæontological details, will appear in due course as the first part of vol. 24 (N.S.) of the *Palaeontologia Indica*.

We have meanwhile studied the Eocene rocks of Waziristan, and the Kohat and Attock Districts, in order to determine the further extensions of these beds to the north and north-west. I also examined the late Sir Henry Hayden's collections from the Cretaceous and Eocene beds of Kampa Dzong in Tibet, due north of Calcutta. Certain of these beds were referred to the Danian by Prof. H. Douvillé in 1916 ; but Dr. G. de P. Cotter, of the Geological Survey of India, afterwards argued that they more probably belong to the Laki. I found that they are really of Upper Ranikot age, their foraminiferal fauna agreeing in closest detail with that of the Khairabad Limestone of the Punjab Salt Range.

It has thus become obvious that the Ranikot Sea, once thought to have been limited to a small area in western Sind, not only reached northwards as far as the Tirah, but also extended thence to the east over the whole length of the Himalayas, as far, at least, as the longitude of Calcutta. The peculiarly rich and characteristic Ranikot foraminiferal fauna

has not, however, yet been traced far to the west; and its distinction from the contemporary faunas of Europe indicates that Indian waters formed a separate zoological province in Palæocene times. Many European species appear in the succeeding Laki, however, and the foraminiferal fauna of the Khirthar is very similar to that of the Lutetian. Thus the isolation of Indian waters during the early Tertiary appears to have been limited to the Palæocene.

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[1] NATURE, **135**, 188 (Feb. 2, 1935).

Racial Theory and Cross-breeding

CROSSES have been the great stumbling block in the path of physical anthropology. Different races can and do breed together, therefore there can be no such thing as a race of men, if by race we mean the human equivalent of a breed of dogs or horses. Anthropologists allow an exception where deserts or other obstacles isolate one lineage from another.

They overlook the possibility that man may be isolated by his own action, by his language, his custom, even by his own decision. In practice, lineages do isolate themselves for breeding purposes where there is no external necessity, just because they like to do so. Not being a physical anthropologist, I have not pursued the facts systematically from the point of view of breeding, but such facts as have come my way in the pursuit of other aims seem to raise two questions which have not been given proper consideration:

1. Is cross-breeding really common?
2. Does such cross-breeding as takes place leave much trace in the long run?

1. In a commune near Alexandria, 'Ali Ahmed 'Isa Eff. counted 53 marriages in two years, of which 23 were within the village or hamlet; 7 were outside the village or hamlet, but within the commune; 13 were outside the commune, but into neighbouring communes; 10 were into towns round about. It is common knowledge that English peasants used until recently to view with disfavour marriages with 'foreigners', that is, strangers to the village.

I can only record the impression left by a Guernsey pedigree now unfortunately lost. Marriages went on mostly within a small group of families. First cousin marriage between two of those families never failed for several generations. Of three marriages I remember outside the circle, all encountered opposition.

Writings on exogamy have encouraged the idea that it means compulsory breeding out. As a matter of fact, it is generally not a system of enforcing marriage outside the family, but of restricting it to another branch than one's own, exactly as happened between the two Guernsey families above (cf. *Genesis*, xxiv and xxviii, and my "Progress of Man", 239 ff.). The exclusiveness of Indian lineages is notorious and extreme, and they constantly split up into lineages exclusive of one another.

These are only a few of the facts.

2. Anthropologists get their impressions from middle-class practice. This class is addicted to promiscuous breeding; in fact, it may be said to be characteristic. The middle classes, however, appear to be dying out, not for the first time in history (see notably S. Dill, "Roman Society in the Last Century of the Roman Empire"). It seems doubtful whether townsfolk generally last many generations. We know that towns are constantly recruited from the country. This is particularly so in Paris. Eventually, towns dwindle and sometimes disappear altogether.

To take a concrete case. The North Central Province of Ceylon was once thickly populated all around an extensive capital. It is now reduced to a miserable remnant of peasants living in small hamlets. From whom are they descended? From the ancient city population? But we have no evidence that city populations ever return to the soil in any numbers, if at all. They can only be descended from the peasants. That is only one of countless cases.

This brings us face to face with a phenomenon which is seldom faced because it is not pleasant. Communities flare up and die down. Therefore only a small fraction carries on the breed. Who? There is every appearance that it is the peasantry, which is most given to self-imposed isolation.

We can no longer be content to note that cross-breeding occurs; we must *observe* its consequences for generations, instead of *assuming* them.

Perhaps if we do so we shall find out a great deal more than by the study of animals, which is experimental, and so works under the unnatural conditions of the laboratory. In observing man, we observe what happens in Nature. When we watch human lineages isolating themselves, we may get the clue to the segregation of species in Nature.

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Negative Protons in Cosmic Radiations

AT Asmara, magnetic lat. 11° 30′, Rossi[1] and Benedetti[2] have counted the number of coincidences between two counters mounted with their axes parallel in such a way that the plane containing them could be rotated about a parallel axis so as to make any given angle with the vertical at the point. They have measured the diminution in the number of coincidences caused by introducing lead between the counters, and also by rotating the plane of the counters so as to make various angles θ with the meridian plane. Certain conclusions follow from these experiments which we shall now deduce.

Benedetti has measured the number of coincidences in the following three cases:

Arrangement.	Thickness of lead between the counters.	Angle θ to the west.	Rate/minute.
(1)	4 cm.	0°	$0{\cdot}625 \pm 0{\cdot}010$
(2)	16 cm.	0°	$0{\cdot}575 \pm 0{\cdot}009$
(3)	4 cm.	30°	$0{\cdot}516 \pm 0{\cdot}009$

The decrease between (1) and (3) is about twice the decrease between (1) and (2). Since at the height of Asmara 12 cm. of lead corresponds in mass to the extra thickness of atmosphere in going from the vertical to $\theta = 30°$, the difference between (1) and (3) might be ascribed to the greater absorption due to the same mass of air. This possibility can, however, be excluded by the experiments of Street, Woodward and Stevenson[3], who have measured the absorption in lead, iron and marble, and of Clay and his co-workers[4], who have measured it in various substances including water. These investigators find

that, to within a few per cent, all these substances absorb the hard radiation proportionately to their mass. It is impossible that air[5] should absorb essentially differently, so that we are led to the conclusion that the larger difference between (1) and (3) is due to the fact that, *before entering the atmosphere*, the number of particles arriving in a direction 30° to the west of the meridian is appreciably less than the number arriving vertically. This can only be due to the magnetic field of the earth, if there are *negatively* charged particles present.

These negative particles may be electrons or *negative* protons. The possibility that the smaller number of coincidences in (3) may be due to the intensity at the top of the atmosphere of electrons in a direction 30° west being smaller than the vertical intensity can be excluded at once, *provided these electrons behave in accordance with the theory*. For in order that this should be the case, at least the difference between (2) and (3), that is, more than 10 per cent of the number of coincidences in (2) with 16 cm. of lead between the counters, must be attributed directly or indirectly to them. It now follows from a recent paper[6] where successive processes of emission of radiation and pair-creation by γ-quanta have been treated according to quantum mechanics, that the absorption in 12 cm. of lead is so great that the number of coincidences with 4 cm. of lead, namely in case (1), should be at least a thousand-fold this difference, which is in flat contradiction to the actual observation. The results of Benedetti then force us to one of the two following conclusions.

(1) Extremely high energy electrons do not behave in accordance with the theory, and in particular, the radiation formulæ of quantum mechanics break down for these high energies.

(2) There are negative protons in cosmic radiation in considerable numbers, or alternatively, some other negatively charged particles hitherto unknown to physics.

I believe that sufficient experimental evidence,[7] direct and indirect, has accumulated by now to exclude the first possibility, particularly when taken in conjunction with the fact that the theoretical arguments showing that the theory should hold for all energies are sounder than any against the validity of the theory. It seems, then, that we are compelled to admit the existence of negative protons or new negative particles in appreciable numbers in cosmic radiation.

That we are forced to choose between the conclusions (1) or (2) is indeed not new, and follows also from a number of other observations, for example, the power some negatively charged particles have of apparently penetrating great thicknesses of lead[7]. The interest in the above considerations, however, lies in the conclusion that *negative primaries* entering the top of the atmosphere are responsible in part for the *penetrating* component of cosmic radiation.

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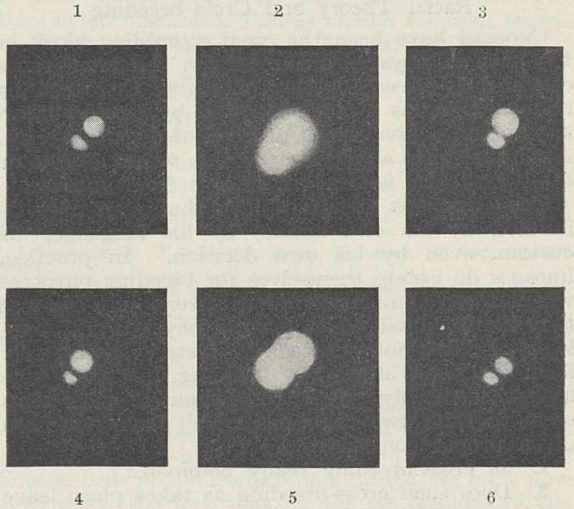
[1] *Phys. Rev.*, **45**, 212 (1934).
[2] *Phys. Rev.*, **45**, 214 (1934).
[3] *Phys. Rev.*, **47**, 891 (1935).
[4] *Physica*, **2**, 645 (1935); **3**, 332 (1936).
[5] Prof. Clay has kindly informed me that experiments on substances containing nitrogen show the same absorption as for other elements.
[6] Bhabha and Heitler, NATURE, **138**, 401 (1936); *Proc. Roy. Soc.*, in the press.
[7] Leprince-Ringuet and Crussard, *J. Phys.*, **204**, 112 (1937). Anderson and Neddermeyer, *Phys. Rev.*, **50**, 263 (1936).

Diffraction Experiments on the Resolving Power of Telescopes and Microscopes

THE diffraction of light on a circular aperture in a thin opaque screen has been studied by G. B. Airy[1], E. Lommel[2] and many others after them. The experiment is of fundamental importance for the theory of the image formation in optical instruments. The formula given by Airy has been but little modified, and in its present form (Preston[3]) is :

$$X = 0{\cdot}5F\frac{\lambda}{d},$$

where X is the minimum separable distance between two neighbouring disks, representing points of the object, λ the wave-length of the light, F the focal length and d the diameter of the lens.



DRAWINGS BY W. TH. SHEILLS AFTER PHOTOGRAPHS ENLARGED 4 TIMES.

Experiments with virus bodies, the size of which was below the limit of resolution given in the above formula, led to investigations of the experimental basis of that formula. It had been observed that reduction of intensity shows details that should not be visible in some cases and not resolvable in other cases if the formula was strictly right.

Compared with Airy's and Lommel's arrangements, one alteration was introduced, namely, instead of one hole in the opaque screen two holes were used. These two holes were observed in a telescope with an aperture variable by means of an iris diaphragm. A carbon arc served as a light source. White light as well as that of different wave-lengths was employed for the experiments. Photographs of the image were obtained by fitting a camera on top of the eyepiece of the telescope.

Fig. 1 shows the two holes in the screen as they appear with a large aperture of the telescope. The shape of the holes is well defined.

Fig. 2. The same holes illuminated with white light of higher intensity: the shape of the holes is not distinguishable.

Fig. 3. The intensity of the light is reduced again to that of Fig. 1, and the aperture of the telescope is reduced so far that the shape of the holes just cannot be discriminated.

Fig. 4. By the introduction of two polarizing prisms (Polaroid screens) into the path of the rays,

the intensity of the light was reduced until the threshold of the eye was reached for the minimum visible light intensity : the shape of the holes could be recognized and recorded photographically to a certain extent.

These experiments show that structure in the object can be resolved with an aperture of the optical instrument smaller than that postulated by the formula. Therefore it was desirable to test whether two points could be separated if their distance is too small to be separated otherwise than by this new principle.

Fig. 5. Shows the two holes imaged through a small aperture which does not enable them to be separated.

Fig. 6. Shows the effect of reduced intensity : discrimination of two points (the holes are not resolved) is achieved.

The effect has been reproduced on microscopic objects as well and the experiments are being published elsewhere.

Arising from the experiments described above, it is suggested that a factor I for the intensity of the light should be included in the formula of resolution. The value of I cannot be given as a constant as it necessarily varies with the light source employed. In my experiments it had the rough value of 0·1, judging by the respective times of exposure necessary to record the effect.

My thanks are due to the Council of the Middlesex Hospital Medical School and to the Trustees of the Sir Halley Stewart Trust Fund for facilities which enabled this work to be carried out.

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[1] Airy, G. B., *Trans. Camb. Phil.*, **5**, 238 (1834).
[2] Lommel, E., Beugungserscheinungen an einer Kalisronschen Öffnung, München, 1884.
[3] Preston, T., "The Theory of Light", 327 (London, Macmillan & Co., Ltd., 5th Edition, 1928).

The Modern Centrifugal Pump as a Plankton Collector

THE elimination of the many sources of error encountered in some form or another when collecting plankton for quantitative work with silk nets is a problem that has been attacked many times. During the last fifty years, a number of workers, many of them with some measure of success, have from time to time used a pump and filter as a means of collecting a small, but quantitatively accurate sample, of plankton.

Encouraged by the obvious possibilities and advantages of this method, we have recently conducted experiments with a modern centrifugal pump. The experiments were made from the Research Ship *Explorer*, Fishery Board for Scotland, and the results have proved to be of great value and interest. We are preparing a paper on the subject in which the whole aspect of the problem of sampling is discussed, and the historical position of the plankton pump reviewed.

The experiments were conducted with a water meter included on the delivery side of the pump, and show how a comparatively large volume of water (two and a half cubic metres) was filtered in ten minutes with a two-inch pump. A three-inch machine would deal with almost double the volume (five cubic metres) in the same time, and it is a pump of this calibre that we suggest for general use.

Filtering can be done either by suspending the net in a tank of water to take up the force of heavy delivery, or direct on to the ship's deck. This latter method was used in our work and the results show that the plankton so collected is little, if at all, damaged in passing the impeller at 2,000 revolutions per minute. Even complicated chains of diatoms and delicate forms such as *Aglantha* remained whole, while some of the zooplankton forms were seen swimming actively in the filtered sample. The suction action is more than ample to take all forms of life, so that the collections are in no sense selective, and the results obtained indicate clearly the greater quantity of small forms, both of phyto- and zooplankton, as compared with the larger forms.

The suction hose, which is made in jointed lengths of 25 feet (8 metres), can be readily attached to a steel warp weighted with lead, and though in the experiments only two such lengths were used, they presented no difficulty in handling. As the pump was designed to overcome the frictional resistance in ten or more such sections, there would presumably be no more difficulty with 100 metres of pipe than with 12–15 metres. The joints are made with a quickly meshed screw thread, and are water-tight ; and it was found that sections of much greater length than those used could be employed without difficulty.

This modern method of plankton pumping overcomes many obstacles familiar to the quantitative worker, and should be of widespread interest.

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Symmetry of Symbols

THE application of the theory of symmetry to decorative designs is well known to students of crystallography and to mathematicians interested in the theory of groups. Text-books on design do not discuss these simple rules for the construction and classification of patterns, most likely because the subject up to the present has been treated only in the technical language of mathematics.

In preparing some articles which have as their purpose to explain the subject in a simpler form, I came across the following example which may be of more general interest. If we classify the letters of the alphabet according to their symmetry characteristics, we find the following five groups (in mathematical language they are the sub-groups of the symmetry group of the rectangle) :

(I)	F G J K L P Q R
(II)	A M T U V W Y
(III)	B C D E
(IV)	N S Z
(V)	H I O X

I. Those letters which have no real symmetry properties.

II. Those of which the left half is the mirror image of the right half.

III. Those of which the upper half is the mirror image of the lower half.

IV. Letters which can be rotated over half a circle without changing; they remain the same when the page is turned upside down.

V. Letters which have all the above characteristics combined.

What stands out in this classification is that the letters *N*, *S* and *Z* are together in one group. They are just the characters which are always written incorrectly by uneducated people. It seems, therefore, that their type of rotation symmetry is slightly more difficult to grasp than the more common reflection symmetry. In this connexion it may be noted that many of the magic symbols used by ancient people possess such rotation symmetry over a half, a third or a quarter of a circle. This may perhaps help to understand why various primitive tribes independently have come to worship symbols like the swastika.

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Points from Foregoing Letters

PROF. E. A. MILNE relates considerations recently advanced by Dirac with his own results, but concludes that there is no inference as to the creation of matter. The form of the differential relation connecting intervals for the $t \rightarrow \tau$ transformation is stated.

Under very feeble illumination the eye sees the visible spectrum in a uniformly grey colour (scotopic vision). It had been found that the maximum luminosity for *equal energy* is at 5000–5040 A., while the maximum absorption of the visual purple pigment in the eye is at 5100 A. Dr. H. J. A. Dartnall and C. F. Goodeve point out that if instead of comparing energies one compares equal *quantum intensities*, then the two maxima coincide. They consider this, and also further approximate calculations of the relative intensities of the light absorbed at different wave-lengths, to give support to the hypothesis that the primary process in scotopic vision is the absorption of light quanta by visual purple.

Recent experiments on the resistance of ferromagnetics show a sharper Curie point than the specific heat measurements. Prof. N. F. Mott and Dr. H. H. Potter state that this is to be expected, because the resistance depends on long-range order (domain of more than about 8,000 atoms) and the magnetic energy depends on the interaction of electronic spins at close range.

The percentage of glutamic and aspartic acids in Cotswold wool and in seagull quill has been determined by Dr. J. B. Speakman and F. Townend. They conclude that the results support the 'salt-linkage' theory developed by Speakman to account for the elastic properties of wool-fibres in solutions of varying acidity. According to that theory, the long peptide chains of the keratin molecule are bridged by linkages arising from the combination of the acid side-chains of aspartic and glutamic acids, with the basic side-chains of arginine, lysine and histidine.

A study of spore-forming bacilli by a vital staining technique leads Dr. L. A. Allen, Miss J. C. Appleby and J. Wolf to the conclusions: (1) that a single species of bacillus may show alternative methods of forming endospores, resulting in two different cell structures extraneous to the spore; (2) that the spores, after being released from the cells, are at first refractile, but may later (in old cultures) take up stain, revealing an internal structure which undergoes rearrangement during a considerable period of time.

The ovary and testis of young and embryonic rats and mice have been grown *in vitro* by P. N. Martinovitch. The ova developed and survived for three weeks, but at the end of a month the whole organ degenerated. Spermatogenesis was less successful, stopping at the pachytene phase during the chromosome reduction stage during meiosis.

Some of the changes taking place when the larvæ of the oyster settle and become 'spat' are described by H. A. Cole. Within ninety hours a considerable metamorphosis occurs while the diameter of the shell increases from 0·3 mm. to 0·6 mm. There is still a gap in the life-history of the oyster, since the next stage described is one in which the diameter of the shell has reached 1·2 mm.

It is suggested by Dr. J. R. Baker that the breeding seasons of equatorial birds may be controlled by changes in the intensity of visible and ultra-violet illumination.

Lieut.-Colonel L. M. Davies finds evidence that the Ranikot (Palæocene) Sea of India extended from Sind to the Tirah, and from the Tirah to Tibet. It was apparently isolated from the contemporary marine waters of Europe.

A. M. Hocart adduces a few examples and impressions of lineages which voluntarily isolate themselves for breeding purposes. These he considers give a clue to the segregation of species in Nature.

From recent observations by Rossi and Benedetti, H. J. Bhabha infers that the number of cosmic particles arising from a direction 30° west of the meridian is appreciably less than the number arriving vertically. These, he reasons, must be negatively charged, and if the radiation formulæ of quantum mechanics hold for the high energies involved, then either negative protons or some other negatively charged particles hitherto unknown must be assumed to be present in appreciable numbers in cosmic radiation.

An effect of increased resolving power of telescopes and microscopes produced by means of reduced light intensity in some diffraction experiments is described by Dr. K. B. Merling-Eisenberg.

S. G. Gibbons and J. H. Fraser have experimented with a modern high-speed centrifugal pump for collecting plankton, and find that even delicate organisms are undamaged. They claim that accuracy is obtained by this quantitative method of sampling.

Research Items

Milk-Drinking Habits of School Children

SPECIAL efforts have been made in Great Britain during the last few years to popularize milk consumption. The most important measure designed for this purpose was the so-called milk-in-schools scheme, by which milk is supplied free or at a reduced cost to children attending grant-aided schools. The object of this scheme was to encourage the milk-drinking habit in the younger generation, but little information exists regarding the habits of the children prior to its commencement. To remedy this defect, an inquiry was undertaken by the Hannah Dairy Research Institute, Kirkhill, Ayr, under the director, Dr. Norman Wright, the results of which have now been published by that Institute (Bulletin No. 7, 1936). The inquiry covered nearly 14,000 school children, about two thirds of whom were resident in Glasgow and one third in rural and urban districts of Ayrshire. The outstanding fact revealed by the inquiry is the small extent to which milk is normally drunk by children of school age. Of the 13,317 children investigated, more than one half did not drink milk at all and one third only took it once daily. Tea drinking, on the other hand, was almost universal, only five per cent of the children failed to take tea once, while fifty per cent took it three or more times in the day. Only twenty-five per cent of the children took porridge at breakfast. Of other drinks, coffee was rarely taken, and cocoa only by about seven per cent. Only seven per cent took water at dinner, but nearly half the children took it between meals or at supper.

Return of Swallows to their Nesting Sites

UP to the end of 1935, the number of swallows marked with numbered rings under the *British Birds* scheme was 34,243, the great majority being nestlings. The number recovered up to the middle of 1936 was 285, of which 24 were found abroad. A. W. Boyd and Dr. A. Landsborough Thomson (*British Birds*, **30**, 278, Feb. 1937) have analysed the British returns, and find that adult swallows which have nested almost invariably return to the same place in subsequent summers, and often to the same nest. There is no record of an adult being recovered elsewhere in the breeding season, and there are records of pairs returning to a nest in more than one season. But young swallows very seldom return to the exact place where they were hatched, although many are found in the neighbourhood and within a few miles. A few were recovered so far away as 75–160 miles. A new feature which the analysis brings out is that soon after they are fledged, swallows tend to disperse from the nesting centre, previous to the setting in of true migration. This movement seems to take place in any direction, but since the observations are based upon the recovery of only 15 birds, confirmation is desirable.

Spawning of Black-headed Minnow

THE small North American cyprinoid, *Pimephales promelas*, known as the black-headed minnow, frequents areas where the bottom is covered with silt, and this leads to a peculiar spawning habit, described by L. R. Richardson (*Canadian Field-Naturalist*, **51**, 1, Jan. 1937). To avoid the smothering of the eggs in mud, they are adhesive and are attached to the under surface of some substantial object lying clear of the river bed. The site is selected by the male minnow, which thereafter shepherds a female to the place, after having cut her out from a group of various species. Invariably the male swims below the female during the shepherding operation, chivvying, pushing and even snapping at her if she shows any sign of an attempt to escape. On the arrival of the pair beneath the nesting site, the male by steady pushing causes the female to rotate with gradually increasing speed in an anti-clockwise direction. At the same time he presses her into a sideways position, in which her belly comes in close contact with the under surface of the log, to which during or after a few seconds of extreme commotion the eggs are attached and fertilized. The female is then driven away by the male, who repeats the performance with another and perhaps a third female. No special attention is given to creating a protective structure about the eggs, but the male guards the egg-mass assiduously from the attacks of other individuals who would devour them.

The Brown Bat in Western North America

IN Canada, the United States and Lower California, and Mexico, five races of *Eptesicus fuscus* are recognizable. These conform to Bergmann's law, showing a progressive decrease in size from north to south, the greatest difference being 19 per cent in total length and 8–9 per cent in skull length (William L. Engels, *Amer. Midland Naturalist*, **17**, 653; 1936). From the author's descriptions, it would also appear that richer coloration is more frequent in the moist coastal regions and that the inland race (*E. f. pallidus*) is distinguished by a much larger number of pale individuals.

Reactions of Nauplii to Light

THE nauplii of *Balanus amphitrite* and *Tetraclita squamosa* show remarkable reactions to light. Shuzo Ishida (*Sci. Papers Inst. Phys. and Chem. Res., Tokyo*, **30**, No. 659) describes how in the same culture some move to the side of the beaker that is illuminated, and others, fewer in number, move to the opposite side; he terms these movements skotophobic and photophobic. By using a beam of light passing through a slit, the concentration becomes more marked since the illuminated area is limited, and by altering the direction of the beam it can be shown that the phenomenon is independent of geotropism. If the light is directed horizontally and half the beaker is screened vertically, the two types show an interesting circulation in opposite directions in the darkened half of the beaker.

Physiological Effects of Polyploidy in Tomatoes

DR. A. C. FABERGÉ has made a statistical investigation of the effects of tetraploidy in the tomato in two recent papers (*J. Genetics*, **33**, No. 3) in which the effects on growth and size and variability are carefully analysed. It is well known that auto-tetraploids

generally differ from their diploid parent in being larger and stouter in many of their parts and in having larger cells and nuclei, although the fruits appear to be always smaller. Dr. Fabergé finds, however, that tetraploid tomato plants contain no more substance and no more water than diploids, although $4n$ embryos are 30 per cent heavier than $2n$. This advantage is lost during germination. It is concluded that heterosis in the F_2 generation is due only to the greater initial weight, and is of the same magnitude in $2n$ and $4n$ plants. As regards variability, the results agree with those of Lindstrom in showing less variation in fruit-weight of $4n$ than of $2n$ plants. The same is true of the weight of whole plants, where the decreased variation is found to be due entirely to diminution in variability of the embryos. Possible causes of this surprising decrease in variation of tetraploids are discussed. In the fruits, the reduction of variability occurs not between different plants but between the fruits of the same plant. This appears to mean greater stability in the plants. It cannot be accounted for as a direct genetic effect of segregation, and the author suggests that doubling of the genes results in an increased probability of the action of quantitative factors, which is reflected in the greater physiological stability of the early meristems. In the terms of Timoféeff-Ressovsky, the penetrance and expressivity of quantitative genes may both be increased by an increase in their absolute number.

Vernalization of Garden Crops

THE process known as vernalization, in which the time of flowering can be controlled by treatment of the seed and seedling, seems to promise such beneficial results, that any practical contribution to the subject is of great interest. A short paper by Miss D. M. Turner and Mr. S. Burr (*Gard. Chron.*, Jan. 2, 1937) shows that tomato plants respond to vernalization. The most successful treatment seemed to be a chilling of the seed for twenty-four days previous to sowing, and the application of twelve days' continuous light to the young seedlings. Experimental results are on rather a small scale, but show that the yield of vernalized plants is both heavier and earlier than normal. *Calendulas* and peas apparently did not respond to the treatment.

Migmatites of Central Sweden

IN a recent memoir of the Sveriges Geologiska Undersökning (*Årsbok*, **30**, No. 8, 88 ; 1936), Nils H. Magnusson describes his investigations of the veined gneisses of the iron-ore district of Kantorp in Södermanland. The ores belong to the leptite formation, which consists largely of volcanic rocks and sediments and their metamorphosed equivalents. Transformation of these rocks to veined gneisses was brought about, during regional subsidence, by emanations and solutions which arose from deeper levels where palingenetic processes were active. The change begins with the appearance of pegmatitic spots and strings, and these gradually increase in proportion until pegmatitic veins dominate the rocks. It is noted that slates everywhere appear to be most readily pegmatized. Comparative studies of nineteen chemical analyses indicate that granitic emanations 'soaked' through the leptite complex with its iron-ores and limestones. The emanations were followed up by intrusive pegmatites and these, in turn, by granites. The latter are regarded as concentrated segregation products, the material of which came partly from below, and partly from the rocks now accessible at the surface. Reasons are given for rejecting the earlier view that the gneisses are products of magmatic differentiation during conditions of high tectonic pressure.

Earthquakes in New Zealand

DR. J. HENDERSON and Mr. R. C. Hayes have recently issued the report on New Zealand earthquakes for the year 1935 (Wellington, N.Z., : *Dom. Obs. Bull.*, No. 116), a report prefaced by some general considerations on the earthquakes of the islands. During the century 1835–1934, sixty-nine destructive earthquakes were felt, of which forty-nine were of intensity 8 (Rossi-Forel scale) or semi-destructive, fourteen of intensity 9 and six of intensity 10. The regions visited most frequently by such earthquakes were the eastern and southern parts of the North Island and the northern part of the South Island. In the fiord region of the latter, sealers are said to have felt violent earthquakes in 1792, 1810 and 1826–27. Thus, although some parts of New Zealand have experienced no severe shocks during the last century, it does not follow that their immunity will continue. The year 1935 was a comparatively quiet one ; there were no destructive earthquakes, and only one of intensity 7, the total number reported as felt being 150.

A New Mass-Spectrograph

IN part 7 of vol. 145, Section 2*A* of the *Sitzungsberichte* of the mathematical sciences division of the Vienna Academy of Sciences, Dr. Josef Mattauch, of the Physical Institute of the University, gives an account of the behaviour of the mass-spectrograph constructed by the Institute with financial help from the Academy and the Rockefeller Foundation on the lines laid down by himself and Dr. Herzog in the *Zeitschrift für Physik* (**89** ; 1934). It depends on the power of a radial electrical field of mean radius a to render parallel a beam of positive rays diverging from a point $a/\sqrt{2}$ from the entrance plane of the field, whatever their velocities. If the parallel beam then enters a magnetic field at right angles, each mass component of it when bent through a right angle is focused on a plane through the point of entrance at 45° to the line of entry, and the distance of a line from the point of entry is proportional to the square root of the mass of each constituent. This system of double focusing has been generally adopted recently and gives excellent results. Dr. Mattauch finds a new isotope of strontium ^{84}Sr, new bands due to the dissociation of hydrocarbons, separates ^{15}N and ^{18}O from CH_3 and OH_2 and can resolve triplets.

Excitation of Phosphors in a Neon Discharge Tube

IN connexion with a note appearing in these columns under the above heading (NATURE, **139**, 160 ; 1937), we are informed by Mr. C. C. Paterson, director of the Research Laboratories of the General Electric Company, Ltd., that a neon discharge tube in which a zinc silicate phosphor is excited by the discharge was patented by the G.E.C., Ltd. and H. G. Jenkins in May 1935, the patent becoming available to the public in November 1936. Such discharge tubes are at present being used commercially, while mercury discharge tubes with phosphors have been on the market in England for at least three years.

Science and Building Exhibition

THE Building Centre at 158 Bond Street, London, W.1, is an organization formed by architects and others associated with the industry, and supported by official bodies for the benefit of all engaged or interested in building. Its most prominent function is the formation and maintenance of a permanent but continually changing exhibition of building materials and equipment, where a technical staff is available to give unbiased information regarding these. Its range of usefulness to the industry and to the general public is extended by special temporary exhibitions held from time to time and by lectures on cognate subjects. In another direction, a very important contribution to the progress of building technique is being made by the work of the several research stations engaged on one or other aspect of this many sided subject and the Department of Scientific and Industrial Research has arranged at the Centre a special Science and Building Exhibition to remain open until March 25.

In relation to timber, the Forest Products Research Laboratory has been engaged on several lines of investigation. The attack of insects is under constant inquiry involving the study of their food supplies and digestive processes. Here, emphasis is given to the fact that the lyctus beetle is the most serious cause of loss in Great Britain. In relation to fungus attack, models of properly and improperly ventilated buildings show how the progressive destruction occasioned by dry-rot can be avoided, while in another section the quantitative relation of moisture content to shrinkage of timber is demonstrated. Two other lines of inquiry relate to the wearing qualities of wood and to the best cutting angles of wood-working tools. In the former, a comparative test has been devised whereby the relative value of each sample of wood can be stated, while the improvements obtained in economy and finish resulting from the latter investigation can only be adequately appreciated by inspection of the results.

Geological data regarding sites and resources of building stones, clay pits, limestones, etc., come within the province of the Geological Survey and Museum which, manifestly, can exhibit here only a few items from the store of maps, publications and other accumulated information available at its headquarters.

The pivot of this Exhibition may be said to be work of the Building Research Station, wholly directed as it is to the interests of the industry. Its exhibits are of a varied nature. Here are on view examples of tests on concretes, plasters, bituminous preparations, etc., and of the machinery devised for the testing and correct manipulation of the materials in use. Photographs are shown of the full-size tests conducted under fire conditions at the Elstree Fire Research Station.

The insistent problem of noise and its mitigation is dealt with at the National Physical Laboratory, and several models are exhibited to show how the use of suitable materials and methods of construction can eradicate its worst effects. The conditions under which double walls and windows can be made effective, the right use of floating flooring to reduce impact noises, the elastic support of machinery and the application to walls of sound absorbent linings are demonstrated by means of models fitted with stethoscopes. On analogous lines, the work being done in connexion with illumination, wind pressures on structures and vibrations in roads and buildings is illustrated by means of diagrams and models.

In a series of photographic sequences, some aspects of the work of the Paint Research Station can be studied. A good paint requires to possess certain definite and distinct properties at different stages in its life—flow and 'brushability' during application, drying properties in the next stage, and elasticity, durability and appearance in its finished state. The photographs illustrate the tests applied at each stage and those also to which the raw materials are subjected. Of especial interest are those illustrating the electron diffraction camera used for ascertaining surface properties of pigments, the pattern obtained on a photographic negative and finally the actual atomic structure which can be deduced therefrom.

The Water Pollution Research Board and Chemical Research Laboratory have exhibits of fuller's earth in various conditions and of base-exchange and acid-exchange resins. These have been found to possess water-softening properties and the samples illustrate several stages in the processes of preparation. Apparatus used in determining the average concentration of lead in water for cooking and drinking is shown together with specimens illustrating the rate of the action of water on lead. Another activity represented is the purification of effluents from dairies and milk-products factories.

Domestic heating comes within the programme of the Fuel Research Station, the staff of which are showing samples of several fuels and are prepared to advise on this point with due respect to the national prejudice in favour of the open fire. The measurement of conditions in the domestic chimney is shown, and it is explained that so easily are these upset that special precautions are necessary as, for example, in ascertaining the amount of air passing up the chimney it is necessary to seal the room and admit air by one aperture in which the anemometer is placed.

A steel structure model illustrating the stages in the construction of multi-story flats is exhibited by the Iron and Steel Industrial Research Council and shows a number of alternative exterior treatments. Other exhibits and models illustrate the preparation and uses of 'foamed slag' for light-weight concrete. The British Non-Ferrous Metals Research Association is represented by tests on the behaviour of galvanizing and zinc coatings in domestic hot-water systems. The glass apparatus shown is used to test materials either in replacement of the corresponding glass part or by suspending a sample in the apparatus. The B.N.F. jet test, also exhibited, is designed to determine simply and rapidly the thickness of a metal coating, and an outline is given of the more important points emanating from the Association's research on the frost-bursting of water pipes.

Further opportunities of learning of these activities will be given in a number of lectures by members of research stations during the period of the exhibition.

Royal Botanical Gardens and Empire Botanists

By Sir Arthur Hill, K.C.M.G, F.R.S.

THE leading article in NATURE of January 9, on "National Museums of Natural History", discusses the relationship, "beyond the ordinary courtesies of friendship, which exists between these institutions". In the final paragraph, it is said: "We know of no such ties, and we wonder whether the interests of science in our Commonwealth of Nations would not be best served by attempting to develop such links. A free interchange of co-types could do much", and concludes, "But more is wanted, for the taxonomists in all [institutions] must have the same methods and ideas as to species in their work, and this can be secured by the periodical interchange of their staffs".

With regard to the Royal Botanic Gardens, Kew, which were specifically included with the "Museums" in the terms of reference of the Royal Commission on National Museums and Galleries appointed in July 1927, it seems desirable to direct attention to the fact that arrangements have been in operation for many years with other institutions and Governments, which are far more than "the ordinary courtesies of friendship" which, also, are of a very intimate nature with all other kindred institutions.

The Royal Botanic Gardens, Kew, being the headquarters of botanical work for the Empire, has built up in its herbarium and museums a vast collection of type specimens from all parts of the Empire, and the "Floras" of British India, Australia, South and Tropical Africa, etc., have been written at Kew. Kew, therefore, is the Mecca for our botanists from overseas, who must also pursue their studies among the historic specimens, especially from Australia, preserved in the British Museum (Natural History).

Sir Joseph Hooker, so long ago as 1882, realized the importance of establishing a close liaison between botanists working in India and those at the Royal Botanic Gardens, Kew, and on his proposal the Government of India appointed an Assistant for India to work in the Herbarium, and this post, paid by the Government of India, has been maintained since the year 1883. Several of the holders of the assistantship have formerly held Government botanical posts in India.

The Government of the Union of South Africa similarly maintains an Assistant for South Africa at Kew, but in this case a botanist on the staff of the Union Government is sent to work at Kew on the historical South African collections in the Kew Herbarium and returns to his duties in South Africa at the end of two or three years' service in the national herbarium. The salary of the Assistant for South Africa is paid by the Government of the Union of South Africa. This valuable arrangement came about as a result of a meeting of botanists of the Division of Botany held at Pretoria in 1918, in connexion with the establishment of the Botanical Survey of South Africa. At the moment, the South African Government has two officers working at Kew.

An Assistant for West Tropical Africa was appointed to Kew by the Governments of the West African Colonies in connexion with the preparation of "The Flora of West Tropical Africa". The assistant was appointed in 1909, but the post has now lapsed on the completion of the "Flora".

The proposal for the establishment of liaison officers between the Commonwealth of Australia and the Dominion of New Zealand and the Royal Botanic Gardens, Kew, was put forward by the Director of Kew in his report to the Governments of the Commonwealth and the Dominion after his visits to Australia and New Zealand in 1927–28, and received their approval. Nothing, however, resulted, for various reasons, and when the Third Imperial Botanical Conference was held in London in August 1935 the following resolution was passed:

"*Liaison Officers.*

"(1) This Conference commends to the Government of the Commonwealth of Australia the importance of maintaining close liaison in botanical matters with the Royal Botanic Gardens, Kew, and urges the Government to consider favourably the appointment of one of the younger Australian Systematic Botanists to work at Kew for a period of at least two years in making a critical examination of the historic Australian type-specimens at Kew and the British Museum and determining current collections made in the Commonwealth and sent over to Kew for critical examination.

"(2) It is further suggested that, at the expiry of his term of service, the officer appointed as Assistant for Australia should be replaced by another of the younger Australian Systematic Botanists."

Similar resolutions, appropriately worded, were passed with regard to New Zealand and Canada.

It is most gratifying to be able to record that the Commonwealth of Australia has now arranged to send over the Botanist from Perth, Western Australia, as its liaison officer to work for two years at Kew, who will be replaced at the end of the period by another botanist from the Commonwealth.

The resolution is also being considered favourably by the Dominion of Canada and by the Dominion of New Zealand. The Government of New Zealand hopes it may be able to send over in the near future a botanist to work at Kew, and it is expected that the Canadian authorities may eventually be able to send over an officer.

An interchange of officers has also been effected at Kew. A few years ago, one of the botanists on the staff of the Herbarium at Brisbane was sent over to Kew by the Queensland Government and a Kew Herbarium assistant was sent to Queensland to take his place, the two institutions paying the salaries of their officers. This exchange proved of the greatest possible value not only to the two institutions but also to the individuals themselves. The Australian botanist was able to study the historic types at Kew and the British Museum, while the Kew botanist had the opportunity of studying the flora of Queensland both in the field and in the Brisbane Herbarium, and also of getting into personal touch with all the botanists in the Commonwealth. Botanists from Kew have also been sent out to South Africa, Rhodesia and Malaya to study the flora, and botanists from all parts of the Empire are constant and welcome visitors at Kew.

It may be of interest to record that on the Gardens side the principle of exchange has for some time been in active operation, as we now exchange student gardeners with Germany, France, Italy, Sweden, Switzerland, Belgium, Canada, the United States of America and New Zealand, and other parts of the Empire when opportunity offers. The Kew student is sent out in exchange for one or two years, his place being taken by a student gardener from the botanic garden or other centre to which he has been sent. At the present time, twelve exchanges are in operation, much to the advantage of the men concerned and certainly to the advantage of Kew.

Wetting and Detergent Action

THE symposium on the "Scientific and Technical Aspects of Wetting and Detergency", held at the Imperial College of Science on February 19–20 under the auspices of the British Section of the International Society of Leather Trades Chemists, brought together a large company of scientific and technical workers for the discussion of nearly twenty interesting papers, which dealt with many of the known important points in these two problems, and suggested new points of view likely to prove important in future research.

The fundamental quantities determining whether a solid is, or is not, completely wetted by a liquid, are the surface tensions of the solid, and the liquid, and the amount of adhesion between the solid and the liquid. The impossibility, at present, of measuring the surface tension of solids is not such a serious difficulty in the scientific study of wetting as might be supposed, since the contact angle, which can be measured, is simply related to the surface tension of the liquid and the adhesion between solid and liquid, and is itself the immediately relevant quantity in most problems of wetting; and probably also in detergency.

C. G. Sumner described modifications in the 'plate' method for determining contact angles; N. K. Adam showed how contact angles can be determined on single textile fibres or thin wires visible under low powers of the microscope; and J. O. Cutter and C. W. Price reported a careful study of the method (originally due to Bartell and Osterhof) of measuring the adhesion tension and contact angles of liquids against solid powders, by determination of the pressure required to prevent the liquid penetrating into solid plugs of the powder, kept compact under high compression. This method, the only one available for the quantitative study of the wetting of fine powders, is not easy; it depends on careful attention to details of the apparatus and on the maintenance of a high pressure on the powder.

Probably the most important single industry dependent on the wetting properties of solid surfaces is that of mineral flotation; H. Freundlich dealt, in a short paper with a valuable bibliography, with the principal features of this process, including a discussion of the importance of contact angle, and of the surface films formed by the selective adsorption of the 'collectors' on the surface of the valuable minerals, which decrease their ease of wetting by the water and consequently cause them to stick to the air bubbles rising in the froth, and thus become collected at the surface. H. Martin described the very important applications of wetting agents in assisting the spread of insecticide solutions over the surface of leaves and fruit. He has taken particular account of the difference between the advancing and the receding contact angles, directing attention to which of the two is relevant for each practical problem; and he deserves gratitude for his timely protest against the pernicious and short-sighted practice of some manufacturers, in placing on the market, and expecting intelligent and chemically minded customers to use, or advisory officers to recommend, mixtures of unspecified and possibly inconstant composition bearing names suggestive of 'nostrums' rather than of scientifically manufactured and reliable products.

A paper by E. J. Daniels and D. J. Macnaughtan directed attention to some effects of surface impurities and inclusions in metals, on their ease of wetting by solders or by tin; this is a very important subject to which but little quantitative study appears to have been given. A. de Waele discussed the importance of wetting in the deflocculation and the plasticity of solid suspensions; and W. E. Wornum and G. A. Campbell dealt with the wetting problems of the paint industry, including the fundamental problem of the wetting of pigments by the liquid medium, and that of the surfaces to be painted by the finished paint or varnish. Wetting, it must be remembered, is not identical with deflocculation or dispersion; it is but one of the two main factors concerned. The other is the adhesion of the solid particles for each other, which must be overcome by the wetting liquid for the dispersion to be effective.

Detergency, which formed the subject of the second day's discussion, is a more complicated and perhaps more interesting problem. C. Robinson, in his introductory paper, discussed a theory due to N. K. Adam which places the emphasis in detergent action on the displacement of the grease from the solid surface, as comparatively large globules; the contact angle formed by the surface of separation between grease and aqueous detergent solutions, and the solid being cleaned, being the important measurable quantity determining the efficiency of detergent action. If this is correct, detergent action is essentially a preferential wetting of the solid surface by the detergent, instead of by the grease, and not, as has been occasionally held in the past, simply a wetting of the grease by the detergent, with consequent emulsification of the grease or other dirt. Surface and interfacial tensions, of course, enter into the problem, but neither alone is necessarily of predominating importance. Robinson considered also the problem of the removal of detached globules of grease from entanglement with the cloth; and described his measurements of the interfacial tension between oils and detergent solutions, which show some very remarkable effects of traces of polyvalent salts. G. S. Hartley discussed the power that solutions of soaps and paraffin chain colloidal electrolytes ('soap-like' substances) possess, of actually dissolving organic compounds which are

insoluble in water. These substances, even in quite dilute solutions, have their long paraffin chain ions aggregated into 'ionic micelles', and Hartley suggests that the solvent power is due to the interior of these micelles closely resembling liquid paraffin, and having similar solvent properties; so that when such a substance as azobenzene, or cetyl alcohol, is caused to dissolve in a soap solution, it is not distributed evenly over the whole solution, but is all to be found in the interior of the ionic micelles. A discussion of the changes in vapour pressure, as the ionic micelles increase in size through taking up other organic substances, leads to the conclusion that they can increase only to a certain size before becoming unstable; hence the solvent power of a soap solution for organic substances insoluble in water is definite and limited, and there is an unstable region of sizes between the largest micelles which can exist, containing dissolved organic material, and the droplets of an emulsion stabilized by a monolayer of the soap-like material: these emulsions simulate stability, though they are not strictly stable in a thermodynamic sense. Whether such solvent action has any practical bearing on the problem of detergent action is not certain; but it is a most interesting and novel theory of solvent action in unusual circumstances. E. K. Rideal directed attention to the possibility that the molecules of detergent substances may penetrate and displace films of other substances adhering to a solid surface; that such penetration often occurs in monolayers at an air-water surface has been shown by J. H. Schulman and A. H. Hughes. An extension of v. Búzagh's work on the adhesion of solid particles to solid faces was also described, with particular reference to detergent solutions.

Space scarcely permits of an adequate notice of the important points in the chemical constitution of detergent and wetting agents, but papers by H. K. Dean, and by E. T. Williams, C. B. Brown and H. B. Oakley gave a general account of them. As a rule, the successful detergents have a long hydrocarbon chain attached to an ionizable, strongly acidic, end group; compounds of similar constitution but basic, yielding paraffin chain cations, may be good detergents but suffer from the practical difficulty that, being mutually precipitated by soaps, they cannot be utilized in conjunction with soaps. One case was mentioned, however, of a new detergent in which there is no ionized end group, but instead a polymerized glycerol derivative, partially esterified with fatty acids.

That wetting and detergent agents operate by forming surface films on the surface both of the solid and of the grease or other dirt to be removed is clear. Part of the discussion turned on the orientation of the molecules in these films. Though the proof is not complete, it appears probable that when the wetting of a greasy surface, that is, one externally composed mainly of paraffin groups, is assisted by a wetting agent, the hydrocarbon part of the molecule of the wetting agent lies flat on the surface; the observed increase in hydrophilic character can probably be accounted for by the presence of only one water-attracting group in the space on the surface occupied by a molecule of the wetting agent lying flat. Such observations as are available on the amount of adsorption of detergents by paraffin wax surfaces show it to be much less than that required to cover the surface with a monolayer oriented perpendicular to the surface, but of the right order for a complete layer of molecules lying flat. In cases where a soluble agent is required to diminish the ease of wetting of a solid surface, as with the collectors used in flotation, the molecules may be oriented perpendicular to the surface, but with the hydrophilic groups towards the solid; this is not yet, however, certain, as a considerable diminution of wetting could probably be attained even with the molecules lying flat. A rather interesting case of the deposition of a layer difficult to wet on glass was mentioned; substances such as cetyl trimethyl ammonium salts, with a long paraffin chain cation, cause (in dilute solution) clean glass to become greasy in appearance, probably through their hydrophilic ends being attracted to the glass, which thus acquires a paraffin-like exterior.

The papers presented will be published in a separate volume, shortly; and they constitute a valuable focusing of ideas on many very important, and not yet fully understood, industrial questions.

N. K. A.

Maiden Castle, Dorchester

A REPORT by Dr. Mortimer R. E. Wheeler on the results of three years' work on the hill-top site of Maiden Castle, Dorchester, on behalf of the Society of Antiquaries and the Dorset Archæological Society, was presented at a meeting of the former Society on February 25.

As originally planned, the excavation was intended to occupy three seasons. The third and last of these in the autumn of 1936 was prolonged until December 24. As, however, the site has proved of even more intense interest than was anticipated, providing evidence of signal importance in its bearing on the development of civilization in the south and south-west of Great Britain, it has been decided to extend the investigation for another season to enable supplementary excavations to be carried out next year.

Maiden Castle has always been impressive by its size alone; and its vast dimensions have borne witness to a capacity for economic and political organization, which it seemed difficult to credit to a population so primitive as the early inhabitants of Britain. Dr. Wheeler's excavations have shown that not only was the construction of a far more complex and imposing character than surface indication showed, but also that it embodies a complete picture of all known phases of urban life in Britain before the days of the building of Roman towns in the latter part of the first century; while the presumedly primitive character of early British culture is shown to be anything but in accord with the facts now revealed.

Dr. Wheeler distinguishes at least four major phases in the occupation of Maiden Castle. The first, belonging to the early neolithic, was a settlement at the eastern end of the mound which had long been covered over, and became known only by this excavation. It had been enclosed by at least three rings of entrenchment excavated in the chalk by deer-horn picks. A large section of this was uncovered

in the excavations of the last season. From the contents it was evident that the settlers had been farmers, pasturing sheep and long-horned cattle, as well as practising agriculture. Their pottery showed that here in Wessex was a meeting place of the two strains of the neolithic in Britain, the western deriving from Brittany and the eastern from the Baltic. After a brief occupation by beaker folk from the Rhine, there followed a period extending over fifteen hundred years in which the site was abandoned.

Resettlement began in the eighth or seventh centuries; and by the fifth century B.C. settlers landing from north-east France had begun to raise the downland population to crowding point, necessitating organized defence behind the ramparts and entrenchments of the first Maiden Castle, concerning which recent excavation has revealed so much that is new in the elaborate limestone faced walls, the impressive double entrance, and the great ditch, 50 ft. wide and 25 ft. deep. Then comes the great enclosed city, covering forty-five acres, with a population of upward of four thousand—a city, however, primarily of farmers and industrially self-supporting, with few imports. Finally, in the first century B.C., there was the last and most ambitious enlargement, a monument of civic dignity, when spreading ramparts and ditches and high stone walls were added, with a provision of twenty thousand sling stones at the gates to ward off attack—walls which were to be laid low and finally abandoned save for a brief period, when Roman Dorchester was built.

Science News a Century Ago

Lyell and his Views on Geology

ON March 7, 1837, Lyell wrote a long letter to Whewell regarding the criticism with which some of his views had met. "As we had some conversation the other day," he said, "touching the extent to which I carried my doctrine of 'Uniformity' in the 'Principles of Geology' I wish to refer you to the first edition of that work . . . in order to show you that certain passages were somewhat unfairly seized upon by the critic, and not duly considered with and interpreted by others and by the context generally of the first volume. . . .

"It was impossible, I think, for anyone to read my work, and not to perceive that my notion of uniformity in the existing causes of change always implied that they must for ever produce an endless variety of effects, both in the animate and inanimate world. . . .

"In the review in the *British Critic* . . . you stated three formidable theses which I had undertaken to defend, in order to hear out my theoretical views. . . . I am sure that none of the propositions can now seem to you extravagant and visionary. . . . I allude to, first the adequacy of known causes as parts of one continuous progression to produce mechanical effects resembling in kind and magnitude those which we have to account for; secondly, to changes of climate; thirdly, the changes from one set of animal and vegetable species to another. . . .

"I was taught by Buckland the catastrophical or paroxysmal theory, but before I wrote my first volume, I had come round, after considerable observation and reading, to the belief that a bias towards the opposite system was more philosophical."

Geology of Suffolk

AT a meeting of the Geological Society held on March 8, 1837, the Rev. W. B. Clarke concluded the reading of his paper on Suffolk. The substratum of the whole of Suffolk, Norfolk and Essex, he said, is chalk overlaid with clay, sand and crag. While the crag still lay beneath the sea a violent catastrophe broke up many of the secondary strata from the chalk to the lias inclusive, and the debris thus caused, together with numerous masses of ancient rocks, was spread by a rush of water, over the surface of the tertiary formations and the chalk, in some places to a depth of 400 feet, constituting the beds of drift, clay, etc., which occupy so great an area in Suffolk. Afterwards a series of shocks elevated the whole district until the crag attained the height of nearly 100 feet above sea-level.

Shillibeer's Voltaic Battery

WRITING from the Grammar School, Oundle, on March 9, 1837, to William Sturgeon, the Rev. John Shillibeer gave a "Description of a new arrangement of the Voltaic Battery and Pole Director". "In the course of the last winter," he said, "when I was preparing a few lectures on experimental philosophy for the amusement of my scholars, I was struck with the complicated arrangement of the voltaic battery, and the difficulty which frequently occurred from the number of connexions, to get all the wires into so perfect a contact as to ensure success to the experiment." To get over the difficulty he experienced, Mr. Shillibeer had devised a battery consisting of a copper trough divided into five compartments by copper partitions, the trough being filled with a solution of copper sulphate. Into the compartments dipped five plates of zinc the tops of which were soldered to a copper bar which was fixed to a wooden cover to the trough. In a groove in the wooden cover were two sliding terminals by which contact could be made with the copper or the zinc. By means of these terminals the direction of the current in a wire could be easily reversed. In concluding his description, Mr. Shillibeer said, "I cannot but feel gratified at the success which has hitherto attended the career of my little instrument; and very glad shall I be if it may lead to other and more important improvements in aid of a science which, let us hope, may be ultimately applied to purposes of solid benefit to all mankind." (*Sturgeon's Annals*, 1, 224.)

Airy's Observations at Cambridge Observatory

ON March 10, 1837, Airy communicated to the Royal Astronomical Society the "Results of the Observations of the Sun, Moon and Planets, made at Cambridge Observatory in the Years 1833, 1834 and 1835". During those three years, he said, the sun, moon and planets were observed on the meridian at Cambridge Observatory with the transit and mural circle, with as much regularity as the limited personal establishment of the institution permitted. The instruments with which the observations were made were not, he thought, surpassed by any in the world. The immediate results of observation were systematically compared with the places given by tables, and the apparent error of the tabular place in right ascension and north polar distance was given in the *Cambridge Observations*. The series of apparent errors thus found was, he believed, one of the most complete that had been formed from observations over the same period.

University Events

CAMBRIDGE.—D. H. Barron has been appointed University lecturer in the Department of Anatomy.

In a report of the Buildings Syndicate, it is recommended that the plans for a new School of Anatomy prepared by Mr. J. Murray Easton be approved, and that the Financial Board be authorized to accept a tender.

The degree of M.A. has been conferred on J. S. Baxter, D. V. Davies, M. T. Greig and W. R. M. Morton, University demonstrators in anatomy.

W. T. Astbury, lecturer in textile physics in the University of Leeds, has been approved for the degree of Sc.D.

The Sedgwick Prize offered every third year for the best essay on some subject in geology or kindred sciences and valued at about £90 has been divided equally between Dr. E. C. Bullard of Clare College and Dr. F. C. Phillips of Corpus Christi College.

Dr. J. Gray, University reader in experimental zoology, fellow of King's College, has been elected, as from October 1, 1937, to the professorship of zoology vacant owing to the retirement of Prof. J. Stanley Gardiner.

OXFORD.—Sir Arthur Salter (Independent) has been elected an M.P. for the University in succession to Lord Hugh Cecil, who resigned on his appointment as Provost of Eton. Sir Arthur, who is professor of political theory and institutions in the University, has been a member of the Economic Advisory Council since 1932.

In Convocation on February 27, the honorary degree of D.Sc. was conferred upon Prof. The Svedberg, director of the Physical Chemical Institute at Uppsala.

H. W. Thompson, St. John's College, has been appointed University demonstrator in chemistry for two years as from October 1, 1937.

Prof. N. V. Sidgwick has been re-appointed University reader in chemistry.

The following have been reappointed for four or five years as from October 1, 1937, as University demonstrators in their subjects: Dr. R. S. Creed and Dr. C. G. Douglas (physiology), T. C. Keeley (physics), Dr. R. L. Vollum (pathology), E. Whitley (biochemistry) and J. Z. Young (zoology).

Societies and Academies

London

Royal Society, February 25.

JULIA BELL and J. B. S. HALDANE: The linkage between the genes for colour-blindness and hæmophilia in man. Colour-blindness and hæmophilia are known to be sex-linked. The genes responsible for them should therefore be carried in the same chromosome, and exhibit partial linkage with one another. Six pedigrees are described in which both conditions are found. In three of these, the genes are located in the same chromosome, and are associated throughout the pedigree, all hæmophilics investigated being also colour-blind, and none of their non-hæmophilic brothers being colour-blind. In two pedigrees, the opposite condition holds, whilst one is doubtful, including two colour-blind brothers only one of whom is hæmophilic. This fact is attributed to crossing-over. A function $P(x, p)$ of the frequency x of crossing-over, and the frequency p of colour-blindness in the male population, is calculated, which represents the probability of the observed association. The probability that the association attributed to linkage is due to sampling is less than 4×10^{-6}. The frequency of crossing-over is as likely to be above as below 5 per cent. Further confirmation has been obtained for the view that hæmophilia originates by mutation.

D. E. LEA, R. B. HAINES and C. A. COULSON: The action of gamma rays on growing and on non-proliferating bacteria. Experiments are described on the lethal action of gamma radiations upon aqueous suspensions of *B. coli* and spores of *B. mesentericus*. Exponential survival curves are obtained, the mean lethal ionization dosages being approximately equal to those previously obtained for beta rays under conditions in which the rate of death was very much greater. Experiments upon *B. coli* in nutrient media are also described which suggest that the lethal action of the radiation proceeds independently of growth in the medium. Under certain conditions, abnormal *B. coli* in the form of long filaments have been obtained. A quantitative analysis of the results of viable counts, total counts, and length distribution measurements leads to the conclusion that the production of long forms is due to division being inhibited, while growth, in the sense of increase of volume, is unaffected.

Dublin

Royal Irish Academy, February 8.

L. B. SMYTH: Some observations on *Lophophyllum cyathophylliodes* Vaughan. This carboniferous coral was described by Vaughan under the generic name *Lithostrotion*. It is here transferred to *Lophophyllum*, and shown to be very variable. A young stage is described. The type is in Dublin.

J. SELWYN TURNER: The faunal succession in the carboniferous limestone near Cork. Lower Carboniferous zones from Z to D_1, inclusive, are identified in the limestone facies east of Cork city, and their fauna discussed, as a preliminary to a study of the Culm facies immediately to the west. At Little Island, the succession is best exposed, but observations were also made at Blackrock and Midleton.

Paris

Academy of Sciences, February 1 (*C.R.*, 204, 305–383).

EMILE BOREL: An elementary problem of strategy.

MAURICE GIGNOUX and FRANCK BOURDIER: The history of the ancient Rhone glacier at its exit from the Geneva basin.

CHARLES PISOT: The modulo 1 distribution of successive powers of the same number.

ROBERT FORTET: Probabilities in chains.

DANIEL DUGUÉ: An extension of the law of large numbers.

PAUL DELENS: Studies on the tetrahedron.

SERGE FINIKOFF: Series of Laplace for which the index surfaces of the same parity have their asymtotics in correspondence.

ANTOINE APPERT: The relations between Linfield spaces and complexes.

GEORGES KUREPA: The problem of Souslin and abstract spaces.

I. PRIVALOFF : The general theory of polyharmonic functions.

LÉOPOLD ESCANDE and GEORGES SABATHÉ : Researches on hydrometric velocity meters. Study of the errors introduced by the usual method of calibration.

KENTARO YANO : The unitary theory of fields proposed by M. Vranceanu.

EMILE SEVIN : Novæ and white dwarfs.

RAYMOND GRANDMONTAGNE : The photo-electric study of the colour of the night sky. Application of a recording photo-electric photometer, fitted with colour screens, to the study of the variations of brightness of the night sky. The distribution of energy differs from that of a black body, and shows a high proportion of red.

MME. IRÈNE MIHUL and CONSTANTIN MIHUL : The propagation of radio-electric signals between two points at a distance from each other.

AUGUSTIN BOUTARIC, LOUIS FERRÉ and MME. MADELEINE ROY : Spectro-photometric researches on the dilution and mixture of wines.

SALOMON ROSENBLUM and MARCEL GUILLOT : The possibility of the existence of equidistant energy levels in the nuclei of radioactive bodies.

P. CARRÉ and H. PASSEDOUET : The influence of the terminal group on the melting point of normal chain fatty compounds.

JULES BRÜLL : The influence of electrolytes on the hydration of some complex cobaltic compounds.

MAURICE CURIE : Phosphorescent glasses. The influence of crystallization. Experiments are described proving clearly the influence of crystallization on the duration of phosphorescence. Ordinary glass and zinc borate were used, the latter with additions of small proportions of manganese, lead, bismuth, samarium and uranium.

JEAN SAVARD, MARC DE HEMPTINNE and PAUL CAPRON : The ionization potential of carbon monoxide. The number of critical points was so numerous that doubts arose as to the apparatus used; but a repetition of the work, with tantalum replacing copper, proved the correctness of the first experiments. The ionization potential of the molecule CO is given as 13·5 eV.

ARAKEL TCHAKIRIAN : The germanioxalates and zirconioxalates of quinine and strychnine.

JOSEPH HOCH : The action of organomagnesium compounds on the trialkylacetophenone oxims.

PAUL CHOVIN : Researches on the Pechmann colouring matters. A method of synthesis allowing the preparation of colouring matters with unequal substituents.

RAYMOND PAUL : The action of Raney nickel on some aldoxims.

GEORGES DANTLO : The esterification of Congo copal in the oil varnish industry.

JEAN CUVILLIER : Discovery of the nummulitic in the island of Shadwan (Red Sea).

RENÉ PERRIN : Metamorphism and folding.

LUCIEN PLANTEFOL : The respiratory oxidations : intrinsic and extrinsic oxidations.

MAURICE LANGERON : Statistical and mycological observations on human scald-head in Morocco.

J. RISBEC : The crystal sac of *Nerita*.

LOUIS FAGE : The apneumonic spiders.

CONSTANTIN DAWYDOFF : Some observations on the embryonic development of the madrepores.

ARTHUR BRUNEL : A new enzyme, allantoicase. Its presence in the animal kingdom. This enzyme is capable of splitting allantoic acid into two molecules of urea and one molecule of glyoxylic acid. Originally isolated in *Sterigmatocystis*, it is now shown to be present in the liver of *Raja punctata* and in the liver of frogs.

MAURICE DOLADILHE : The relations between alexine and the viscous protein of serum.

Moscow

Academy of Sciences (*C.R.*, 4, No. 6 ; 1936).

S. SOBOLEFF : The algorithm of Schwarz in the theory of elasticity.

N. KOŠLIAKOFF : Some infinite integrals.

B. SEGAL : Generalized Waring's problem in connexion with the estimation of trigonometrical sums.

G. FICHTENHOLZ : Contribution to the theory of linear functions.

M. P. ŽELDAK : Influence of cutting on the distribution of the first order strains in a cylinder.

P. M. MURZAJEV : Sericitization of pegmatites of the Gdov district, Leningrad region, and its genesis.

A. G. EBERZIN : Miocene of south-east Transcaucasia.

G. G. MARTINSON : Distribution of sponge spiculæ in a bore hole of deep borings near the village Possolsk on the Baikal Sea.

G. LAEMMLEIN : Twisted quartz.

A. E. KRISS : Anthocyanin in Actinomycetes.

V. VASNECOV : The caudal keels of fishes.

Vienna

Academy of Sciences, November 12.

ERNST CHWALLA : A new type of solution in the theory of stability. The case of a symmetrically loaded rectangular framework having two joints is considered.

OTTO BENNDORF : Anthracene-1, 2-dicarboxylic acid anhydride.

November 19.

JOVAN JURIŠIĆ : (1) Germination and morphology of the seeds of *Bryophyllum*. (2) Physiology of germination of Gesneriaceæ. Some species of Gesneriaceæ will germinate in the dark, provided the temperature lies within a certain range, while others will not germinate in any circumstances in the dark.

RUDOLF WAGNER : Existence of typical non-bracteolate blossoms of Rubiaceæ.

HERBERT SCHOBER and HEINRICH ANGENETTER : Spark spectrum of radium emanation.

LOTHAR KOSCHMIEDER : Operational calculus with two variables, and the bilinear form of the Laguerre polynomial.

FRANZ E. SUESS : Periplutonic and enorogenic regional metamorphosis. Regional metamorphs are divided into two classes according to whether the diffusion of material is brought about by temperature gradients or by tectonic displacements.

JULIUS PIA : Principal data from a stratigraphical study of the Prague Dolomites (south Tyrol).

KARL STRUBECKER : Circular quadratic complexes.

M. PESTEMER and G. SCHMIDT : A new polarization photometer for the visual determination of differences of blackness, and its application to photographic spectrophotometry.

Forthcoming Events

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

Monday, March 8

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Prof. George Barbour: "The Tennessee Valley Project".

Tuesday, March 9

ROYAL HORTICULTURAL SOCIETY, at 3.30.—Prof. E. J. Salisbury, F.R.S.: "The Plant and its Water Supply" (Masters Memorial Lectures. Succeeding lecture on March 23).

QUEKETT MICROSCOPICAL CLUB, at 7.45—(at 11 Chandos Street, Cavendish Square, W.1).—H. S. Sarson: "The Microscope and Distillation of Vinegar".*

PHARMACEUTICAL SOCIETY, at 8.30.—Dr. W. H. Hatfield, F.R.S.: "The Uses of Stainless Steel for Pharmaceutical Apparatus".

Wednesday, March 10

GEOLOGICAL SOCIETY, at 5.30.—Dr. G. M. Lees and P. T. Cox: "The Geological Basis of the Present Search for Oil in Great Britain".

INSTITUTE OF WELDING, at 6.30—(at the Institution of Mechanical Engineers, Storey's Gate, S.W.1).—Dr. V. E. Pullin: "The X-ray Examination of Welds".

ROYAL SOCIETY OF ARTS, at 8.15.—Dr. C. S. Myers, F.R.S.: "Industrial Psychology and the Modern World".

Friday, March 12

ROYAL SOCIETY OF ARTS, at 4.30.—Dr. E. J. H. Mackay: "Excavations at Chanhu-daro".

PHYSICAL SOCIETY, at 5—(at the Imperial College of Science and Technology, South Kensington, London, S.W.7).—Annual General Meeting.

ROYAL INSTITUTION, at 9.—Sir Gerald P. Lenox-Conyngham, F.R.S.: "Monteserrat and the West Indian Volcanoes".

INSTITUTE OF METALS, March 10 and 11, at 10 a.m.—Twenty-ninth Annual General Meeting to be held in the Hall of the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1.

Appointments Vacant

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

ASSISTANT LECTURER IN ELECTRICAL ENGINEERING AND HYDRAULICS in University College, Swansea—The Registrar (March 10).

SCIENCE LECTURER (chemistry, physics and mathematics) in the County Technical College, Worksop—The Principal (March 12).

SENIOR PHYSICIST in the Wool Industries Research Association—The Secretary, Torridon, Headingley, Leeds, 6 (March 12).

VETERINARY BACTERIOLOGIST in the Imperial Veterinary Research Institute, Muktesar, India—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (March 13).

SENIOR SCIENTIFIC OFFICER in the Explosives Directorate, Research Department, Woolwich, S.E.18—The Chief Superintendent (March 13).

ASSISTANT (GRADE III) (physics or engineering) in a War Department Establishment—The Secretary, Royal Engineer and Signals Board, Regent's Park Barracks, Albany Street, N.W.1 (March 13).

GENERAL INSPECTOR OF AGRICULTURE in the Ministry of Agriculture for Northern Ireland—The Secretary, Civil Service Commission, Stormont, Belfast (March 15).

PRINCIPAL of the Bihar Veterinary College, Patna—The Director, Veterinary Services, Bihar, Patna, India (March 31).

LECTURER IN MATHEMATICS in the West Ham Municipal College, Romford Road, Stratford, E.15—The Principal (April 3).

CARTOGRAPHER in the Hydrographic Department of the Admiralty—The Secretary, Civil Service Commission, Burlington Gardens, W.1 (April 8).

ASSISTANT LECTURER IN METALLURGY in the University of Manchester—The Registrar (April 17).

REGIUS PROFESSOR OF CHEMISTRY in the University of Glasgow—The Private Secretary, Scottish Office, Whitehall, London, S.W.1 (April 30).

Official Publications Received

Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh, Session 1936–1937. Vol. 57, Part 1, No. 1: Some Philosophical Aspects of Modern Physics (Inaugural Lecture as Tait Professor of Natural Philosophy, University of Edinburgh). By Dr. Max Born. Pp. 18. 1*s.* 6*d.* Vol. 57, Part 1, No. 2: Some Formulæ for the Associated Legendre Functions of the Second Kind; with Corresponding Formulæ for the Bessel Functions. By Prof. T. M. MacRobert. Pp. 19–25. 6*d.* Vol. 57, Part 1, No. 3: Quantitative Evolution in Compositæ. By Prof. James Small and Miss I. K. Johnston. Pp. 26–54. 2*s.* 6*d.* Vol. 57, Part 1, No. 4: Studies in Clocks and Time-keeping, No. 6: The Arc Equation. By Prof. R. A. Sampson. Pp. 55–63. 9*d.* (Edinburgh: Robert Grant and Son, Ltd.; London: Williams and Norgate, Ltd.) [22

The British Electrical and Allied Industries Research Association. Sixteenth Annual Report, October 1, 1935, to September 30, 1936. Pp. 136. (London: British Electrical and Allied Industries Research Association.) [32

Ministry of Agriculture and Fisheries and Department of Agriculture for Scotland. Soils Surveyors' Conference: Executive Committee ("Soils Correlation"): Third Report, England. Pp. 68. (London: Ministry of Agriculture and Fisheries.) [52

Other Countries

The Science Reports of the Tôhoku Imperial University. Second Series (Geology). Special Volume No. 1: Recent Reef-Building Corals from Japan and the South Sea Islands under the Japanese Mandate. By Hisakatsu Yabe, Toshio Sugiyama and Motoki Eguchi. Pp. 66+59 plates. (Tôkyô: Maruzen Co., Ltd.) [22

Bulletin of the American Museum of Natural History. Vol. 73, Art. 1: Results of the Archbold Expeditions, 14: Birds of the 1933–1934 Papuan Expedition. By Ernst Mayr and A. L. Rand. Pp. 248. (New York: American Museum of Natural History.) [42

South Australia. Annual Report of the Director of Mines and Government Geologist for 1935. Pp. 8. (Adelaide: Government Printer.) [52

Association de Géodésie de l'Union Géodésique et Géophysique Internationale. Bibliographie géodésique internationale. Tome 1: Introduction; années 1928, 1929, 1930. Par Georges Perrier et Pierre Tardi. Pp. 221. (Paris: Association de Géodésie de l'Union Géodésique et Géophysique Internationale.) 70 francs. [62

Lucknow University Studies. Faculty of Science, Session 1934-35. No. 111: Parasitic Worms and Disease; Lectures on Certain Aspects of Helminthology. By Dr. Gobind Singh Thapar. Pp. iv+46. (Lucknow: Lucknow University.) [82

A Memorandum on the Spirit and Pharmaceutical Industry of India, with a Discussion of its Difficulties, Needs and Requirements. By Raj Mitra B. D. Amin. Pp. iii+52. (Baroda and Bombay: The Alembic Chemical Works Co., Ltd.) [82

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 35: Technological Reports on Trade Varieties of Indian Cottons, 1936. By Dr. Nazir Ahmad. Pp. v+144. (Bombay: Indian Central Cotton Committee.) 1.8 rupees. [82

Imperial Council of Agricultural Research. Scientific Monograph No. 10: The Spotted Boll-Worms of Cotton (*Earias fabia* Stoll. and *Earias insulana* Boisd.) in South Gujarat, Bombay Presidency. (Final Report on Investigations financed by the Indian Central Cotton Committee, 1923 to 1931.) By B. P. Deshpande and N. T. Nadkarny. Pp. v+208+25 plates. (Delhi: Manager of Publications.) 5.14 rupees; 9*s.* 6*d.* [82

New Zealand: State Forest Service. Leaflet No. 28: Terminal Hypertrophy in *Pinus radiata* in relation to Frost Damage. By T. T. C. Birch. Pp. 11. (Wellington: Government Printer.) [92

Sveriges Geologiska Undersökning. Ser. Ca, No. 25: A General Earth Magnetic Investigation of Sweden carried out during the Period 1928–1934 by the Geological Survey of Sweden. Part 1: Declination. By Kurt Molin. Pp. 98+4 plates. (Stockholm: Sveriges Geologiska Undersökning.) 10.00 kr. [92

Statens Meteorologisk-Hydrografiska Ånstalt. Arsbok, 16, 1934, iii: Vattenstånden vid rikets kuster. Pp. 23. 2.00 kr. Årsbok, 17, 1935, v: Hydrografiska mätningar i Sverige. Pp. 12. 3.00 kr. Meddelanden, Serien Uppsatser. No. 10: A Contribution to the Knowledge of the Influence of the Gulf Stream on the Winter Temperature of Northern Europe. By Folke Bergsten. Pp. 298–307. 1.00 kr. No. 11: A Coefficient of Humidity of General Applicability. By Anders Angström. Pp. 245–254. 1.00 kr. No. 12: Radiation Measurements on Isachsen's Plateau. By Hilding Olsson. Pp. 225–244. 1.50 kr. No. 13: Physik der Troposphärischen Fronten und ihrer Störungen. Von Tor Bergeron. Pp. 381–395. (Stockholm: Statens Meteorologisk-Hydrografiska Anstalt.) [92

U.S. Department of Agriculture. Farmers' Bulletin, No. 1624: The Mexican Bean Beetle in the East and its Control. By Neale F. Howard, Loyd W. Brannon and Horatio C. Mason. Pp. ii+21. (Washington, D.C.: Government Printing Office.) 5 cents. [125

Catalogues

Old Science and Medicine. (Catalogue 43.) Pp. 64. (London: E. P. Goldschmidt and Co., Ltd.)

The Colorimetric Determination of Oxidation-Reduction Balance. Second edition, revised. Pp. 20. (London: The British Drug Houses, Ltd.)

A Catalogue of Books, including Bibliography and Palæography, European History and Literature, Genealogy, Heraldry and Topography, Occult Sciences, Periodicals and Publications of Learned Societies, Political Economy, Sports and Pastimes, followed by a Selection of Books on Botany. (No. 529.) Pp. 124. (London: Bernard Quaritch, Ltd.)