Editorial & Publishing Offices:
MACMILLAN & CO., LTD.
ST. MARTIN'S STREET
LONDON, W.C.2

NATURE

Telegraphic Address:
PHUSIS, LESQUARE, LONDON

Telephone Number:
WHITEHALL 8831

No. 3458 SATURDAY, FEBRUARY 8, 1936 Vol. 137

Intellectual Freedom and the Progress of Science

THE disappearance of the atmosphere of political freedom of Huxley's day, in which scientific inquiry grew to its full stature, though happily as yet less marked in Great Britain and in France than in some other countries, poises many problems which are closely related with the advance of science and the development of society. The fears for the future of intellectual freedom expressed by Prof. A. V. Hill in his Huxley Memorial Lecture delivered at Birmingham in 1933 have been justified by the events of the last year or more, and the Conference on Academic Freedom held last summer at Oxford, the report of which is now available*, discussed important matters concerned not merely with the establishment of the principle but also with its application for the safeguarding of human culture.

Although the major threat to academic freedom has come from Germany, the danger is not confined to that country, and the Conference passed a resolution recognising the need of relief for persecuted teachers in other countries besides Germany. The great majority of university teachers in Great Britain have already affirmed their support of the principles of academic freedom, and any attempt to infringe it would be met by determined opposition, but the position is not nearly so satisfactory as regards teachers in schools and research workers. There have been several instances of dismissals on account of political activities, and even in regard to university teachers, tranquillity may be due largely to very careful selection at the start.

The existence of this tendency, which is antagonistic, both in intent and in fact to freedom, like the tendency to lay claim to freedom in ways that cannot always be defended, is sufficient reason for considering carefully the wise organisation of means for safeguarding academic freedom. The report of the recent Conference presents a cogent case for such organisation to which the scientific worker will do well to pay heed while there is yet time.

The question of intellectual freedom was also discussed by Dr. A. W. Pickard-Cambridge in his presidential address to Section L (Educational Science) at the British Association meeting at Norwich last September. Dr. Pickard-Cambridge made the assumption—to which scientific workers will find little difficulty in assenting—that individual freedom, subject to such a minimum of restriction and organisation as is necessary for life as a member of a community, is the indispensable condition of a good or even a tolerable human existence, and that the educational system of a democratic State should be directed towards the maintenance of that freedom, and the encouragement of its responsible use. An exactly analogous question of freedom is the central problem of team work in industrial research, and the reconciliation of individualism and initiative with co-operative effort is an essential factor in the resolution of many of the most important problems in science as well as in industry or society.

Freedom, as Dr. Pickard-Cambridge reminded us, has a social as well as an individual aspect, and in both aspects it depends partly on the individual's own capacity and partly upon the political and social structure and behaviour of the community. The freedom which the scientific and professional worker can justly claim involves three kinds of rights. There are those which he

* Report of the Conference on Academic Freedom, Oxford, August 1935. Published for the Academic Freedom Committee. Pp. 94. (Cambridge: W. Heffer and Sons, Ltd., 1935.) 2*s.* 6*d.* net.

has in common with other men as a citizen, rights which he has in matters of personal conduct and behaviour, and rights relating to his work in his own professional field.

In regard to civic rights, the professional worker has exactly the same rights as any other citizen, and so long as he does not claim rights that interfere with the satisfactory discharge of his duties, it is unreasonable to object to his participation in political or civic activities. Not only have such objections been raised, but also strong prejudices exist in regard to his personal rights, and in some quarters there is a tendency to impose on the professional worker disabilities as to his private conduct which do not equally apply to other citizens.

The strong protest against this tendency uttered at the Conference on Academic Freedom has the greater weight in view of the desirability of the scientific worker participating much more fully in the life of the community both as a citizen and as a professional worker. Any such limitations on his life and conduct cannot but react against the evolution of a new order in which the scientific and technical factors in our complex industrial, social and international problems are handled in an impartial and scientific spirit.

The scientific worker cannot participate in the life of the community to the extent that is desirable unless he is free to express his opinion sincerely and impartially. That is a first condition of his co-operation, and inevitably it involves a right to freedom of speech upon controversial issues. It is at this point that the question of academic freedom becomes linked up with the question of the utilisation of science. It is unnecessary here to recapitulate the factors which are forcing scientific workers to consider much more closely the relations between their work and the society in which they find themselves. If freedom to seek the truth in the scientific worker's own way is an essential condition for creative thought and discovery, a like freedom is no less essential if we are to plan the development of science and the utilisation of its results most wisely and for the maximum benefit of mankind. To-day, no less than in Huxley's time, scientific inquiry can only develop to its full extent in an atmosphere of political freedom.

The case for organisation in defence of academic freedom, urged at the opening session of the Conference from the point of view of the professional worker himself, was powerfully reinforced by the arguments advanced at the discussion on the utilisation of science. Means must be found of avoiding the dissipation of energy and of facilitating co-operation between different organisations of scientific and professional workers. Only thus can we expect either the formulation of a constructive and agreed programme of action for the utilisation of science—to remove the paradox of poverty in the midst of plenty and of the breakdown of civilisation, in spite of the resources with which physical science has endowed mankind—or united action and support of the programme when it has been delineated.

The Price Problem

Gold and Prices

By Prof. George F. Warren and Prof. Frank A. Pearson. (The Price Series.) Pp. vii+475. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1935.) 25*s*. net.

AMID the plethora of books on economics and its vague indefinite hinterland there have been, in recent years, comparatively few comprehensive and authoritative studies of prices in relation to the deep and searching problems of world trade and industry. As the authors rightly point out, the world is still passing through the greatest economic catastrophe that has ever occurred, and the rather roseate and optimistic statements on 'recovery' in Great Britain, mainly put forward for political jugglery and propaganda, should not blind us to the real facts. The real facts, of course, are that we still have, even in this country, a vast amount of unemployment, destitution and misery, and that these evils exist in still greater degree over most of the world to-day.

The present work has been evolved in the firm belief that the present state of affairs is primarily a price problem, the problem of finding a stable medium of exchange, and that the two greatest enemies of the human race are war and monetary instability. It is indeed scarcely too much to say that the latter, directly or indirectly, may be a

potent source of war, so that the real enemy—the arch-villain of human tragedy—is monetary instability, with war as one of the deplorable consequences thereof. Therefore the importance of the subject, and of an adequate and intelligent treatment of its many complexities and far-reaching ramifications, cannot be overrated. Such a treatment is undoubtedly provided in the present work, wherein all the many and sometimes obscure factors governing prices and monetary standards are fully and clearly described by those who have made a specialised life study of the subject. By specialised, nothing of a narrow or restrictive sense is implied ; it is a common delusion that specialism means a narrowly concentrated view, and this delusion is still more absurd in relation to such a vast field of investigation as that of world prices. The chief trouble with specialists and their works is that they are just a little apt to overlook the fact that their readers have not perhaps the same amount of time and mental energy to spare from their other preoccupations to devote to a proper study of the somewhat formidable tomes they produce. Although it has just been insisted that adequate treatment is essential, this does not necessarily mean over-elaboration ; and if there is any ground for criticism it is the very slight one that this book is too large and expensive for any but academic students, for whom indeed it is excellent. For the business man, the general student, and the politician, a condensed and cheaper version would seem to be a primary desideratum.

A particularly interesting point which will doubtless appeal to many who, like the reviewer, regard the present time as most opportune for actual social experiment and test rather than for interminable discussion, is made at the very beginning—in the second paragraph of the preface in fact :

"One reason why progress in production is more rapid than monetary progress is that production is subject to individual experimentation. The individual who has a new idea tries it out, even though he is ridiculed by the public. If the idea works the successful demonstration hastens general adoption."

This could form a fruitful text for discussion on social experiment, but would carry us too far from the present purpose. As already pointed out elsewhere, a vast amount of social and political experiment of a somewhat haphazard and unscientific kind has been undertaken in recent years, including currency experiments ; but can it be asserted with unquestionable conviction that such experiment has been either adequate or rightly conducted under all the exacting conditions of true scientific research ? To what extent can new ideas in the social and political realm be carried to the test of experiment ?

In regard to prices, much can be done by the dissemination of greater knowledge, and it is one of the primary aims of the present work to aid in that dissemination, an aim which would certainly be more effectively achieved by a smaller and simpler edition. It also seeks to aid individuals with their immediate problems, so that they may adjust their affairs to the probable economic weather. Part of the book is based on advice given during the past fifteen years to farmers as to the probable trend of agricultural prices, and some remarkable predictions of price movements are quoted (pp. 107–116) made between October 1918 and January 1933, most or all of which appear to have been completely correct ; and if the test of scientific status is correct prediction, then the theory of prices as here presented may well claim to be scientific.

A comparatively simple explanation of depression can be given in terms of gold demand :

"The present depression is not an act of God for the purification of men's souls. It is not a business cycle. It is not due to extravagant living. It is not due to unsound business practices. It is not due to over-production. It is not due to too great efficiency. It is not due to lack of confidence, but is the cause of lack of confidence.
". . . it is due to high demand for gold following a period of low demand for gold. It teaches the devastating effects of deflation, but teaches no other lesson that is good for society."

The authors deal fully with the general question of measures of value, index numbers, with particular reference to important groups of commodities, the physical volume of production, money, gold and prices, the production, use and price of gold, with effects of changes in that price ; silver and bimetallism, and much else of cognate interest.

All the various expedients adopted by different Governments for dealing with the monetary chaos are described more or less caustically. Tariffs and the many other forms of trade restriction are simply the result of price instability and of the other evils attending a muddle-headed money policy. "Tariffs and quotas are merely another form of monopoly efforts to go through with deflation and yet prevent prices from falling." In other words, trying to pull both ways at the same time.

The final chapter on the price outlook is of supreme interest. It is insisted that, before business can proceed in a normal way, a better balance in the price structure is necessary. There

are three possible ways of getting it. Either the slow-moving charges and services must be reduced, or those things that fell most must be further increased. If the latter procedure is adopted, there are only two ways in which it may occur. Either prices in gold must rise throughout the world, or the American price of gold must be increased. It is probable that the world price level in gold ultimately will rise somewhat, but this is likely to come as a result of, rather than as an aid in, world-wide recovery. That is, gold hoarding and the panic to get gold are likely to be relieved somewhat after general recovery has arrived. This will probably require a considerable period of time. The gold standard as hitherto worked has evidently failed, and failed utterly. If the price level of the future is to be kept more stable, and more nearly in balance than the supply of and demand for gold will keep it, a measure of value more stable than gold must be adopted. The book ends with a quotation from a committee report to the British Association for the Advancement of Science :

"The price history of the century before the war affords abundant evidence that the gold standard has neither kept the price level stable, nor—except temporarily and by accident—forced it to follow any other reasonable course. Nor are there grounds for greater optimism with regard to the future."

W. G. L. C.

Rocks and Fossils of the Tertiary Period

Tertiary Faunas

a Text-Book for Oilfield Palæontologists and Students of Geology. By Dr. A. Morley Davies. Vol. 1 : The Composition of Tertiary Faunas. Pp. xi+406. 22*s*. 6*d*. net. Vol. 2 : The Sequence of Tertiary Faunas. Pp. x+252. 15*s*. net. (London : Thomas Murby and Co., 1934, 1935.)

GEOLOGISTS who are concerned with the exploration and working of oilfields need a special acquaintance with the Tertiary rocks and their fossils. Dr. Morley Davies has therefore prepared for their use an exhaustive text-book on the invertebrate fossils which are of most stratigraphical importance, and the geological and geographical distribution of the various faunas in which they are grouped. For many years he taught palæontology to students of oil technology in the Imperial College of Science, and his experience well qualifies him for the task. He has produced two volumes which are not only admirably adapted for their immediate purpose, but also are full of interest for all geologists who are engaged in research. He does not restrict himself to a bare record of the facts and published conclusions, but enlivens his work by many valuable comments and criticisms which suggest problems and stimulate thought.

The first volume, which appeared at the end of 1935, gives a systematic technical description of the Tertiary Foraminifera, Echinoidea, Lamellibranchia, and Gastropoda, besides a brief sketch of the other Tertiary Invertebrata and the Vertebrata. Each section is illustrated by very clear line drawings, and concludes with a glossary of technical terms and a well-selected bibliography. The glossaries are extended by the addition of the more important French and German terms, and the bibliographies are often annotated to make them more useful. The distribution of each genus described is mentioned, and, when possible, lineages are traced through successive formations. The attempt to record the evolution of the nummulites in parallel lineages is especially interesting. The great difficulty throughout the book is the naming of the genera, which has been confused by too many essays on the "law of priority". Dr. Davies is compelled to give two or more names to a large proportion of the genera to make intelligible the literature which he quotes.

The second volume, which was published in 1934, deals with the sequence and distribution of the Tertiary faunas, and is illustrated by many useful sketch-maps. After preliminary chapters on the geographical distribution of animals and the geological interpretation of fossils, there are separate accounts of the Paleogene (Paleocene to Oligocene) and Neogene (Miocene and Pliocene) faunas ; and each section is followed by a bibliography. The wide distribution of the Paleocene formations, linking the Cretaceous with the Tertiary periods, is especially remarkable. The extent and variety of the Miocene formations are also striking. A summary of the whole subject in tables of correlation at the end of the volume will prove valuable for reference.

In so comprehensive and technical a treatise, there must naturally be oversights and mistakes, and the author himself notices a few in a postscript to vol. 2 inserted at the end of vol. 1. We have, however, tested some of his statements about the distribution and interpretation of the Tertiary faunas, and have found them to be both justified and well up to date. Dr. Morley Davies is indeed to be congratulated on the outcome of his arduous labours, which have provided geologists with another reliable and indispensable work of reference.

A. S. W.

Matter, Motion and Mechanism

(1) Properties of Matter
By H. Steels. Pp. vi+173. (London: John Murray, 1935.) 4*s*.

(2) Mechanical Properties of Matter
By S. G. Starling. Pp. vii+336. (London: Macmillan and Co., Ltd., 1935.) 6*s*.

(3) Mechanics:
for the Use of Higher Forms in Schools, and First Year Students at the Universities. By A. H. G. Palmer and K. S. Snell. Pp. xiv+335. (London: University of London Press, Ltd., 1935.) 15*s*.

(4) A Comprehensive Treatise on Practical Mechanics:
an Introduction to Mechanical Science and its Practical Applications. By J. M. Lacey. Pp. viii+320. (London: The Technical Press, Ltd., 1935.) 18*s*. net.

(5) Principles of Mechanism
By F. Dyson. Second edition. Pp. vii+323. (London: Oxford University Press, 1935.) 12*s*. net.

DESPITE the contrasts implied by their titles, there is a considerable measure of common ground in the subject matter of these five volumes, but their respective authors have distinctly different points of view, methods of treatment and purposes. As arranged above, they show a gradation from the teaching of physics with familiar practical applications, through the purely mathematical treatment of mechanics, to the strictly practical mechanics and theory of machines required by the engineering student. All are on common ground in treating of statics and dynamics and in that they expect from their readers a good working knowledge of the notation, operations and applications of the calculus. Each makes its appeal to and has its value for a particular class of student, but it might well be that most students would be considerably helped by a careful perusal of two contrasted methods of presentation.

(1) In "Properties of Matter", Mr. Steels writes for those preparing for the intermediate, higher school certificate and university scholarship examinations, and takes it for granted that his readers have already acquired an elementary knowledge of the principles of mechanics up to work, energy and momentum. In an easy and attractive way he presents the theories of matter and motion, the kinetic theory, surface tension, viscosity and elasticity as included in the syllabuses. Mainly his descriptions and explanations are simple and direct—moment of inertia, for example, is well expounded—but at times he will sorely try his inexperienced students. In the pendulum, to give the tangential force as equal to the mass multiplied by the horizontal acceleration will either puzzle the student or mislead him into thinking that he can make this kind of approximation freely. Again, on page 34, an x inserted instead of a sign of multiplication will trip the unwary, as will several other mistakes which more careful proof-reading would have eliminated.

A good balance is maintained between exposition, mathematical analysis and experimental verification, and the book includes numerous exercises taken from papers set in the examinations referred to.

(2) It is for the same class of students that Mr. Starling has written his "Mechanical Properties of Matter" but, while he assumes less preparatory knowledge of elementary mechanics, which are therefore included in the earlier chapters, he demands a somewhat higher standard of attainment in mathematics. Throughout the book, the argument is more strictly mathematical, and the treatment is quite suitable for the student with keen mathematical perceptions. In the hands of a teacher capable of arousing the enthusiasm of his class, its thoroughness and its logic make it a valuable text-book.

In addition to the subjects dealt with in the previous book, there are sections on hydrostatics, friction, diffusion and osmosis, and wave motion. Exception has to be taken to the quite unnecessary use of the term "centre of gravity" where "centre of area" is meant—in particular problems, that of

a flap valve, for example, the centres of area, gravity, and pressure have to be found and a clear distinction is essential. The experiments which are suggested require a greater amount of apparatus than in the previous book, and a much larger selection of exercises from similar sources is made available.

(3) Messrs. Palmer and Snell write for the future mathematical specialist. Their "Mechanics" is suitable for those who have passed the stage of the two books already mentioned and are ready to take up the study from the purely mathematical point of view. The authors show the subject developing from an experimental science into a branch of mathematics, and it is their intention to make the foundations of Newtonian mechanics sufficiently clear to lead on to an exposition of the mechanics of Einstein. Following a chapter on vectors, their differentiation and their integration, the subjects of statics and dynamics are fully and rigorously dealt with, being developed from explicit assumptions without evasion of logical difficulties.

Although the treatment is academic, the examples are based on practical problems and the engineering student will find here the necessary material to prepare himself for the theory of structures. Many of the recommendations made in the *Mathematical Gazette* and in the report of the Mathematical Association have been followed, and numerous sets of graded examples and also of more difficult miscellaneous exercises are provided.

(4) The aim here is definitely towards the practical, to work from the first principles of mechanical science to their practical applications in machinery and structures, and the book should occupy a place between the elementary treatise on mechanics and the more advanced and specialised works on particular branches of that science. Of the three parts into which the book is divided, Part 1 treats of the general laws of gravity, inertia, mass, velocity and force as expounded by Newton and of the physical properties of matter. On page 5, the word "of" instead of "the" in the eighth line completely alters the meaning and unfortunately mis-states the point the author intends to make. Part 2 deals with statics and includes their application to the stability of frames, beams and blocks of masonry. Hydrostatics and earth pressure on retaining walls, friction and the funicular polygon and Culman's Theorem are also explained and applied.

The third part, on dynamics, treats of projectiles, impact, constrained motion, flywheels, rotation due to impulsive action and other applications of Newton's laws of motion. The misuse of centre of gravity for centre of area occurs here also and the illustrations, in many cases, leave much to be desired in accuracy and workmanship —Fig. 44(b), for example, shows a rope coiled on an axle in a wholly unnatural way.

(5) This is a text-book suitable for those studying for the National Certificate examinations and those of the engineering institutions. In the earlier chapters the fundamental principles of mechanics are stated in preparation for the exposition of mechanism which occupies about half the volume. The treatment is on familiar practical lines and includes mechanisms, link motions, velocity and acceleration diagrams, slider crank chains, wheel gears, epicyclic gears and cams. The remainder treats of the theory of machines, friction, belts and ropes, flywheels, governors and balancing.

Throughout the book the mode of exposition is clear and concise, and both the letterpress and the diagrams have been well prepared. The exercises here, of which an ample selection is given, are taken from the London B.Sc. papers and those of the Institutions of Civil and Mechanical Engineers.

J. A. C.

The Collected Works of George Abram Miller
Vol. 1. Pp. xi+475. (Urbana, Ill.: University of Illinois Press, 1935.) 7.50 dollars.

UNTIL about 1875, the contribution of the United States to the progress of pure mathematics had been negligible. There was comparatively little mathematical activity, and what little existed was chiefly concerned with applications to astronomy and physics. Then suddenly came a revolutionary change, due partly to the inspiration of J. J. Silvester, and partly to a small group of Americans who had studied in Germany and returned full of enthusiasm for research. Among these was F. N. Cole, the first American to make any contribution to the theory of groups. One of his pupils was George Abram Miller, who, after publishing a treatise on determinants in 1892, produced his paper on group theory in 1894.

Since then he has published about four hundred memoirs, in addition to about an equal number of papers of an expository or historical nature. "For forty years the name of Professor Miller has called to mind the theory of groups, and for most of that time the theory of groups has called to the minds of those acquainted with American mathematics the name of Professor Miller." On his retirement, in 1931, the University of Illinois decided to publish his collected works. The present volume contains papers up to 1900, together with three new ones giving a historical summary of the whole subject up to that date. The collection and republication of these papers is not only a tribute to the esteem in which Prof. Miller is held, but also a service to present and future students of the subject.

H. T. H. P.

The Moths of South Africa

By Prof. A. J. T. Janse. Vol. 1: Sematuridæ and Geometridæ. Pp. xi+376+15 plates. 35*s*. Vol. 2: Geometridæ (concluded). Pp. v+448+15 plates. 35*s*. (Pretoria: University of Pretoria, 1932–1935.)

FAUNAL lists of the Lepidoptera Heterocera do exist, but their gross inaccuracy renders them almost valueless; and the number of comprehensive works presenting a really precise critical revision of the known moths of any particular part of the world is deplorably small. The only publication that deals in any way extensively with the moths of Africa is Seitz's "Macrolepidoptera of the World", but this excludes the Pyralidæ, a family on which Prof. Janse specialises, and the other small moths covered by the somewhat unsatisfactory term Microlepidoptera.

There is no complete work treating of the moths of Africa, and a valuable step in the direction of filling this gap is made by Prof. A. J. T. Janse in the two volumes before us. It is true that, of the forty-odd families which have to be investigated, Prof. Janse has only so far produced an account of the Geometridæ, but this is one of the largest families of moths, and only a glance through these two volumes is needed to convince anyone of the vast amount of accurate work the author has put into this treatise, and the vast task which still confronts him.

One feels that some of the author's otherwise excellent figures lose clarity through his lavish use of doubtfully necessary heavy shading, but in the majority of cases he has shown the important features clearly.

Scenery and the Sense of Sight

By Dr. Vaughan Cornish. Pp. xii+111+9 plates. (Cambridge: At the University Press, 1935.) 7*s*. 6*d*. net.

THE appreciation of scenery may be due to an association of ideas or it may be the outcome of physical satisfactions of the eye. The latter, as Dr. Vaughan Cornish notes, are apprehended as emotions and not as local sensations, and thus are liable to escape recognition. In this small volume, the author has expanded with his accustomed fluency of exposition a subject that he has made his own, the relation between æsthetic impressions of scenery and the habits of the eye. The eye unconsciously exercises a selective process among the constituent features of a view and thus gives an impressions of enjoyment. Thus, for example, the apparent enlargement of the setting sun is due to a reduction of the field of vision, and the dwarfing of mountainous scenery upon near approach is related to an unconscious enlargement of the field.

Dr. Cornish illustrates his theme by admirable accounts of scenic impressions gathered during years of travel in many parts of the world, and illustrates them by his own freehand sketches. It is a book that is full of suggestion and is conspicuous as an attempt at the scientific analysis of scenic appreciation, a beginning of a subject of great complexity.

Race, Sex and Environment: a Study of Mineral Deficiency in Human Evolution.

By J. R. de la H. Marett. Pp. 342. (London: Hutchinson's Scientific and Technical Publications, 1936.) 21*s*. net.

THE accumulation of knowledge has made specialisation inevitable. The different branches of science tend more and more to advance along lines which become narrower and deeper. It is refreshing, therefore, to read a book which draws upon many different sources of scientific knowledge for the study of a problem of wide interest.

In this ambitious anthropological study of the interplay of life and environment, the author, who is evidently primarily a geneticist, seeks an explanation for the physical and mental evolution of man in the biological distribution of the mineral elements, especially calcium, phosphorus and iodine which are essential constituents of living matter. According to the highly speculative hypothesis advanced, the available supply of these has been an important factor in the evolution of the race.

The book could be easily criticised. In some parts neither the argument nor the phraseology is as lucid as it might be, and there are several inaccuracies, which is not to be wondered at in view of the very wide range of scientific data brought in to support the argument.

The value of the book lies in its original ideas, and in the number of interesting problems which it raises, without offering any very satisfactory solution.

Microscopic Objects: How to Mount Them

By Jean C. Johnson. Pp. viii+144+9 plates. (London: The English Universities Press, Ltd., 1935.) 3*s*. 6*d*.

THIS small book evidently incorporates the results of practical experience, and is eminently one for the amateur and lone worker. A summary is given of methods for the preparation and mounting of a number of objects for microscopy—insects and their parts, diatoms, Foraminifera and Radiolaria, crystals, rock and metal sections, blood and bacteria, and animal and vegetable tissues, together with a full account of section cutting. A few pages on ciliates, flagellates and rotifers would have been a useful addition.

The information given is generally clear and detailed enough for all purposes. Under Leishman staining, the directions read as though the diluted stain is to be washed away immediately after dilution. The Ziehl-Neelsen staining of bacteria is not at all clear; and for decolorising, the strength of the "strong . . . acid in water" is not given. In washing tissues after corrosive sublimate fixation, the addition of tincture of *quinine* is recommended—it should be *iodine*. The Van Gieson stain, so useful in histology, is not mentioned. The book is illustrated with diagrams, and with a number of excellent plates of photo-micrographs of mounted objects.

R. T. HEWLETT.

The Liver Principle Active in Pernicious Anæmia

By Dr. Charles C. Ungley, Leverhulme Scholar of the Royal College of Physicians

THE past decade has seen a complete change in our conception of the etiology of pernicious anæmia: formerly attributed to hæmolytic toxins, it is now regarded as a nutritional disorder. In 1926 Minot, Murphy and their co-workers demonstrated that liver was effective in pernicious anæmia[1] and that the hæmopoietic response was quantitatively related to the amount of material administered[2]. Following the bone marrow studies of Peabody[3], it appeared that a substance contained in liver allowed the maturation of megaloblasts to normoblasts and thus to adult red blood cells.

The true significance of the achlorhydria associated with pernicious anæmia soon became apparent. Fenwick[4] in 1880 had observed the atrophic condition of the stomach in pernicious anæmia and noted the inability of the gastric juice to digest protein, but his conception of the disease as a nutritional disorder was lost sight of in an age when 'toxic theories' were in vogue. The classical experiments of Castle and his fellow workers[5, 6, 7, 8, 9] have shown that pernicious anæmia is a conditioned deficiency, based on a gastric defect. Material effective for blood regeneration in pernicious anæmia arises from the interaction of an intrinsic (gastric) factor present in normal gastric juice and an extrinsic (food) factor. The material which results from this interaction is absorbed from the intestine and stored in the liver and other organs.

Addisonian pernicious anæmia results from a deficiency of the gastric factor, but the syndrome of nutritional macrocytic anæmia may arise in other ways. Thus a diet deficient in the extrinsic factor is a chief etiological factor of the tropical macrocytic anæmias. Deficient absorption of preformed hæmopoietic material from the intestine or its destruction therein may contribute to the production of the macrocytic anæmia found in some cases of sprue, intestinal stricture, and multiple intestinal anastomoses. In pregnancy a latent partial deficiency may become manifest owing to the demand of the fœtus for hæmopoietic material. Defective storage of hæmopoietic material in the liver may account for the macrocytic anæmia sometimes found in hepatic cirrhosis.

The extrinsic factor is soluble in water and in 80 per cent alcohol, and is not destroyed by heating at 120° C. for 5 hours. It is present in muscle meat, wheat germ[10, 11], rice polishings[11], eggs[12, 13] and possibly tomatoes[14]. Liver[15] and liver extract[16] contain, in addition to fully formed active principle, a considerable amount of the extrinsic factor. Marmite (vegex), an extract derived from autolysed yeast, is a rich source of extrinsic factor[17], but dried yeast is apparently inactive in this respect[18]. Ungley and James[10] observed reticulocyte responses in some cases receiving alcoholic extracts of non-autolysed yeast as a source of extrinsic factor, and found that autolysis did not lead to noticeable increase in hæmopoietic effect. Groen[14] finds that autolysis alone does not produce the factor, but has obtained positive results in four out of five cases with an extract of brewer's yeast, which after being autolysed by the addition of HCl and NaCl was heated in the autoclave. He suggests that extrinsic factor may arise from the hydrolysis of yeast proteins occurring at a high temperature in an acid medium. Strauss and Castle[17] originally suggested that the extrinsic factor might be vitamin B_2, but other workers[10, 14, 18, 19, 20, 21] have been unable to identify it with any known portion of the vitamin B complex.

The gastric or intrinsic factor is a heat-labile substance extracted with difficulty from stomach tissue and is associated with the protein fraction of stomach press juice. According to Klein and Wilkinson[22], who call the substance hæmopoietin, it is probably a protein and is possibly enzyme-like in nature. Desiccated stomach, which probably contains a mixture of intrinsic and extrinsic factors, is effective in daily doses of 30 gm. derived from about 200 gm. of fresh tissue. Wilkinson[23] has obtained fractions effective in doses of 5 gm. daily. The work of Meulengracht[24] suggests that in the pig the formation of the gastric factor takes place in the pyloric gland region, and also in the glands of Brunner in the duodenum, which are morphologically similar. On the other hand, the production of hydrochloric acid and pepsin is confined to the corpus region (Swedish terminology: fundus region) with its oxyntic and chief cells, this region being hæmopoietically inactive[24].

The site of interaction of the intrinsic and extrinsic factors is unknown, but Castle[25] suggests that at least one stage of the process of formation

of the end-product active on the bone marrow takes place in the gastrointestinal tract presumably at or near neutrality. *In vitro* the resultant of this interaction is destroyed by heating to 70°–80° C. for an hour or by boiling for five minutes. The synthesis of a thermostable product identical with the liver active principle has yet to be accomplished.

Cohn, Minot and their co-workers[26] obtained liver extracts active intravenously in doses as small as 0·025 gm. daily, but the earlier methods were not practicable for general use because of the large amounts of active material lost or destroyed in the process of fractionation. Using simpler procedures, Gänsslen[27] and Castle[28] produced extracts which were effective parenterally in daily amounts derived from 5–20 gm. of liver. Given by injection, the extracts were 30–100 times more effective than when administered orally. Attempts to isolate the liver factor have been hampered by the fact that the product is easily inactivated by chemical processes, and by the lack of a reliable non-clinical test for activity. Early steps were the removal of inert protein by coagulation with heat or alcohol and the precipitation of active material from the filtrate by phosphotungstic acid.

The product obtained from commercial liver extract by Dakin and West[29] is of interest in view of its relative constancy of composition, the isolation of crystalline products of hydrolysis, and the apparent fact that clinical potency is constantly associated with the compound and is absent from preparations in which it has been either removed or chemically altered. Preliminary purification of the commercial liver extract was effected with calcium acetate in 75 or 80 per cent alcoholic solution. Thereafter almost the whole of the active material could be precipitated from the filtrate with Reinecke salt in acid solution. After decomposing the Reineckate the active material was repeatedly salted out with ammonium sulphate and afterwards with magnesium sulphate. Further fractionation was carried out with the aid of sodium chloride. The clinically potent products were light buff-coloured granular powders, the yield being approximately 1 per cent of the dry liver extract. Intravenously, doses of 75 mgm. have produced maximal reticulocyte responses. The material was soluble in water and dilute alcohol but insoluble in absolute alcohol and in ether. Hydrolysis yielded an aminohexose and a number of amino acids, namely, lysine, arginine, glycine, leucine, hydroxyproline, and aspartic acid. Pyrimidine or purine bases were absent. The substance was slowly decomposed by pepsin and more rapidly by erepsin. Pancreatic juice had no effect.

In pernicious anæmia during relapse, red marrow largely replaces the fatty tissue in the shafts of the long bones, the hyperplastic marrow being characterised by the presence of numerous megaloblasts. During remission the megaloblasts disappear and the bone marrow reverts to normal type. It seems that the liver principle aids the maturation of megaloblasts to normoblasts and thus to erythrocytes. At first many of the newly formed red blood cells escape into the circulation in a state of immaturity as reticulated cells. These reticulocytes, which usually number less than two per cent before treatment, begin to increase rapidly about four days after the commencement of liver administration and reach a peak on the seventh to the tenth day. Up to a point the height of the reticulocyte response increases with the amount of active material administered, but even with maximal amounts the height of the peak is inversely proportional to the initial red blood cell count. From a red cell level of 1 million a peak of more than forty per cent may be expected, whereas with a level of two and a half millions the expected maximum is not more than fifteen per cent. When an adequate dose of liver extract is injected intravenously the rise of reticulocytes occurs earlier and reaches a higher level than when maximal doses of material are given daily by mouth.

The amount of material required to produce a maximal reticulocyte response or a maximal rate of increase of red cells, or to maintain a normal red blood cell level, is subject to marked individual variations and is influenced by factors such as age, arteriosclerosis and infections. There is thus no fixed dose, and each patient must be given sufficient material to suit his individual needs. The danger of over-dosage is negligible; even when very large amounts are administered parenterally over long periods of time the red blood cell count and hæmoglobin value rarely go much above the normal limits. During the reticulocyte crisis there is a marked increase in the urinary excretion of uric acid, possibly due to disintegration of red cell nuclei. Leucopenia disappears and the platelet count becomes normal. As the blood picture improves, the low protein and cholesterol values in the serum return to normal. Bilirubunæmia is abolished and the increased excretion of urobilin in fæces and urine ceases. Siderosis of the organs disappears, and indeed the rapid output of new red cells may exhaust the iron stores of the body, so that the colour index falls below unity, and a return to a normal blood picture is delayed. This can be overcome by the administration of iron.

During the remission there is a rapid increase of body weight due to fluid retention and to increased

caloric intake[30]. The basal metabolic rate returns to normal or subnormal levels as the anæmia disappears[30]. Soreness of the tongue usually disappears during the first week of treatment. Regeneration of the atrophic lingual papillæ occurs in some cases. In the early stages of treatment, before the red blood cell count has risen significantly, there is a feeling of well-being and a return of appetite. At the same time there is a pink coloration of the face and extremities associated with dilatation of the skin capillaries. Gastro-intestinal symptoms such as flatulence, epigastric discomfort or pain, vomiting or diarrhœa frequently clear up during a liver-induced remission. In some cases, however, the administration of hydrochloric acid and pepsin is necessary to produce this result. The gastric defect which underlies the syndrome and which is accompanied by achlorhydria persists almost without exception. Nevertheless the fact that yeast preparations in large amounts will produce a hæmopoietic response of variable degree in many patients with pernicious anæmia suggests that the impairment of secretion of intrinsic factor is often relative rather than absolute[10]. Castle[9] has observed the recrudescence of intrinsic factor in a patient who originally secreted free hydrochloric acid without intrinsic factor in the gastric juice.

In a proportion of cases of Addisonian pernicious anæmia degenerative lesions are present in the brain, peripheral nerves and spinal cord, especially the latter. The incidence of subacute combined degeneration bears no relation to the severity of the blood dyscrasia, and may occur without anæmia. Relapses and remissions are frequent in pernicious anæmia, but in the absence of treatment the spinal cord condition is progressive. For amelioration of the neurological condition much larger doses of potent material may be required than are necessary to bring about a remission of the anæmia. In a recent series of 31 cases treated intensively for many months with liver extract intramuscularly[31] we found that the degree of neurological improvement showed little or no correlation with age, initial anæmia or final blood-counts, and depended less upon severity than upon duration. Eighteen patients with difficulty in walking for under one year improved, however severe the initial disability, whereas six long standing cases with an average duration of five years showed little change. Paræsthesiæ, dysfunction of the hands, sphincter disorders, mental disturbances, inco-ordination and impaired joint sense improved fairly consistently; impaired vibration sense and hypoæsthesia less so. Absent knee- and ankle-jerks often returned; increased jerks altered less frequently. Extensor plantar responses became flexor in six instances. Many patients who before treatment were completely bedridden and unable to stand regained more or less completely their ability to walk.

It is probable that subacute combined degeneration like pernicious anæmia itself is the result of a nutritional deficiency conditioned by a gastric defect. The substance necessary for the nutrition of the nervous system is possibly distinct from the hæmopoietic principle, arising in a similar way from the interaction of two factors, extrinsic and intrinsic. An investigation of the dietaries of cases of pernicious anæmia has shown no differences between those with and those without spinal cord degeneration[10]. On the other hand, there are certain facts which suggest that there is an intrinsic difference and that the gastric juice in cases of subacute combined degeneration lacks a factor distinct from "hæmopoietin" and for which Hurst[32] suggests the name "neuropoietin".

In Addisonian pernicious anæmia, where defect in gastric secretion is marked, the incidence of subacute combined degeneration reaches 30–40 per cent. In pernicious anæmia associated with polyposis of the stomach the incidence may be even higher[33]. In marked contrast in this respect are the tropical macrocytic anæmias and those macrocytic hyperchromic anæmias occurring in sprue, cœliac disease and pregnancy, in which factors other than gastric defect (for example, deficient diet, poor absorption, demands of the fœtus) are largely responsible for the deficiency of hæmopoietic principle. In these cases free hydrochloric acid is often present in the gastric juice, the response to extrinsic factor alone (as Marmite) is usually excellent, and subacute combined degeneration is extremely rare.

It has been suggested that the lesions in the nervous system in pernicious anæmia are due to deficiency or poor utilisation of vitamin A (Mellanby)[34], vitamin B_1 (Gildea, Kattwinkel and Castle)[35] or iron (Sargant)[36], but the results obtained therapeutically with these substances have been disappointing. There is no conclusive evidence that any material lacking the characteristic effect of liver upon hæmopoiesis in pernicious anæmia can arrest the progress or influence the course of subacute combined degeneration.

The isolation of the hæmopoietic liver principle in a pure form would be an important step towards the solution of the problem. Up to the present, tests with liver extracts prepared in a variety of ways have failed to demonstrate any lack of parallelism between hæmopoietic potency and neurological effect. Should the highly-purified product prepared by the method of Dakin and West prove to be as effective in subacute combined

degeneration as our preliminary observations would suggest, the hypothetical cord factor, if not identical with the hæmopoietic liver principle, must at least be closely allied to it chemically.

[1] G. R. Minot and W. P. Murphy, *J. Amer. Med. Assoc.*, **87**, 470–476; 1926.
[2] G. R. Minot, E. J. Cohn, W. P. Murphy and H. A. Lawson, *Amer. J. Med. Sci.*, **175**, 599–622; 1928.
[3] F. W. Peabody, *Amer. J. Path.*, **3**, 179–202; 1927.
[4] S. Fenwick, "On Atrophy of the Stomach and on Nervous Affections of the Digestive Organs". (London: J. and A. Churchill, 1880.)
[5] W. B. Castle and E. A. Locke, *J. Clin. Invest.*, **6**, 2–3; 1928.
[6] W. B. Castle, *Amer. J. Med. Sci.*, **178**, 748–764; 1929.
[7] W. B. Castle and W. C. Townsend, *Amer. J. Med. Sci.*, **178**, 764–777; 1929.
[8] W. B. Castle, W. C. Townsend and C. W. Heath, *Amer. J. Med. Sci.*, **180**, 305–335; 1930.
[9] W. B. Castle, C. W. Heath and M. B. Strauss, *Amer. J. Med. Sci.*, **182**, 741–764; 1931.
[10] C. C. Ungley and G. V. James, *Quart. J. Med.*, **3**, 523–548; 1934.
[11] W. B. Castle, *Ann. Int. Med.*, **7**, 1–5; 1933.
[12] K. Singer, *Wien. klin. Wchnschr.*, **45**, 1063–1064; 1932.
[13] D. K. Miller and C. P. Rhoads, *New Eng. Med. J.*, **211**, 921–924; 1934.
[14] J. Gröen, "Klinisch en experimenteel onderzock over anaemia perniciosa en voorwaardelijke deficientie". (Amsterdam: Scheltema et Holkema's Bockhandel, 1935.)
[15] F. Reimann, *Med. Klin.*, **27**, 880–881; 1931.
[16] P. J. Fouts and L. G. Zerfas, *J. Amer. Med Assoc.*, **101**, 188–192; 1933.
[17] M. B. Strauss and W. B. Castle, *New Eng. J. Med.*, **207**, 55–59; 1932.
[18] L. Wills, *Lancet*, **1**, 1283–1286; 1933.
[19] L. Wills and A. Naish, *Lancet*, **1**, 1286; 1933.
[20] F. Diehl and J. Kuhnaü, *Deutsch. Arch. klin. Med.*, **176**, 149–153; 1933.
[21] H. C. A. Lassen and H. K. Lassen, *Amer. Med. Sci.*, **188**, 461–472; 1934.
[22] L. Klein and J. F. Wilkinson, *Biochem. J.*, **28**, 1684–1692; 1934.
[23] J. F. Wilkinson, *Proc. Roy. Soc. Med.*, **26**; 632–634; 1933.
[24] E. Meulengracht, *Proc. Roy. Soc. Med.*, **28**, 841–868; 1935.
[25] W. B. Castle, *Science*, **82**, 159–164; 1935.
[26] E. J. Cohn, T. L. McMeekin and G. R. Minot, *Trans. Assoc. of Amer. Physicians*, **45**, 343–349; 1930.
[27] M. Gänsslen, *Klin. Wchnschr.*, **9**, 2099–2102; 1930.
[28] W. B. Castle and F. H. L. Taylor, *J. Amer. Med. Assoc.*, **96**, 1198–1201; 1931.
[29] H. D. Dakin and R. West, *J. Biol. Chem.*, **109**, 489–522; 1935.
[30] J. Vaughan, *Arch. Int. Med.*, **47**, 688–689; 1931.
[31] C. C. Ungley and F. J. Nattrass: to be published.
[32] A. F. Hurst, *Brit. Med. J.*, **2**, 665–669; 1934.
[33] C. C. Ungley, *Proc. Roy. Soc. Med.*, **28**, 868–870; 1935.
[34] E. Mellanby, *Edin. Med. J.*, **40**, 197–222; 1933.
[35] E. F. Gildea, E. E. Kattwinkel and W. B. Castle, *New England J. Med.*, **202**, 523–527; 1930.
[36] W. Sargant, *Lancet*, **1**, 230–232; 1932.

Fire-Walking

By Ernest S. Thomas

SOME forty cases of the ember-walk and the stone-walk (to distinguish the two forms by these terms) selected from a larger number, collected from a wide range of accredited sources, were analysed for a paper I wrote for the Society for Psychical Research (published in the *Proceedings* in December 1934).

These narratives, with very few exceptions, are characterised by a lack of essential details, and that over-emphasis of the sensational aspects of the performance which seems inseparable even from some would-be scientific accounts. This lack of essential detail is not at first sight apparent, and it was not until I tried the ember-walk on a small scale myself in socks that these defects became apparent: namely, on a trench 9 feet long by 12 inches wide and some 6 inches deep filled with red hot, flameless, firestick-embers. I was able several times to take four steps in threadbare woollen socks (treading the embers five times) in 3 seconds without singeing, scorching or blistering —or discomfort at the time, but my foot-soles burned and tingled for several hours afterwards.

I attribute the immunity of my socks to their brief contact with the red hot coals and probably in part to the coating of ash, and that of my 'uncallused' feet to the woollen substitute for callus. I am, it should be stated, slight in build, of light weight (barely 9 stone) and tolerably agile.

Most of the observers of the ember-walk note the presence of ash, as well as of the great heat of the furnace walked upon. Regarding the latter, the fact that the surface coals are loosely packed over the furnace should not be lost sight of; so that the heat radiates out between the interstices of the cooler (because rapidly cooling) surface. Where the ash is not mentioned in accounts, there was clearly time for it to form before the walk began. In many cases (and one may assume it in all the important Indian cases) the legs of the walkers before the performance are wet (and doubtless cold) after bathing and/or immersion in turmeric water, and often coated with mud.

In a number of cases more or less rigorous ascetic training with meditation and concentration has been undergone, designed doubtless to enhance the powers of protective auto-suggestion. In several instances, the walkers bore silver skewers transfixing the dorsal muscles and other parts of their bodies, and one performer prior to the walk sat on a swing-seat full of 3-inch thorns; they pierced his flesh, but there was no bleeding. Dr. J. H. Hunt noted the almost total absence of bleeding when fakirs pierced their necks and abdominal muscles with rapiers[1]. Dr. William Brown noticed this also in the case of Rahma and Tara Bey[2]. Such contraction of the blood-vessels, through self-hypnotism, would tend to lower the temperature of the legs and feet (apart from the

bathing), and, with the anæsthesia, enable the walkers to withstand the great heat of the large furnaces, as well as resist the tendency to blistering[3].

The Fijian stone-walk seems at first sight to present features more baffling of a normal explanation than the ember-walk. The setting is more sensational with its blazing logs and white- and red-hot stones exploding and scattering with the heat.

The furnace prepared is usually round and a few feet deep, and varies considerably in size. In it dry poles are sometimes, if not always, set radially to support and heat the pile of large stones. In the performance witnessed by Prof. S. P. Langley (whose account given in NATURE[4] is the first attempt at a scientific record) the number of stones is estimated at 200, weighing 40–80 lb. each. Unfortunately, no account tells us how the fire is fed. If, as seems probable, fresh fuel is thrown on, clearly the heating effect would be small compared to that of the blazing logs below. In due course, all burning timber is withdrawn and the surface levelled with green poles held by men, and pulled with a stout creeper-stem. Then, according to one account, the stones are turned flat (split) side up on the surface. The rock used is a very vesicular augite-andesite which is slow to acquire (and lose) heat : hence, it has been argued, the flat faces are probably comparatively cool.

The fire observed by Langley had burned for some five hours. The pit was 9 ft. × 21 ft. and 2 ft. deep, and the lower stones only were red-hot. The walker is said to have prepared himself by prayers and spells, and to have crossed the centre and returned, but the time taken to walk and to clear and prepare the surface are not given.

In Dr. R. Fulton's account (summarised in NATURE[5]) the furnace was 20 ft. in diameter and 2 ft. deep. The preparations began after the fire had burned for fifty hours. During this operation, the stones cooled from white to red and then lost their glow. He estimates the time taken as nearer two hours than one, but does not mention the heat-state of the surface stones. The pulse of the walker was 90 before starting ; his hands cool, his feet cold, clean and odourless ; the soles yellow-white like soft kid as they would be after the customary sea-bath, which is not mentioned. He walked deliberately across, according to some spectators, though Dr. Fulton did not think he crossed the centre, and twice round the stones (the latter would certainly be the cooler path). After the walk the pulse was 120, and the feet still cool if not cold, though the legs were of high-fever temperature. The time was estimated at 15 seconds, and 25–30 steps were taken. Thus the soles were not in contact with the stones for more than half a second. (But there is clearly an error in the figures given if the steps cover two circuits ; and from other accounts short steps of about a foot seem to have been taken.)

Fulton appears to think that the soles were not callused because they were soft, and attributes the immunity to the specific qualities of the stone. Experimenting with a block of olivine basalt about 4 in. × 4 in. × 3 in. and weighing nearly 4 lb., of approximately the same specific gravity (2·5 instead of 2·4) as the Fijian rock but less vesicular, I found that, removed after being heated in a coal fire (in a grate) for three hours, it lost its red glow in three minutes, and took about the same time to lose it when left on the fire after four hours heating *in* it. I finally heated it on the red coals in an anthracite stove for five hours and, on breaking it, found it was red only half-way through. I failed to get it above red heat in the fires at my disposal. A sphere of this rock weighing 60 lb. (the average of Langley's estimate) would take roughly thrice the time to cool : other shapes (such as oval) not so long. Thus, in fifteen minutes such red-hot stones would lose their glow. It seems certain then that the performers do not walk on red-hot stones, and probable that the surface stones are never red-hot right through. No observer has noted the time taken by the stones in cooling from white to red. These would be in the centre, the region usually hurried over or avoided by the walkers ; also not at the surface.

In none of the accounts are we given full details of the duration of the firing, log-clearing, and stone-levelling, the duration of the walk, the manner of walking, the number of steps, and in none are we told how the fire is kept up.

In several accounts it is stated that cloths are thrown or placed on the stones, but not applied and withdrawn synchronously with one foot of the walker. In the case where an Englishman walked barefoot, no time details are given except of the heating.

A valuable paper on the Fijian firewalk by Sir J. Purves-Stewart and Prof. D. Waterston appeared in the *British Medical Journal* (Dec. 28, 1935). The fire is stated to have been burning *on* the stones for nine or ten hours and was almost out but glowing. Unfortunately, full details of the performance are assumed to have been given by other observers. Immunity is (*in summa*) attributed to the thickened soles, the raising of the threshold of pain by habitude, the momentary contact, and the autohypnotic effect of the preliminary ritual.

On the evidence, then, there seems to be nothing supernormal in the performance unless the possible effects of self-hypnosis as a protection from the mass heat of the furnace are so considered.

Are supernormal powers and conditions necessary to explain the immunity of Kuda Bux? Mr. Harry Price regards it as definitely proved that the ash plays no part as a protection. But ash forms very quickly as the surface-carbon oxidises away (especially under fanning ?), and a very thin layer is a protection, as anyone can testify by experiment with a finger and a red-hot stick. The photographs[6] seem to show a plentiful supply of ash in his path unless the red glow has photographed white. Mr. C. R. Darling[7], on the other hand, says the surface walked was not visibly red-hot. Regarding his foot-soles, to the medical man who examined them before the first experiment, the epidermis seemed rather thick (although Mr. Price considered it was thin and tender).

On the second occasion, Prof. Pannett found "the skin was not callous but soft as the skin of so many individuals who walk barefoot [*sic*]". The feet were also noted as cold and dry. But callus is *thickened*—not necessarily *hard*—skin. The softness therefore need not exclude thickness. The thickness was not tested. The coldness and softness may have been caused by water (cf. Dr. Fulton above), the coldness enhanced by 'self-suggestion'[8].

Regarding Mr. Price's test with the calico-wrapped boot-last, it is not evident from the account that he raised and lowered it synchronously with one foot of Kuda Bux, that is, twice for half a second's contact. As the calico was scorched (he says) in one second and burned in two seconds, it seems indeed that the test was not properly applied. This lends force to Mr. Darling's findings as to the heat of the surface trodden.

Mr. Darling's positive evidence, then, regarding the heat of the trodden surface, and the uncertainty (*pace* Mr. Price) regarding the ash and the 'callosity' of the foot-soles of Kuda Bux, leaves the question of supernormality in the fire-walk very much where it was.

[1] "Indian Fakirs", *St. Bartholomew's Hospital Journal*, Oct.–Dec. 1934.

[2] "Psychology and Psychotherapy", p. 108 *et seq.*

[3] *Cf.* Dr. Hadfield's experiments (*Lancet*, Nov. 3, 1917) with a hypnotised patient, whose arm was only lightly blistered without hyperæmia when touched with a red-hot pencil-case.

[4] NATURE, **64**, 397 (1901).

[5] NATURE, **67**, 130 (1902).

[6] *Listener*, September 18, 1935.

[7] *Listener*, November 6, 1935.

[8] Dr. William Brown (*loc. cit.*) "Under autohypnosis the respiration can be slowed, the pulse-rate altered, the tendency to bleed diminished". Kuda Bux pulse rates and breathing rates have not been published, if they were taken.

Obituary

Captain S. R. Douglas, F.R.S.

THE death of Captain S. R. Douglas, on January 20, after a short illness, will be deeply regretted by all who are interested in medical research. He was born in 1871 and educated at Haileybury College and St. Bartholomew's Hospital. After taking the double diploma M.R.C.S., L.R.C.P. in 1896, he joined the Indian Medical Service in 1898 as surgeon lieutenant. He served with the Plague Commission in 1899, and with the China Expedition in 1900–1, being promoted captain. He was invalided home at the end of 1901, but in spite of poor health, he soon took up work at St. Mary's Hospital with Sir Almroth Wright. In 1903, Wright and Douglas communicated to the Royal Society an important paper on the role of the body fluids in phagocytosis, a paper which did much to stimulate new work on vaccines and vaccine therapy. In both these lines of study Douglas played his part.

On August 1, 1914, Douglas joined the pathological staff of the Medical Research Committee, but the War interfered with projected research schemes, and he joined the R.A.M.C. After a short period of research work in France, he was invalided home, and in spite of continued ill-health, he was busily engaged in the production of vaccines on a large scale, the study of war wound infections and bacillary dysentery. In 1914, he described the method of preparation of a tryptic digest medium for cultivation of bacteria. This was of great immediate value for vaccine production, and has since proved to be of great value for general purposes.

From 1920 onwards to the close, Douglas was engaged in building up the Department of Experimental Pathology at the National Institute for Medical Research at Hampstead, and in pressing forward the work of others. In 1921, he was director of the Department, and in 1930 deputy director of the Institute. He was greatly interested in, and had an extensive knowledge of, virus diseases, and though he did not publish much on this subject, he did much to initiate new lines of work and assist his juniors. On occasion he started and guided an entire research, though his name did not appear on the final publication. He also did much during the period to assist in work with visible bacteria; for example, in 1922, he devised a special tellurite medium for cultivation of diphtheria bacilli, which is still of value to others. Again, he worked out special media (including synthetic media) for cultivation of tubercle bacilli, and he helped others to do valuable biochemical work with this organism. His wide knowledge, great

experience and sympathy for the younger workers made him a particularly valuable member of many research committees.

Douglas's contributions to medical research must not be estimated merely by the publications under his name, significant though these are, but also by the great influence he exerted on the work of others; and only those who had the privilege of working with him or under his guidance can know how great this influence was, just as only those few could realise his great unselfishness and innate kindliness.

Douglas was elected a fellow of the Royal Society in 1922 and of the Royal College of Physicians in 1933. He was an ardent field naturalist, particularly interested in birds; he wrote two papers on the migration of woodcock, and presented bird skins which he had collected to the British Museum (Natural History).

P. P. L.

Prof. A. S. Hitchcock

By the death of Prof. A. S. Hitchcock on December 16 at the age of seventy years, the United States has lost one of its most distinguished botanists and the world its foremost agrostologist. He died on board the liner *City of Norfolk*, in which he was returning to the United States after visiting various European herbaria and attending the International Botanical Congress at Amsterdam.

Albert Spear Hitchcock was born at Owosso, Michigan, on September 4, 1865. He received his education at the Iowa State Agricultural College where he took his B.S.A. degree in 1884, and his M.S. and Sc.D. degrees in 1886 and 1920 respectively. From 1885 until 1887, he was first assistant chemist and later instructor at the above college. Then followed a short period as botanical assistant at the Missouri Botanic Garden, while in 1892–1901 he was professor of botany at the Kansas State Agricultural College. In 1901, he joined the staff of the United States Department of Agriculture as assistant agrostologist, becoming systematic agrostologist in 1905 and at the same time custodian of the Section of Grasses in the United States National Herbarium. Since 1924, he has been the principal botanist of the Bureau of Plant Industry, in charge of systematic agrostology.

Hitchcock's botanical work may be conveniently divided into two phases. The first was mainly occupied with teaching, but during that period he published a number of papers on the plants of Kansas, Iowa and Florida, and as a result of his trip to the West Indies (1890–91), an account of the plants collected in the Bahamas, Jamaica and Grand Cayman. The second phase, commencing with his appointment as agrostologist at Washington, was one of specialisation. At the National Herbarium there, he built up with the assistance of his colleague, Mrs. Chase, a large grass herbarium estimated to contain more than 210,000 sheets of specimens, and a very fine private agrostological library. His publications on the Gramineæ are exceedingly numerous and form a most valuable series of contributions to our knowledge of that very important family. They range from short papers containing descriptions of new species to complete grass floras of such regions as Peru, Bolivia and Ecuador, Central America, West Indies (with A. Chase), Hawaiian Islands, etc. For his own country, he produced in 1920 an account of the "Genera of the Grasses of the United States", and in 1935, a "Manual of the Grasses of the United States"—the latter a monumental work containing descriptions and illustrations of about 1,100 species. He also continued the account of the Gramineæ in the North American flora. Two other works which deserve special mention are his "Text-Book of Grasses" (1914) and "Methods of Descriptive Systematic Botany" (1925). It is understood that a new edition of his "Genera of Grasses of the United States" is in the press, and that a revised account of the "Grasses of the West Indies" has been prepared.

Prof. Hitchcock travelled extensively to study and collect grasses in many parts of the world. In addition to visiting all the American States, he made expeditions from 1906 onwards to Cuba, Mexico, Panama, Costa Rica, Nicaragua, El Salvador, Honduras, Guatemala, West Indies, Hawaii, British Guiana, Japan, China, Indo-China, the Philippines, Peru, Bolivia and Ecuador. In the summer of 1929 he was invited to attend the combined meetings of the British and South African Associations for the Advancement of Science in South Africa, when he gave a paper on the "Relation of Grasses to Man". This trip enabled him to make numerous gatherings of grasses in South Africa, and on the return journey, in Southern Rhodesia, Tanganyika Territory, Kenya Colony and Uganda. At one time or another he had visited all the more important herbaria of Europe for the purpose of examining the type-specimens of American species described by European authors.

Prof. Hitchcock took a great interest in the thorny subject of botanical nomenclature, and acted as chairman of the Committee on Generic Types and the Standing Committee on Botanical Nomenclature appointed by the Botanical Society of America. In this capacity he took a leading part in preparing the "Regulations for Fixing Generic Types" (*Science*, n.s. 49, 333–336 (1919)) and the "Type-basis Code of Botanical Nomenclature" (*Science*, n.s. 53, 312–314 (1921)) issued on behalf of the Society. During the period 1923–30 he worked in conjunction with certain British botanists in an attempt to reconcile the conflicting views then held on nomenclature—an attempt crowned with success at the Fifth International Botanical Congress held at Cambridge in 1930. He also took part in the nomenclatural discussions at the Sixth International Botanical Congress, Amsterdam, 1935. His "Methods of Descriptive Systematic Botany" forms a useful introduction to nomenclature as well as to taxonomic methods.

We deeply regret the passing of so kind and able a colleague—one who had accomplished so much, and who for the future had made ambitious plans whereby his vast knowledge of the Gramineæ was to be utilised in preparing, with the collaboration of Mrs. Chase, a classification and a descriptive account of the genera of the world's grasses.

Prof. A. F. Dixon

MANY readers of NATURE will feel a personal sorrow at the loss which Trinity College, Dublin, has sustained by the death on January 15 of Prof. Andrew Francis Dixon, University professor of anatomy since 1903, and dean of the Faculty of Physic. If the life and work of any man merits appreciation in these pages, that man is Prof. Dixon, for he was above all a lover of Nature. His great academic and administrative qualities have already been referred to in the Press, and it is rather of his personal side that I wish to write.

Francis Dixon was a great man, and his life sets an example which we would all do well to follow. To make use of an expression of his own, he was "a whale for work"; his generosity must be known to many; his complete unselfishness was evident in all he did, and his kindliness, humour, simplicity and old-fashioned courtesy will long be remembered by all who knew him. Many will remember the tall, upright figure, with white hair, that used to be so red, and the wonderfully blue eyes; and all who ever met him will recall with joy the great paw thrust out in friendly greeting, the quiet soft voice and kindly grin, and the feeling of personal interest that he gave to anyone with whom he was conversing.

Dixon was beloved by all: the poor people round his country home who never turned to him in vain; the staff of his department, of whom he was so thoughtful and appreciative of any little thing they did for him, and whom he was always so anxious to save from any worry or responsibility which he thought should have been his own; his colleagues in the University, who so often sought his advice and who so greatly valued his opinion; his fellow anatomists in Great Britain and abroad, by all of whom he was loved, respected and admired; the staff of the Dublin Zoo, which he loved so well and to which he devoted so much of his untiring energy; and the generations of students, whose interests and welfare were the main objects of his life. His energy and vitality were astonishing, and his interests were so wide, that no one ever talked with Dixon without feeling that they had learned something from him.

Dixon's tastes were simple. He loved the countryside; the country people; all animals; his bees, though he often got badly stung; indeed all the works of Nature, the sunrise across the Irish Sea, the star-light nights, the night-jars, the cross-bills and all the birds around his country home at Kilternan, in the Dublin mountains. He loved the earth and the sea and all that therein is; the rocks and their fossils; the mountain streams in which he liked to lie and bask in the sun with his pipe in his mouth at full blast; all the creatures of the sea; he would kneel for hours on a board on the sands at Malahide, looking for the anemone, *Halcampa*; he liked to go out with a trawl in Dalkey Sound and bring up all sorts of beautiful creatures.

The hospitality and kindness of the House of Dixon will be long remembered by many a lonely student who came to Trinity from foreign parts; the tea table on Sunday, at Kilternan, was always set for seven or eight, but if a dozen or more arrived unexpectedly it made no difference; there was a kind welcome for all, and Mrs. Dixon seemed to have an inexhaustible larder. There were always jobs to be done at Kilternan for those who liked, and if not, there was a bed and a book on the verandah, looking out on the beautiful Dublin mountains, where Dixon encouraged his visitors to "press their coat" on Sunday afternoon.

"Andy Frank", as he was always known to his students, was the life and soul of the Medical School in Trinity College, and I fear that we shall not see his like again. C. M. WEST.

Mr. A. M. McBain

WE regret to record the tragic death on January 10 at the age of thirty-four years of Alan McBain, assistant in potato virus research at the Scottish Plant Breeding Station. His published work dealt with the physiological side of the subject, and had he lived he would have made a permanent name for himself in this kind of investigation. McBain was by training and inclination a particularly able physiological chemist, and it was a pleasure to watch him at work in a laboratory. He was never at a loss when confronted with some practical difficulty, and he had few equals when it came to a question of erecting or improvising new apparatus.

McBain's first investigation dealt with a comparative examination of the synthesis of carbohydrates in healthy and 'leaf-roll' potatoes. This line of investigation he later extended to the virus complex, crinkle. Afterwards he made an examination of the nitrogen metabolism of healthy and 'leaf-roll' potatoes; but for a variety of reasons he was unable to complete a similar examination of the nitrogen relations of healthy and crinkle plants, although such results as were obtained were of considerable interest.

Apart from his scientific work, McBain had a large number of interests, and his name will long be remembered for his activities in connexion with various unemployment aid centres in Edinburgh, Glasgow and elsewhere. No one could have had a more pleasant colleague, and he will be sadly mourned by his many friends. E. B. W.

WE regret to announce the following deaths:

Prof. J. H. Ashworth, F.R.S., professor of natural history in the University of Edinburgh, on February 4, aged sixty-one years.

Dr. Gilbert Brooke, formerly director of the Far Eastern Health Bureau, Singapore, known for his work in public health especially in connexion with malaria, aged sixty-two years.

Dr. Alfred C. Woolner, C.I.E., Vice-Chancellor of the University of the Punjab, Lahore, on January 7, aged fifty-seven years.

News and Views

The New Spectrograph Objective for the 200-inch Reflector

THE new $f/0{\cdot}36$ spectrographic object-glass referred to in Dr. G. E. Hale's article in our Supplement this week on the Astrophysical Observatory of the California Institute of Technology was designed primarily with the object of increasing the range within which distant nebulæ can be investigated by spectrographic methods. The attention of the British Scientific Instrument Research Association was directed to the need for such a lens as the result of a conversation between Dr. Hale and Sir Herbert Jackson, who was at that time Director of Research of the Association. Spectra obtained with the $f/0{\cdot}59$ lens developed by Dr. W. B. Rayton had indicated that the apparent velocities of recession of the more remote nebulæ increase with increased distance of the nebulæ. This had been verified by observations on nebulæ so remote that satisfactory exposures were obtainable only with the greatest difficulty; but in view of the important implications of these results it was urgently desired to extend the range of investigation to the utmost possible limit. It was obvious that, if any large increase of range were to be obtained, the new spectrographic object-glass would need to be much more 'rapid' than the Rayton lens, that is, the 'focal-ratio' aperture would have to be considerably greater than $f/0{\cdot}59$. To obtain any large increase of aperture, an 'immersion-type' of lens would be needed, that is, a lens to be used in immersion contact with the photographic film or plate on which the spectrum was to be photographed. With such a lens it appeared probable that a 'numerical aperture' of 1·4 (equivalent to $f/0{\cdot}35$) should be obtainable, and consideration was given, therefore, to the problems which would arise in designing, constructing and using a lens of this type.

THE design eventually developed was for a system of aperture $f/0{\cdot}36$, to be used in immersion contact with the coated side of a flat photographic plate and giving, when used with the appropriate collimator and prism system, sharp images of spectral lines over the range 3600–5000 A. The capabilities of the system were communicated to Dr. Hale, who immediately ordered a lens to this design; a collimator and prism system, suitable for use with the lens, were ordered at the same time. These various items were made and supplied by the members of the British Scientific Instrument Research Association mentioned in Dr. Hale's article. The complete system was examined by the Association before it was dispatched to Mt. Wilson. Tests carried out at Mt. Wilson, with the system erected on the 100-inch telescope, have shown that it enables satisfactory exposures to be given in less than one third of the time required for similar exposures with the Rayton lens. It is thus possible to obtain, during a single night, photographs of nebular spectra which previously had necessitated exposures extending over two or three nights in succession. It had been hoped that the system would very nearly double the range within which the more remote nebulæ can be studied spectrographically with the 100-inch telescope. This hope has not been realised up to the present, owing to the brightness of the sky-background at Mt. Wilson; the lens has, however, already proved of very great value in other types of astronomical investigations, and should come into its full sphere of usefulness at Mt. Palomar when the 200-inch telescope is completed.

The British Scientific Instrument Research Association

THE British Scientific Instrument Research Association was established on May 23, 1918, and was the second research association incorporated by Board of Trade licence, under the Department of Scientific and Industrial Research, the first of these associations—the British Photographic Research Association—having received its licence a few days earlier. It will be remembered that, in the year 1917, Parliament allocated a sum of one million pounds for the promotion of industrial research, and that a scheme was drawn up for the establishment of research associations connected with various industries, each of which was to receive for five years a grant on a fifty-fifty basis in aid of its expenses. The first Director of Research of the British Scientific Instrument Research Association was Sir Herbert Jackson, who retired in 1933; and the first Secretary, Mr. J. W. Williamson, who is to retire on March 31 next.

ON January 29 a presentation was made by the council and members of the Association to Mr. Williamson in recognition of the valuable services which he has rendered to the Association since he became the secretary in 1918. Mr. Williamson has contributed largely to the successful organisation and development of the Association, and has also rendered able service, in a variety of ways, to the Research Association scheme as a whole. In making the presentation, Dr. W. H. Eccles, chairman of the Association, specially mentioned the cordial relationships which have existed between Mr. Williamson and all with whom he has come into contact. Sir Herbert Jackson paid high tribute to Mr. Williamson's organising abilities, legal knowledge, foresight and administrative experience; and in a letter, Mr. H. T. Tizard similarly expressed high appreciation of his work and influence. Mr. Williamson, in thanking the Council and members of the Association for their appreciative remarks, and for their gift, expressed his personal gratitude to all with whom he had come in contact in connexion with his work for the Association: the congenial relationships which he had enjoyed during the whole of his eighteen years as secretary, and which he had so much valued, would be among his most pleasant memories during his retirement.

Heidelberg and Academic Freedom

THE University of Heidelberg is to celebrate this year the five hundred and fiftieth anniversary of its foundation, and it is proposed to give to the commemoration more than national significance. To this end, invitations to participate are being sent out widely, and universities and learned societies in Great Britain are being invited to send delegates. The Bishop of Durham, in a letter in *The Times* of February 4 discussing these invitations, quotes from the opening of the article on the dedication of the Philipp-Lenard-Institut at Heidelberg, which appeared in NATURE of January 18 (p. 93). This account, he says, demonstrates that the influence of the racial fanaticism which has swept over Germany and its universities has been specially severe in Heidelberg. In his opinion, which is held by many other intellectual leaders, "The appearance of British representatives at the Heidelberg celebration, and the presenting by them of congratulatory addresses, could not but be understood everywhere as a public and deliberate condonation of the intolerance which has emptied the German universities of many of their most eminent teachers."

Sensitising Dyes in Scientific Photography

IN his Friday evening discourse at the Royal Institution on January 31, Dr. C. E. K. Mees discussed "Sensitising Dyes and their Use in Scientific Photography". While the eye is sensitive to the visible spectrum, and the brightest colours to the eye are yellow, green and red, photographic materials are in their nature sensitive only to the blue-violet and ultra-violet regions of the spectrum, to which the eye has little or no sensitiveness. In 1873, H. Vogel discovered that the addition of dyes to photographic materials would make them sensitive for the region of the spectrum which was absorbed by the dye, and although Vogel's discovery was at first received with incredulity, it eventually proved the foundation of the change in photography which has been effected by the introduction of orthochromatic and panchromatic materials. Until the beginning of the twentieth century, only orthochromatic plates were available, but in 1904 a series of dyes were made in Germany which sensitised plates very readily for those regions of the spectrum which are bright to the eye, notably the red and yellow, and the first commercial panchromatic plates were made in England in 1906.

THESE new dyes were obtained from organic chemicals containing nitrogen and derived from coal tar, but the general structure of the dyes remained unknown until 1920, when Dr. W. H. Mills and his co-workers at Cambridge showed that they were characterised by a chain of carbon atoms which joined two nuclei each containing a nitrogen atom. This clarification of the structure of the cyanine dyes, as they are called, made it possible to prepare a great variety of these dyes, many of which were superior for photographic use to those which had previously been available. By the use of the new dyes 'supersensitive' panchromatic materials were made, and these effected a great advance in the art of photography. In the motion-picture studios the new panchromatic film enabled tungsten lighting with its advantages of convenience and silence to be substituted for arc lamps, and this greatly facilitated the sound recording made necessary by the development of the 'talkies'. Fine-grain panchromatic film has made possible the use of miniature cameras indoors, and by the use of cyanine dyes with especially long chains of carbon atoms, photography by infra-red light has been greatly facilitated. By the use of new dyes of the cyanine series a great variety of plates has been made available for the spectroscopist and the astronomer, who have made discoveries of considerable importance as a result, and it is now easy for the scientific worker to obtain plates sensitive to any spectral region from the ultra-violet to the far infra-red.

Economic Entomology

AT the annual meeting of the Royal Entomological Society of London, held on January 15, the retiring president, Dr. S. A. Neave, discussed the relations between mankind and insects. The growth of economic entomology, as he pointed out, is a relatively modern development. The first official Government entomologist to be appointed appears to have been in the United States in 1853. Between 1884 and 1895 a number of such appointments were established in various parts of the British Empire. In Great Britain, John Curtis, Miss Ormerod and others were early pioneers in economic entomology, but no permanent post of Government entomologist existed until 1912. From that time onwards the need for skilled entomological advice became increasingly recognised throughout the civilised world, and, at the present day, there are between three and four hundred trained entomologists in the British Empire alone. This increasing attention given to insects in relation to man has, as Dr. Neave pointed out, led to the discovery of hosts of important new species and to a demand for the correct identification of thousands of other species. This, in itself, has led to an ever-increasing pressure on the resources of systematists until, at the present time, they are unable to cope with the material awaiting study. This need for more systematists will have to be met if Government departments are to derive the full benefit from moneys voted towards coping with economic problems in entomology.

Destructive Hailstorm in the Transvaal

SIX years ago, in a weekly column devoted to remarkable "Historic Natural Events", many records were given in NATURE of great hailstorms and damage done by them. There is an authentic record, for example, of a hailstone 17 inches in circumference and weighing 1½ lb. having fallen in Nebraska in July 1928 during a storm when the hailstones were "as large as grapefruit". A hailstorm of this character is reported by *The Times* correspondent at Johannesburg to have occurred on February 1 in a

native area of the Northern Transvaal when nineteen natives of the Barolong tribe were killed. The report states: "About 3in. of rain fell in a few minutes, and then came the hail, which consisted of jagged lumps of ice. In 30 minutes the hail was lying everywhere to a depth of 3ft., and in some cases the dead natives had to be dug out of it. There were many cattle killed, which the natives afterwards dragged away on sleighs. Whole crops were obliterated, and there are said to be over 1,000 native families afflicted in the area".

Ancient Shafts at Ipswich

MESSRS. BOLTON'S brickfield at Ipswich, already well known to archæologists as a valuable source of evidence bearing on the cultures of the Old Stone Age, recently has been the site of another remarkable discovery, unique in the annals of British archæology, but not yet explained with certainty. Three shafts of a remarkable character and of a previously unknown type have been exposed, of which two have been partially cleared by Mr. J. Reid Moir. Of these, the first, according to a report in *The Times* of January 29, was cylindrical in shape, and approximately three feet ten inches in external diameter, with walls of puddled clay nine inches thick. It was followed through the London clay into the Eocene sands; but neither here nor in the second shaft did excavation reach the bottom. Work in the second shaft had to be abandoned at a depth of seventy feet owing to the presence of water. This shaft was larger than the first, being some six feet in diameter, and more complex in its filling, at least down to a depth of eighteen feet. It had as a central core a pillar of puddled clay, with two walls of white clay between it and the outer wall. In both shafts at a considerable depth the clay walls coalesced to form a species of basin or false bottom, sealing the lower part of each shaft. Finds of archæological significance were scanty. Fragments of Roman brick, two pieces of silver sheeting, such as might have formed part of the cover of a casket, and a fragment of polished marble, which might have been part of the casket itself, when taken in conjunction with the proximity of a Roman burial ground and the later Roman Castle Hill villa, have afforded a basis for the suggestion that these may be Roman burial shafts, such as the *Puits funéraires* of France, or the late Roman shafts leading to burial chambers of Cyprus.

Journal of the History of Science

A NEW token of the growing interest in the history of science is provided by the appearance of the first number of "a quarterly review of the history of science since the Renaissance", under the title of *Annals of Science*. This new periodical is edited jointly by Dr. D. McKie of University College, London, Dr. Harcourt Brown, of Washington University, St. Louis, U.S.A., and Mr. H. W. Robinson, librarian of the Royal Society. It aims at dealing with the development of modern science in much the same way as *Isis* deals with the science of the earlier eras, and to encourage the study of the life and work of the great masters and makers of science. "The personal note in the history of Science," adds the editorial, "is, indeed, just as interesting and just as valuable as the personal note in the history of Literature or the Arts. And there remain many inviting unworked corners in the field of scientific biography which still await the attention of the interested student and will amply reward his spade-work". The first issue runs to 113 pages, and includes seven articles and two signed book-reviews.

PROF. E. N. DA C. ANDRADE describes an attempt of John Wilkins, Warden of Wadham, Bishop of Chester, and originator of the Royal Society, to found a universal language, based upon a system of signs, or characters. There are articles on early nautical charts; the history of the Chile nitrate industry; Descartes and Henry More on the beast-machine—a translation of their correspondence pertaining to animal automatism; and the detection and estimation of electric charges in the eighteenth century. Prof. T. S. Patterson contributes an interesting identification of a certain Richard Boyle, who was admitted among the original members of the Royal Society. The closing contribution, by Dr. McKie, describes a MS. set of notes of Joseph Black's chemical lectures, made by Thomas Cochrane in 1767–68; these throw some interesting light on Black's chemical views at this early period in his career. Two new sketches of Black at his lecture table, by Cochrane, are reproduced. The journal is well printed and illustrated on a page of satisfying dimensions, with generous margins. Judging from the first issue, it will make a strong appeal to all who are interested in the history of science. It is published by Messrs. Taylor and Francis, Red Lion Court, Fleet Street, London, E.C.4, and the annual subscription is £1, including postage.

British Industries Fair

THE British Industries Fair, 1936, will be held at Olympia and the White City, London, and at Birmingham, on February 17–28. The general exhibits will be seen at Olympia, the furniture and textiles section at the White City and the engineering and hardware section at Birmingham. There will be no less than twenty-four miles of exhibits, of which London's stand frontage will be 12½ miles and Birmingham's 11½ miles. The Overseas catalogue recently issued contains a classified list of exhibitors which alone occupies 170 pages, and the key-parts of the catalogue are printed in nine languages. The organisers are able again to say, as they have said in each preceding year, that it will be a record-breaking Fair. The exhibitors number 1,421, London contributing most of them—775. Other cities and districts sending exhibitors to the Fair are, following the order of their contributions: Birmingham, the Potteries, Manchester, Sheffield, High Wycombe, Nottingham, Leeds and Liverpool. Seven sections are larger than last year, and the display of furniture at the White City will be the largest in the history

(*Continued on p.* 229.)

Supplement to "NATURE"

No. 3458 SATURDAY, FEBRUARY 8, 1936 Vol. 137

The Astrophysical Observatory of the California Institute of Technology

The 200-inch Reflector

By Dr. George E. Hale, For.Mem.R.S.

THE choice of the best aperture for a very large telescope is less simple than it seems. The greater the generosity of a prospective donor the greater the care one should take not to overstep reasonable bounds, which are fixed by many technical considerations. Thus, when the point-blank question was put by Dr. Wickliffe Rose in 1928: "Do you want a 200-inch or a 300-inch ?", careful thought was necessary, though a doubt whether one should attempt to surpass 200 inches was immediately expressed.

Beginning with general considerations, the opinions obtained at once from two eminent engineers were certainly significant. General J. J. Carty, pioneer in telephone development, had covered the North American continent with a perfect telephone service. Gano Dunn, inventor and far-seeing constructor, had built vast engineering projects in many parts of the world. Their response was made without hesitation: a sudden advance from 100 inches to 300 inches would be too uncertain for safety. Walter S. Adams, director of the Mount Wilson Observatory, and many others afterwards consulted, independently expressed the same view. Experience has proved its clear validity.

Several conversations with Dr. Rose, then president of the Rockefeller International and General Education Boards, were held in New York, in response to his invitation to discuss large telescopes. After a visit by Dr. Rose and Mr. Thorkelson (then secretary of the Education Boards) to Pasadena and Mount Wilson, a grant was made to the California Institute of Technology in Pasadena for the construction of an Astrophysical Observatory and Laboratory, provided with a 200-inch reflecting telescope and all necessary equipment. This was conditional on the cordial co-operation of the Carnegie Institution of Washington, which was promptly offered by its president and executive committee. Dr. Adams and the staff of the Mount Wilson Observatory were also in full agreement.

In my initial suggestion to Dr. Rose, made after long acquaintance with the work of the 100-inch Hooker telescope on Mount Wilson, I had no intention of inaugurating a new observatory. The California Institute, which for years had co-operated as closely as possible with the Carnegie Institution of Washington in physical research, also did not plan to establish an observatory. But it could not be denied that the rapidly increasing possibilities of still more intimate co-operation between astronomers, physicists and chemists, the needs of the strong graduate school of the Institute, and the probability that a site even more favourable than Mount Wilson for the study of the most distant attainable nebulæ of the mysterious 'expanding universe' could be found, seemed to call for a new observatory. The rapid multiplication of lights and of manufacturing plants in Los Angeles and its vicinity since 1904 had slightly affected the purity of the sky above Mount Wilson, and while this is appreciable only under certain conditions in the photography of the faintest nebulæ with long exposures, it would be more serious with the desired focal ratio of $f/3{\cdot}3$ of the 200-inch telescope than with the $f/5$ ratio of the

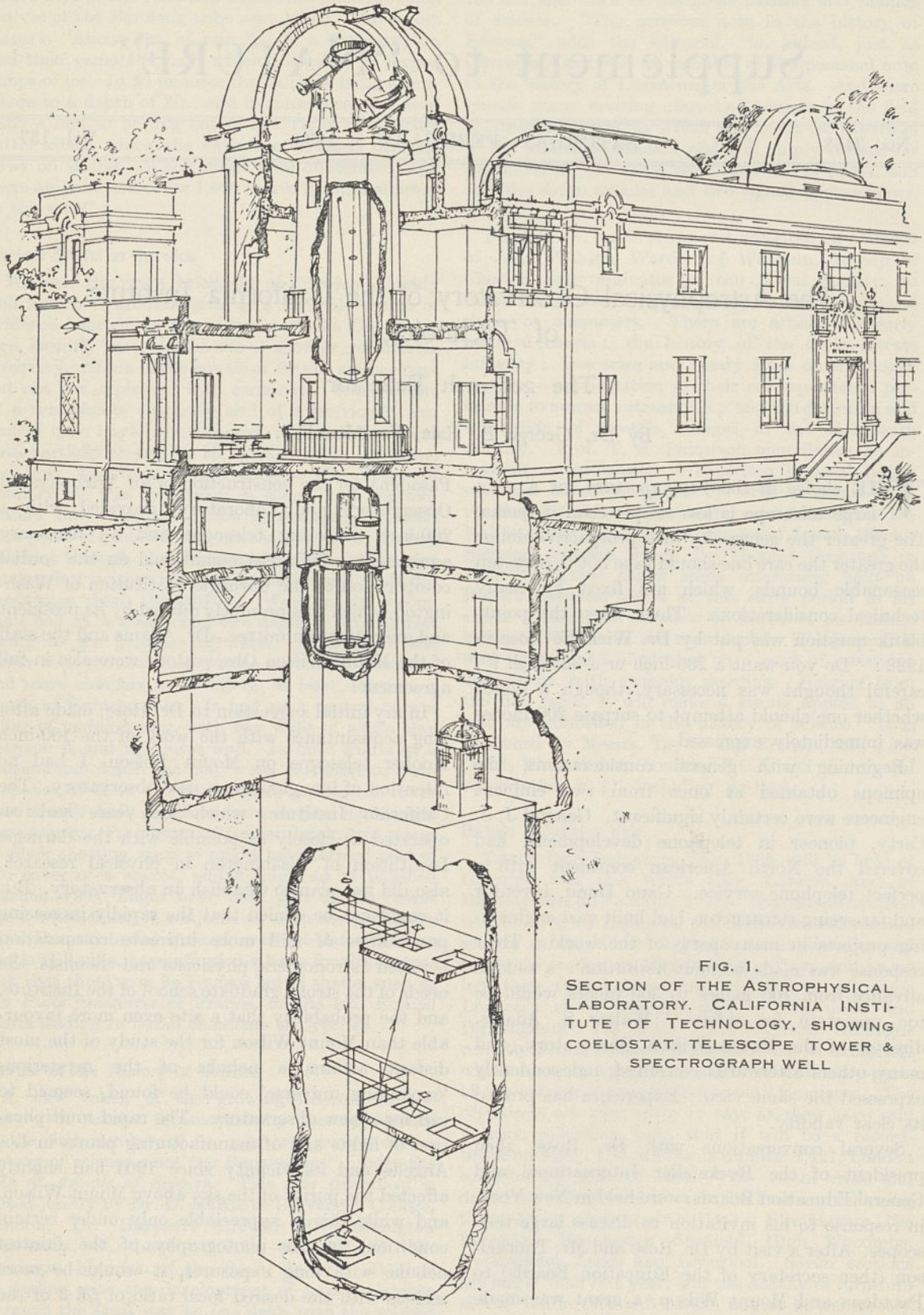


FIG. 1.
SECTION OF THE ASTROPHYSICAL LABORATORY. CALIFORNIA INSTITUTE OF TECHNOLOGY, SHOWING COELOSTAT. TELESCOPE TOWER & SPECTROGRAPH WELL

100-inch Hooker telescope. As 95 per cent of the work of the Mount Wilson Observatory is unaffected by this change of conditions, a plan of co-operative research could be developed which would be highly advantageous to both institutions. This conclusion, which is shared by all members of the Mount Wilson staff, called for the selection of the best site now available within working distance of Pasadena, the common focus of the joint project.

construction of a very complete astrophysical laboratory, a well-equipped instrument shop and an optical shop large enough for the grinding, figuring and testing of the 200-inch mirror, all on the grounds of the California Institute in Pasadena, in close touch with the various laboratories of the Institute and the Pasadena headquarters of the Mount Wilson Observatory. More broadly, it also meant any effective co-operation advisable with individuals and institutions elsewhere.

Fig. 2. The Astrophysical Laboratory of the California Institute of Technology.

As soon as the attitude of the authorities of the Carnegie Institution and the California Institute could be learned, a plan was prepared in New York for Dr. Rose, embodying the following features: (1) Close co-operation between these institutions in the design and operation of the new observatory; (2) the laboratory, instruments and shops to supplement those of the Mount Wilson Observatory, thus providing new and very desirable facilities for joint research; (3) special stress to be laid on the development of new auxiliary instruments, so as to increase the efficiency of the 200-inch and other telescopes. This meant the

Everyone familiar with the limitations of large refractors, such as chromatic aberration, absorption of light by the objective, and the insuperable difficulty of obtaining satisfactory optical glass disks more than 40 inches in diameter, will recognise that the 200-inch telescope must be a reflector. But there remains a number of obstacles to be overcome. The first of these is to obtain a suitable disk for the large mirror.

We had experienced much trouble in securing the 100-inch disk for the Hooker telescope, which weighs four and a half tons. The first disk received was so filled with irregularities, such as apparent

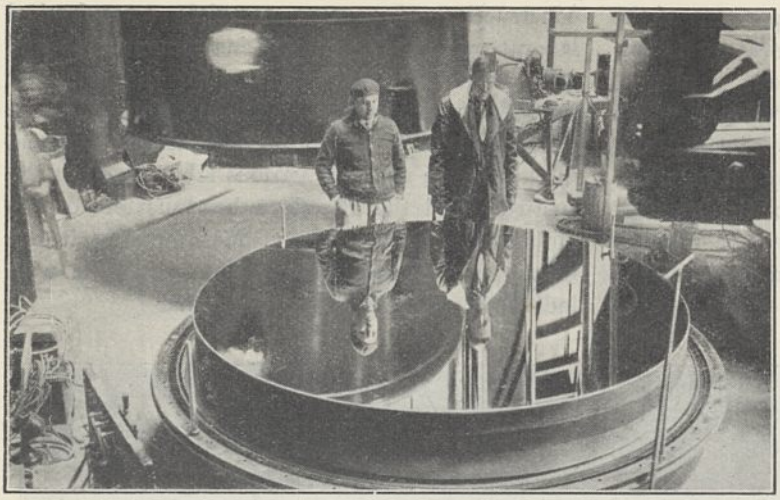


FIG. 3. 100-INCH MIRROR, ALUMINISED, WITH DR. STRONG (RIGHT) AND DR. GAVIOLA (LEFT).

surfaces of discontinuity, liberally besprinkled with air-bubbles, that its use appeared hopeless. After years of experimenting, however, nothing better could be furnished by the glass-makers. It was, therefore, decided to give one surface a spherical figure and rigorously apply the Foucault test under temperature conditions equalling the maximum annual range on Mount Wilson. The results showed that the disk was well annealed and that its internal structure should do no harm, especially as only a few small bubbles were near the surface to be figured. The insistence of the optician that it had a 'strong' and a 'weak' diameter nearly at right angles to one another was overcome by showing that the change of figure observed in these positions was due to an unsuitable edge-support, producing a component causing deflection normal to the mirror face. This having been corrected, the observed differences disappeared, and the disk was then figured to a paraboloidal form. It has served very well in the 100-inch telescope for eighteen years, showing only such variations in figure as occasional rapid temperature changes, and a somewhat defective support system (recently improved), might lead one to expect in the case of ordinary plate glass.

Such variations in form with temperature, however, would not be permissible in a 200-inch mirror, of far greater weight and thickness. After considering various alternatives, the Observatory Council* and its Advisory Committee† decided that a serious attempt should be made to produce a 200-inch disk of fused silica. Through the co-operation of the General Electric Company, Dr. Elihu Thomson, who had previously made several fused silica mirror disks of small aperture, undertook the very heavy task with the assistance of Mr. Ellis. After overcoming various difficulties, they succeeded in producing excellent disks of 25 inches aperture, but beyond this point a completely new procedure was needed. The method devised, which is briefly described in a recent article‡, finally yielded a disk 66 inches in diameter;

* Robert A. Millikan, Arthur A. Noyes, Henry M. Robinson and George E. Hale (chairman), members of the Executive Council of the California Institute of Technology, and Walter S. Adams, director of the Mount Wilson Observatory of the Carnegie Institution of Washington. J. A. Anderson of the Mount Wilson Observatory is the executive officer of the Observatory Council. George E. Hale has remained a member of the Mount Wilson Observatory of the Carnegie Institution since his resignation of the directorship of the Observatory in 1923.

† Walter S. Adams (chairman), Charles G. Abbot, Ira S. Bowen, J. P. Buwalda, W. H. Clapp, P. S. Epstein, Edwin Hubble, T. von Karman, R. R. Martel, H. N. Russell, F. H. Seares, R. W. Sorenson, and Richard C. Tolman.

‡ Hale, "The Astrophysical Observatory of the California Institute of Technology", *Astrophys. J.*, September 1935, pp. 111-139.

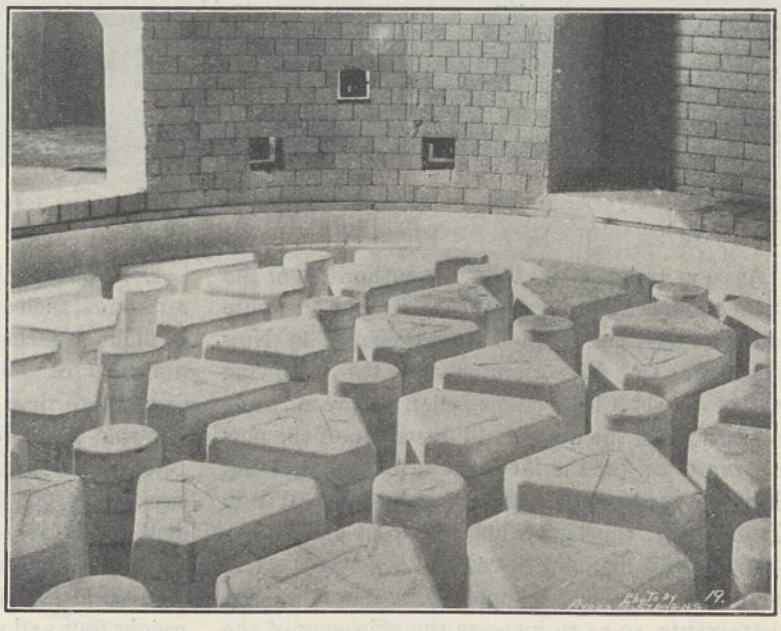


FIG. 4. MOULD FOR 120-INCH DISK SHOWING CORES FOR CIRCULAR HOLES AND TRIANGULAR OPENINGS BETWEEN RIBS.

but this and another disk of the same size proved to be unsuitable, and the long series of experiments was accordingly abandoned in 1931.

The next material chosen was Pyrex glass, so widely and successfully used for chemical and cooking utensils subject to rapid changes of temperature. Here we had the advantage of the long experience of Dr. Arthur L. Day and the Geophysical Laboratory of the Carnegie Institution of Washington, added to that of the able research staff of the Corning Glass Works. Beginning with smaller disks, Dr. J. C. Hostetter and Dr. G. V. McCauley developed a special procedure of casting, preliminary cooling and annealing, which led to the production of a 60-inch disk with ribbed back. At this stage a greatly improved type of Pyrex glass was devised, which was then used in the casting of a 120-inch disk (for testing the 200-inch), now partially ground and figured in our optical shop.

The first 200-inch mirror disk made at Corning was injured by defects in the mould, but a second one was successfully cast in an improved mould on December 2, 1934. After nearly a year of careful annealing, during which the temperature was gradually decreased from day to day by means of electrical controls, the disk has now been taken from the oven and examined.

FIG. 6. THE FIRST 200-INCH DISK AT THE CORNING GLASS WORKS.

As the tests appear to be satisfactory, the 200-inch disk will soon be shipped by rail to Pasadena in 'a well-hole' car. It has safely survived a river flood which rose nearly to the level of the annealing oven and a heavy earthquake which passed through New York State. We trust its transit across the United States, where it will clear the railway tunnels by only a few inches, will be equally fortunate.

After all of this experimental work, it is now possible that a successful 300-inch Pyrex disk could be made. But even if ample funds were available, it might be unwise to undertake it, as both experimental and theoretical studies made here render it doubtful whether a 300-inch telescope would photograph the faintest and most remote nebulæ more effectively than a 200-inch reflector may be expected to do.

The photographic efficiency of a telescope is closely related to its focal ratio. The question as it arises in connexion with a large reflecting telescope is much too complicated to be discussed

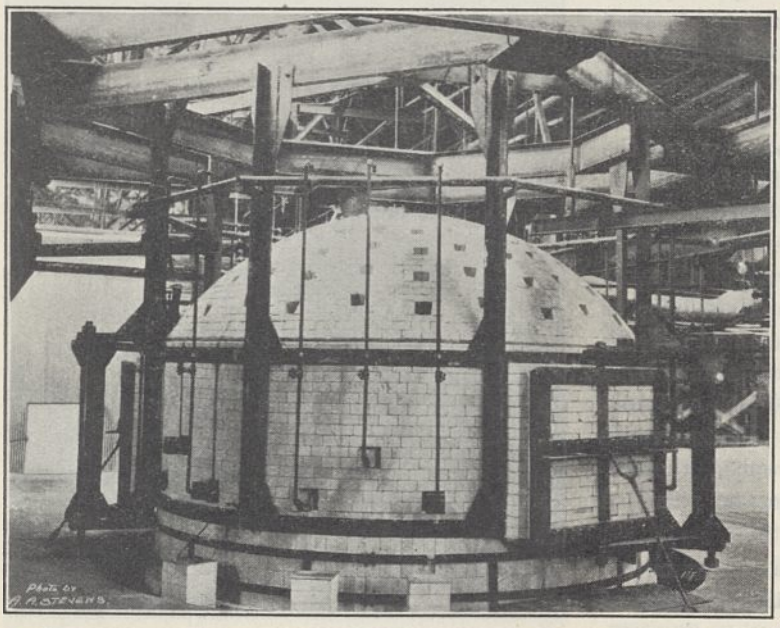


FIG. 5. BEEHIVE OVEN USED TO HEAT THE 120-INCH DISK AND MOULD DURING THE CASTING OPERATION.

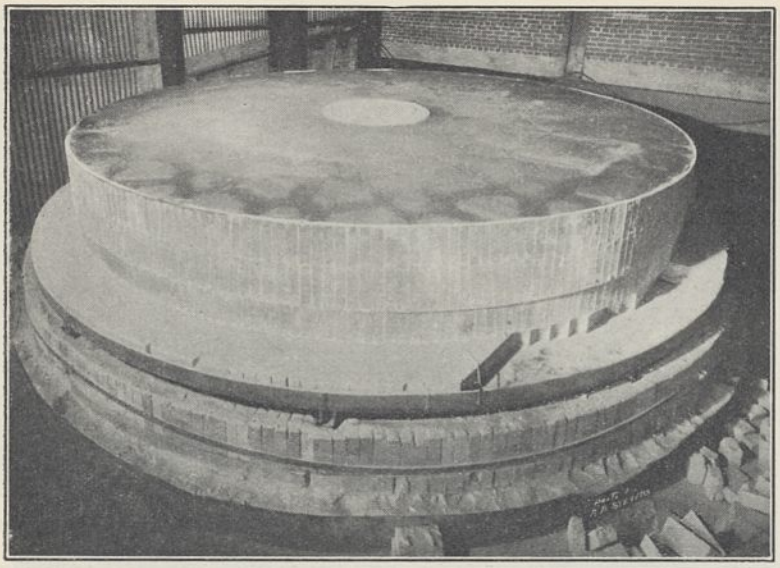


FIG. 7. THE NEW 200-INCH DISK AS IT WAS REMOVED FROM THE ANNEALER AT THE CORNING GLASS WORKS ON DECEMBER 8, 1935.

in detail in this place. The choice of $f/3{\cdot}3$ for the 200-inch mirror was made some years ago. A recent examination of the matter in the light of much additional experience and special test observations obtained with the 60-inch and 100-inch telescopes on Mount Wilson confirms the original choice.

The design of the most suitable form of equatorial telescope mounting for a 200-inch mirror has occupied our attention from the outset. After preparing many alternative designs, one due chiefly to Anderson, Serrurier and Edgar has been adopted. This will permit the telescope to be used on all parts of the visible heavens, extending from the horizon to the north pole. The observer, in one arrangement, will be carried in a cartridge-shaped house at the principal focus, where the comparatively short focal length of 55 ft. will give very bright images and permit the faintest objects to be photographed with relatively short exposures. The field at this point would be very small, were it not for the zero correcting lens devised for us by Dr. F. E. Ross, which will be mounted in front of the photographic plate. Such lenses have been tested with great success in the 60-inch and 100-inch reflectors on Mount Wilson. Photo-electric amplifiers, short-focus spectrographs, thermo-couples, etc., can also be used in the principal focus.

By means of an electric motor, a convex mirror can be instantly turned into position in front of the principal focus, thereby converting the telescope into the Cassegrain form, with a focal ratio of $f/16$, giving a large and sharply defined star field below the central hole in the 200-inch mirror. Here much work will be done, both by direct photography and with suitable spectrographs. A third arrangement will involve the use of an additional plane mirror, sending the converging beam through the hollow declination axis to a totally reflecting prism, mounted before the slit of a long-focus grating or prism spectrograph. This spectrograph will hang parallel to the polar axis within a large hollow cylinder, forming part of the telescope mounting, and will be so geared that the slit will always remain vertical. Another similar arrangement, on the opposite side of the telescope tube, will carry radiometers or such other auxiliary instruments as must always remain vertical. Finally, a fourth optical arrangement will form the star image below the hollow bearing at the south end of the polar axis, where fixed spectrographs or other apparatus of any desired dimensions will be rigidly mounted within a large constant-temperature chamber.

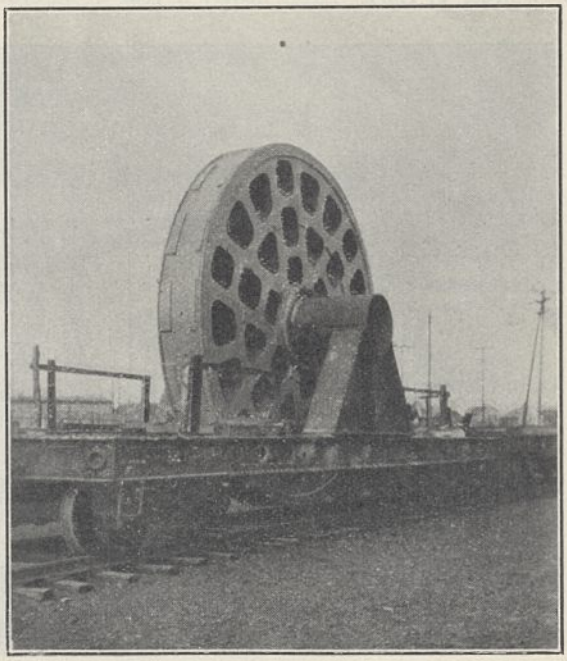


FIG. 8. BASE OF TUBE FOR 200-INCH TELESCOPE. THIS WILL ALSO SERVE TO SUPPORT THE MIRROR DISK ON THE GRINDING MACHINE.

The very short-focus spectrograph objective ($f/0{\cdot}59$) developed for the new observatory by Dr. W. B. Rayton was at once put into use on Mount Wilson with the 100-inch telescope, in accordance with our co-operative scheme. It is with this objective that Mr. Humason has measured the extraordinarily high apparent velocities of the extra-galactic nebulæ, from which Dr. Hubble has deduced their apparent increase of velocity with distance. Dr. Hubble is not yet fully convinced, however, that these apparent velocities are real, and it is hoped that the 200-inch telescope will ultimately throw additional light on the problem of the 'expanding universe'.

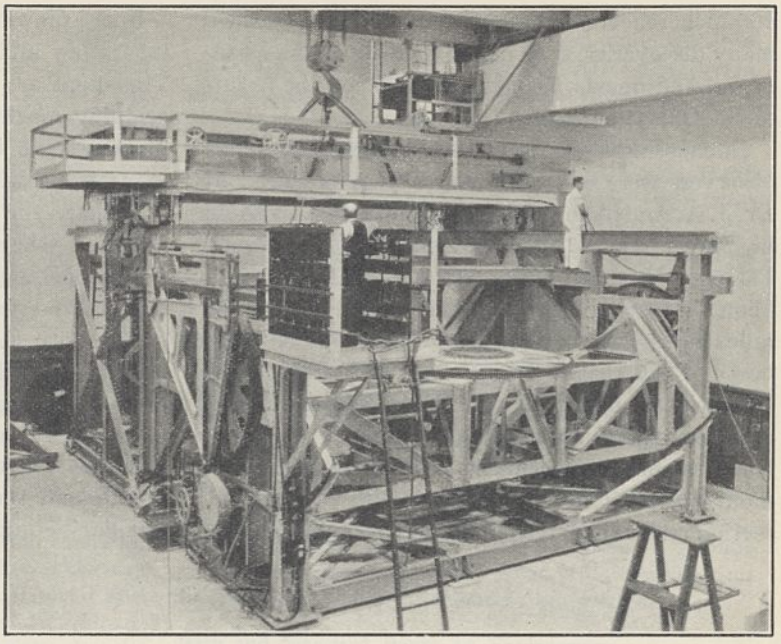


FIG. 10. 200-INCH GRINDING MACHINE READY TO RECEIVE TURN-TABLE, WHICH WILL ULTIMATELY BE USED AS THE BASE OF THE 200-INCH TELESCOPE TUBE.

As an important aid in this task, the British Scientific Instrument Research Association, through the kind collaboration of Sir Herbert Jackson, Dr. Harry Moore and Mr. R. J. Bracey, has recently completed an even more remarkable spectrograph objective, with a focal ratio of $f/0{\cdot}36$. Recent tests by Mr. Humason show that this lens has a flat field over an ample range of wave-length, and is considerably faster than the Rayton lens. The photographic plate is used with its film in immersion contact with the flat face of the rear lens of the system designed by Mr. Bracey. The lens was perfectly made for us by Messrs. R. and J. Beck, Ltd., and is employed with an excellent collimator objective and two prisms made by Messrs. Ross, Ltd. Its speed is so great that its efficiency is determined by the brightness of the sky background. Thus the darker the sky background the fainter the nebular spectra that can be recorded. It is expected that on Palomar Mountain, which is far from city lights, this lens can be used to special advantage with the 200-inch telescope.

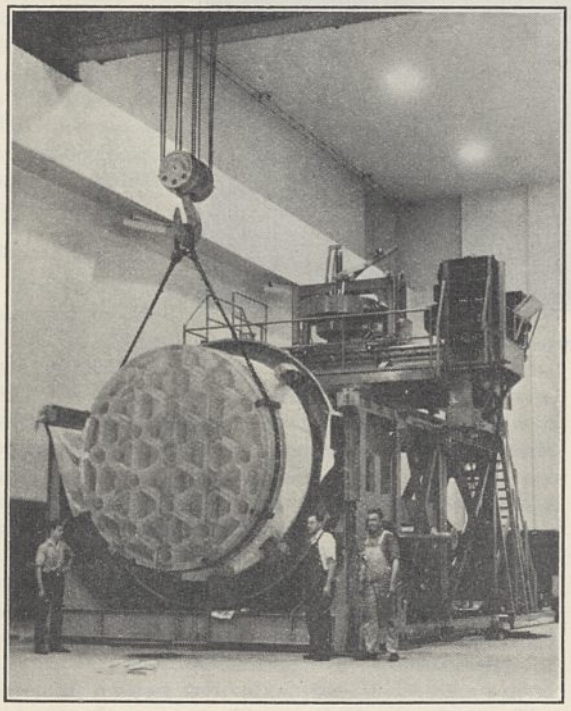


FIG. 9. 120-INCH MIRROR DISK BEING PLACED ON GRINDING MACHINE.

Another great improvement has been developed for us by Dr. John Strong, whose method of applying a coat of aluminium, instead of silver, to large telescope mirrors has been fully tested in the case of the Crossley reflector on Mount Hamilton and the 60-inch and 100-inch reflectors on Mount Wilson. The gain in reflecting power, especially in the ultra-violet, the durability of the aluminium film and its freedom from scattered light, have been amply confirmed both here and at the Lick Observatory.

Still another striking development of auxiliary apparatus effected for use with the 200-inch telescope is shown by the improvement of photo-electric amplifiers accomplished by Dr. A. E. Whitford, working in co-operation with Dr. Joel Stebbins. Already applied to various objects with the

100-inch reflector, these amplifiers have yielded many discoveries, such as the increased dimensions of the Andromeda Nebula, new light on the nature of the Galaxy, etc.

In choosing a site for the new observatory, many observers were enlisted under a plan prepared by Dr. J. A. Anderson. A long series of tests of various high-level regions has resulted in the choice of Palomar Mountain (lat. 33° 21′ 20″ N., altitude about 5,600 ft.), an isolated summit about 93 miles south-east of Pasadena and about 50 miles north of San Diego. The average seeing appears to be distinctly better than on Mount Wilson, and all other conditions are favourable. Much preliminary construction has been done there during recent months, and it is expected that the lower (fixed) section under the large dome will be erected shortly.

Space prevents a description of the astrophysical laboratory and the instrument and optical shops. The shops are very fully equipped, and the large grinding machines for the 120-inch and 200-inch mirrors have been built in them, together with many other instruments.

Perhaps the most important applications of the 200-inch telescope will be in the study of very remote nebulæ, the analysis of the nearer large spirals, and the complete spectrographic investigation with the highest dispersion of many stars in our own Galaxy. It need scarcely be said, however, that many other capital problems, both astronomical and physical, await the utilisation of the great light-gathering power of the 200-inch mirror and the advantages offered by its special auxiliary equipment.

FIG. 11. FIRST RESIDENCE ERECTED ON THE NEW OBSERVATORY SITE, PALOMAR MOUNTAIN.

PRINTED IN GREAT BRITAIN BY FISHER, KNIGHT AND CO., LTD., ST. ALBANS

of the Fair. The largest number of foreign buyers visiting the Fair will come from Holland; Germany is second on the list and Belgium, which was second last year, is third. Large contingents of buyers will also arrive from France, Denmark, Switzerland, the United States, Norway, Sweden, Poland, Czechoslovakia and Spain. From the British Empire countries, the largest number of buyers will come from the Irish Free State, with Canada next, followed by India, South Africa and Australia in that order. Altogether sixty-four countries will be represented.

International Protection of Birds

THE recently re-organised British National Section of the International Committee for Bird Preservation met on January 15 at the British Museum (Natural History). There were present Mr. Percy R. Lowe (chairman); Dr. F. H. A. Marshall (Royal Society); Mr. Hugh Gladstone and Mr. David Seth-Smith (Zoological Society of London); Dr. G. Carmichael Low (British Ornithologists' Union); Mrs. Frank E. Lemon and Mr. A. Holte Macpherson (Royal Society for the Protection of Birds); Mr. N. B. Kinnear and Mr. Hugh Whistler (National Trust); Mr. D. A. Bannerman and Mr. G. E. Lodge (Society for the Promotion of Nature Reserves); Mr. C. W. Hobley (Society for the Preservation of the Fauna of the Empire); and Miss Phyllis Barclay-Smith (hon. secretary). The chairman made reference to the great advance made by the International Committee for Bird Preservation during the past two years, and paid tribute to the pioneer work of its chairman, Dr. Gilbert Pearson, of the United States. Among the subjects which are engaging the activities of the British Section at the present moment are a proposed International Convention for the Preservation of Birds, to take the place of the Paris Convention of 1902, the further protection of the quail from an international point of view, and an investigation as to the actual status of wild duck in the British Isles. The question as to whether there may not be a serious decrease in the numbers of wild duck is giving rise to considerable anxiety to ornithologists and sportsmen.

Modern Spectroscopy

THE three Cantor lectures on the above subject, delivered by Prof. H. Dingle to the Royal Society of Arts in November and December 1934, have now been published (London: Royal Society of Arts, 1935. 2*s*. 6*d*.). They deal with the spectra of atoms, molecular and absorption spectra, and applications of spectroscopy. The first lecture outlines the main characteristics of atomic spectra, primarily from the experimental point of view. The second deals, in a rather more detailed manner, with band spectra; some indication is given of how these arise, and of their structure. The subject of absorption spectra is also touched upon. The non-physicist, to whom the lectures were primarily addressed, will find the third lecture, on the applications of spectroscopy, of particular interest and value, since it contains a good deal of matter not readily available elsewhere. The difficulties of qualitative and quantitative spectrum analysis are clearly set forth, and the present possibilities of such methods are indicated, some interesting examples being cited. This particular application of spectroscopy is, of course, older than any other, but unexpected obstacles to its general application were encountered at an early stage, and until recently the method has been neglected to such an extent that the very meaning of the term 'spectrum analysis' is apparently unfamiliar to some of the younger physicists of the present day, with whom it connotes the analysis *of* spectra, for physical purposes, instead of analysis *by* spectra for chemical purposes. Concerning the section devoted to astronomical spectroscopy, it need only be said that in lucidity and interest it is quite representative of the author's well-known writings on this subject. The text is well illustrated throughout by diagrams and reproductions of spectrum photographs. The lectures will without doubt appeal to a wide circle of readers, that is to say, all those who have no special knowledge of spectroscopy but wish to obtain a general idea of what it is about and what is its contribution to the general body of scientific knowledge.

Rare and Standard Books on Engineering

MESSRS. HENRY SOTHERAN, LTD., have now issued part 2 of their Catalogue of Science and Technology, No. 3, an annotated and classified list of old, rare and standard works on "Exact and Applied Science". This part enumerates books on mechanical and electrical engineering, conveniently arranged in appropriate sections, and includes publications throughout the period from the beginning of the sixteenth century down to recent years. Many famous volumes are mentioned—such as Papin's "New Digester" (1681) and the quaintly bombastic "Century of the Names and Scantlings of such Inventions as at present I can call to mind to have tried and perfected" of Edward Somerset, second Marquis of Worcester, whose work, if inclined towards perpetual motion, was genuinely moving in the direction of the steam engine. Gilbert's "de Magnete" (1600) is of great interest not only as being in Lord Kelvin's view "one of the finest examples of inductive philosophy that has ever been presented to the world", but also in that it contains the rarest of all autographs of men of science, that of Gilbert himself, the father of electrical science. Napier's "Descriptio" (1614) and Newton's "Principia" (1687) are represented by first editions. As many of these books have been the possessions of outstanding men of science, their notes are of peculiar value. A copy of Silvanus Thompson's "Dynamo-Electric Machinery" (1886) is enriched "with very numerous MS. notes (often severely critical and sometimes sarcastic) by Oliver Heaviside, F.R.S.".

Botany in the University of Sydney

VOL. 2 of Botanical Reprints from the University of Sydney shows very valuable work in progress on characteristic groups of the Australian flora. A. Burges has a first paper upon the rust fungi of the Dominion, which deals most appropriately with the genus *Uromycladium*, in which six of the

seven species are endemic to Australia and restricted to the genus *Acacia* for their host plants. Gladys Carey continues her study of the embryology of viviparous seeds, examining two of the mangrove species from tropical Queensland. Lilian Fraser has two papers upon the sooty moulds of New South Wales—those curious fungi that are found superficial upon branches and leaves, living upon the honey-dew secreted by scale insects and aphides; she also describes some of the Mycetozoa of the same State. I. V. Newman, in continuation of earlier studies of the Australian acacias, has two papers dealing with the floral organs and their development, fertilisation and embryology in *Acacia Baileyana*, whilst Joyce W. Vickery deals with the vegetative reproduction by underground tubers of two species of *Drosera* common as winter herbs in the Sydney district. The Botanical Department thus bears witness to its active interest in the flora of the Australian dominion.

Hydrogen Ion Determination

WE have received a copy of the fourth revised and enlarged edition of the booklet "*p*H Values", which may be obtained free on application to British Drug Houses, Ltd., Graham Street, City Road, London, N.1. The booklet gives an elementary account of the subject, with particular reference to indicators. It is based entirely on the idea of a concentration of hydrogen ions, and the question arises whether the time has not come to take account of activities and salt effects more adequately than is the case. Further editions of the booklet should be revised so as to bring it more into line with modern practice.

Popular Reading of Scientific Books

THE librarian of Middlesbrough Public Libraries has made an interesting experiment in endeavouring to guide his readers towards an intelligent use of works of general science. A pamphlet entitled "How to Understand the Sciences" (pp. 28) offers a very readable commentary upon well-known books dealing with scientific subjects in a popular way, and suggests a graduated course of reading, suitable for the plain man, in physics, chemistry, biology and general science. If Mr. Lillie's comments do not increase the intelligent reading of the scientific works in his libraries by the ordinary citizen, nothing will.

Association of American Geographers

THE thirty-second annual meeting of the Association of American Geographers was held on December 30–January 1 at Washington University, St. Louis, Missouri. In the three-day session, seventy-two papers were presented, including six in the field of geomorphology, ten in meteorology and climate, twenty-two in regional geography, six in the field of population, and two in cartography. The remainder represented a diversity of subjects. The morning of January 1 was devoted to a symposium of "Land Utilisation". The papers on this subject were presented by Prof. Lester E. Klimm of the University of Pennsylvania, Prof. H. M. Leppord of the University of Chicago, Prof. Loyal Durand, jun. of the University of Wisconsin, Dr. G. Donald Hudson of the Tennessee Valley Authority and Prof. K. C. McMurray of the University of Michigan. On the evening of December 31, the retiring president, Charles C. Colby of the University of Chicago, addressed the Association and guests on the subject of "Changing Currents of Geographical Thought in America". The following officers were elected for 1936: *President*, Prof. W. H. Hobbs, University of Michigan; *Vice-President*, Dr. John K. Wright, librarian of the American Geographical Society; *Secretary*, Prof. P. E. James, University of Michigan; *Treasurer*, Prof. John E. Orchard, Columbia University; *Members of Council*, Col. Claude E. Birdseye, U.S. Geological Survey (one year), and Prof. R. J. Russell, Louisiana State University (three years).

British Medical Association

THE one hundred and fourth annual meeting of the British Medical Association will be held in Oxford on July 17–24. The president-elect is Sir E. Farquhar Buzzard, regius professor of medicine in the University of Oxford. The meeting will be divided into the following sections with the presidents indicated: Medicine (Dr. A. G. Gibson); Surgery (Prof. G. E. Gask); Obstetrics and Gynæcology (Prof. H. B. Whitehouse); Pathology and Bacteriology (Dr. E. W. A. Walker); Diseases of Children (Dr. R. C. Jewesbury); Neurology and Psychological Medicine (T. S. Good); Ophthalmology (Dr. P. E. H. Adams); Orthopædics (G. R. Girdlestone); Oto-Rhino-Laryngology (L. Golledge); Pharmacology and Therapeutics with Anæsthetics (Prof. J. A. Gunn); Physical Medicine (Dr. W. J. Turrell); Physiology and Biochemistry (Prof. R. A. Peters); Radiology (R. H. Sankey); Anatomy (Prof. W. E. Le Gros Clark); Dermatology (Dr. S. E. Dore); History of Medicine (Dr. A. Chaplin); Medical Sociology (Sir George Newman); Nutrition (Dr. A. F. Hurst); Public Medicine (Dr. W. M. Willoughby); Tuberculosis (Dr. W. Stobie). Further information can be obtained from the Secretary, B.M.A. Office, The Cottage, Keble Road, Oxford.

Second International Congress for Microbiology

THE second International Congress for Microbiology will be held in London on July 25–August 1 under the presidency of Prof. J. C. G. Ledingham. The headquarters of the Congress will be at University College, Gower Street, W.C.1, but additional accommodation, if required, will be available in the adjacent buildings of the London School of Hygiene and Tropical Medicine and the Wellcome Research Institution. During the Congress week, official receptions will be given by His Majesty's Government, by the Royal Society and other official bodies. Excursions have been arranged by the Ladies' Committee for the ladies and any members of Congress desiring to take part in them. Also the Sectional Committees are arranging visits to laboratories and institutes concerned with the scientific business of the sections. Extended excursions are being arranged for the

two week-ends over which the Congress extends. The scientific business of the Congress will be conducted in the following eight sections: General Biology of Micro-organisms; Viruses and Virus Diseases in Animals and Plants; Bacteria and Fungi in Relation to Disease in Man, Animals and Plants; Economic Bacteriology—Soil, Dairying and Industrial Microbiology; Medical, Veterinary and Agricultural Zoology and Parasitology; Serology and Immunochemistry; Microbiological Chemistry; Specific Immunisation in the Control of Human and Animal Disease. A comprehensive programme of discussions within these sections has been prepared, full particulars of which are given in the preliminary programme of the Congress which has recently been published and distributed. Copies of this programme are available from the Hon. General Secretary, Dr. R. St. John-Brooks, Lister Institute, Chelsea Bridge Road, London, S.W.1.

Announcements

THE Council of the Institution of Chemical Engineers has awarded the Moulton Gold Medal for 1935 to R. W. Powell and Dr. Ezer Griffiths for their paper on "The Evaporation of Water from Plane and Cylindrical Surfaces".

DR. A. D. IMMS, reader in entomology in the University of Cambridge, has been elected president of the Royal Entomological Society of London for 1936–37.

SIR ARTHUR KEITH, lately Hunterian professor of the Royal College of Surgeons of England; Dr. R. R. Marett, University reader in social anthropology, Oxford; Prof. David Waterston, Bute professor of anatomy, University of St. Andrews; and Prof. Herman Geijer, director of the Archive for Dialects and Folklore, Uppsala, Sweden, have been elected fellows of the Scottish Anthropological Society in recognition of their distinguished services to anthropological science.

DR. JUNGEN WILHELM HARMS, professor of zoology at Tübingen, has been appointed to the corresponding chair at Jena.

M. LAPIQUE has been elected president of the French Society of Biological Chemistry and M. Perpère president of the Society of Hydrology for 1936.

THE Imperial Leopold Caroline German Academy of Natural Philosophers in Halle has elected as honorary member Dr. Kurt Poppe, professor of medicine at Rostock, in recognition of his work in the investigation of infectious diseases.

PROF. RICHARD OTTO, departmental director of the Robert Koch Institute for Infectious Diseases at Berlin, has been nominated director of the State Institute of Experimental Therapy and Georg Speyer House at Frankfort-on-Main.

IN No. 11 of the *Bulletin de la Classe des Sciences* of the Royal Academy of Belgium it is announced that the Academy has awarded prizes for the year 1935 as follows: to Prof. B. Segre, of the University of Bologna, for a memoir entitled, "Quelques résultats nouveaux dans la géométrie sur une V_3 algébrique"; jointly to M. J. Van Mieghem and M. F. Bureau, for their memoirs on the theory of Huygens' principle; to M. P. Manil, for his memoir entitled "Contribution à l'étude de l'immunité chez les Végétaux".

AT a meeting of the Royal Microscopical Society held on January 15, the following officers were elected: *President*, Dr. R. S. Clay; *Vice-Presidents*, Prof. W. A. F. Balfour-Browne, J. E. Barnard, Conrad Beck, and Dr. J. A. Murray; *Hon. Treasurer*, C. F. Hill; *Hon Secretaries*, Prof. R. T. Hewlett and J. Smiles; *New Members of Council*, F. Martin Duncan, N. I. Hendey, Andrew More, A. S. Newman; *Hon. Editor*, Dr. G. M. Findlay; *Hon. Librarian*, Dr. Clarence Tierney; *Hon. Curator of Instruments*, W. E. Watson Baker; *Hon. Curator of Slides*, N. I. Hendey.

A SERIES of special lectures on "Work and Play in the British Empire" is being given at the Imperial Institute, South Kensington, S.W.7, on Thursdays from February 6 until April 2, at 2.30. Admission is free. Further information can be obtained from the Secretary of the Institute.

MESSRS. H. K. LEWIS AND CO., LTD., are issuing guides to lectures of medical and scientific interest, most of which are open to the public. The list for February is comprehensive for lectures delivered in London. Copies of the guide can be obtained free on application to the Compiler, Messrs. H. K. Lewis and Co., Ltd., 136 Gower Street, W.C.1.

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

An official fellow in mathematics in Queen's College, Oxford—The Provost (Feb. 15).

A principal of the West Ham Technical College—The Town Clerk, Education Offices, 95, The Grove, Stratford (Feb. 19).

A head of the Engineering Department of the Cardiff Technical College—The Director of Education, City Hall, Cardiff (Feb. 22).

A professor of physiology in the University of Leeds—The Registrar (Feb. 29).

A Sir Jesse Boot professor of chemistry in University College, Nottingham—The Registrar (March 2).

A professor of animal husbandry and a professor of plant husbandry in the Canterbury Agricultural College (University of New Zealand)—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (March 31).

Letters to the Editor

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

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 238.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

The Nature of Light

ON Maxwell's theory, lines of electric force which are not anchored to charged particles travel at right angles to themselves with the velocity of light. A circular line of force travelling at right angles to its plane would fulfil this condition and would travel unchanged without loss of energy; it would thus possess one of the properties of the photon. I suggested some time ago that the photon is a ring of force of this kind. A single ring, however, would not account for interference; to possess this property it would have to be accompanied by a train of Maxwellian waves. If these came from the atom emitting the light, they would diminish rapidly in intensity as the distance from the source increased, so that the light from a distant star would differ from that of the same wave-length produced in the laboratory. Again, on this view we have to explain why the path of the photon is guided by these waves. I suggested that this might be done by the momentum which these waves possess; that it was in fact an effect analogous to those due to the pressure of light.

It occurred to me later that a great many difficulties could be got over if we suppose that the photon, instead of being a single ring of electric force, consisted of a harmonic train of such rings; such a train would have a wave-length of its own, and could produce interference by itself without the assistance of waves of another kind. It would thus be free from the very embarrassing dual character of light which the current theory requires. The quantum of light would be a train of waves of finite length given out by the electron when it falls from one energy level to another in the luminous atom; the electron would not at once come to rest on its new level, but would oscillate about this, and radiate until the energy given out was that due to the fall of an electron from one energy level to the other. Thus the energy in the train would be that postulated for the photon on the current theory.

The equations representing such a train are simple. Suppose that the centre of the circular lines of force are on a line parallel to the direction in which the light is travelling and that the planes of the circles are at right angles to this line. Then, using cylindrical co-ordinates, for which this line is the axis of z, and ρ the distance of a point from this axis. If P, Q, R are the components of electric force, along ρ, at right angles to ρ, and along the axis of z respectively, and α, β, γ the components of the magnetic force in these directions, in our case $P = R = 0$, and Maxwell's equations become, since the system is symmetrical around the axis:

$$0 = -\frac{d\beta}{dz};\quad K\frac{dQ}{dt} = \frac{d\alpha}{dz} - \frac{d\gamma}{d\rho};\quad 0 = \frac{1}{\rho}\frac{d}{d\rho}(\rho\beta); \qquad \ldots (1)$$

$$\mu\frac{d\alpha}{dt} = \frac{dQ}{dz};\quad \mu\frac{d\beta}{dt} = 0;\quad \mu\frac{d\gamma}{dt} = -\frac{1}{\rho}\frac{d}{d\rho}(\rho Q);$$

where K is the specific inductive capacity and μ the magnetic permeability of the medium. From these equations we get

$$\mu K\frac{d^2Q}{dt^2} = \frac{d^2Q}{dz^2} + \frac{d}{d\rho}\left(\frac{1}{\rho}\frac{d}{d\rho}(\rho Q)\right) \quad \ldots \quad (2)$$

When waves are travelling in the direction of z with the velocity of light,

$$\mu K\frac{d^2Q}{dt^2} = \frac{d^2Q}{dz^2};$$

hence equation (2) becomes

$$\frac{d}{d\rho}\left(\frac{1}{\rho}\frac{d}{d\rho}(\rho Q)\right) = 0;$$

of which the solution is

$$Q = A\rho + \frac{B}{\rho}.$$

B must be zero in a region where ρ can vanish and A in one where it can become infinite.

We see from the equation for $d\gamma/dt$ that unless ρQ is constant, there will be a longitudinal wave of magnetic though not of electric force, accompanying transverse waves of electric and magnetic force. Quite close to the axis ρQ cannot be constant, for Q must vanish when $\rho = 0$.

Outside this core we may put

$$Q = \frac{D}{\rho}\,\varepsilon^{c(pt-mz)};$$

and equation (1) shows that:

$$\mu\alpha = -\frac{m}{p}Q.$$

Now $m/p = c$ and μ in electrostatic measure $= 1/c^2$, where c is the velocity of light, hence $\alpha = -cQ$. It follows from the same equations that $\beta = \gamma = 0$. Thus the magnetic force is equal to c times the electric and is at right angles both to it and to the direction of propagation of the waves just as in Maxwellian waves.

In the core, $Q = A\rho$, we get from equation (1):

$$\mu\frac{d\gamma}{dt} = -2A.$$

So that γ is constant across the cross-section of the core, and the rate of alteration in the number of lines of magnetic induction passing through the core is thus $= -2A\pi a^2$, where a is the radius of the core. The electromotive force round a circle of radius ρ outside the core is $2\pi Q\rho$, or since $Q = B/\rho$, $2\pi B$. If Q is the same just inside as just outside the core, $B/a = Aa$, so that the electromotive force is equal to the rate of alteration in the magnetic lines passing

through the circuit. Thus if the system of longitudinal magnetic waves inside the core were established, it would produce the system of transverse waves around it.

Flow of Energy

The rate of flow of energy through unit area at right angles to ρ is by Poynting's theorem proportional to the product $Q\gamma$. As γ vanishes outside the core, there is no radial flow of energy and hence no leakage of energy as the photon passes through space. The energy in the wave front will be concentrated round the axes. On the axis itself both Q and α vanish and only the longitudinal magnetic force is left. As we recede from the axis the amplitude of Q and α increase until the boundary of the core is reached; here both have their maximum values and continually diminish as the distance from the axis increases, the energy per unit area of the wave front varying inversely as the square of the distance from the axis. Thus the radiation may practically be regarded as confined within a cylindrical pencil and not as extending throughout space.

The train of waves emitted from a luminous atom will be of finite length, and the amplitude of vibration will not be constant along the train, while those to which we have applied the mathematics are infinitely long trains of constant amplitude. We know, however, by Fourier's theorem that we can regard the first type of waves as the sum of a number of those of the second, and the results we have obtained will apply to each constituent of this sum.

Owing to the symmetry in Maxwell's equations between the electric and magnetic forces, a system of rings of magnetic force would possess the properties of the system of lines of electric force which we have been considering.

J. J. Thomson.

Trinity Lodge,
Cambridge. Jan. 27.

The Ceremonial Dedication of the Philipp-Lenard-Institut at Heidelberg

The description given in Nature of January 18 of the proceedings at the ceremonial dedication of the Philipp-Lenard-Institut at Heidelberg must form sad reading for the general body of scientific workers throughout the world, and more especially for those of us who owe so much to the stimulating instruction and courteous hospitality which we had the privilege to enjoy as students at one or other of the German universities in the past. In reading the almost incredible utterances of some of the present representatives of academic Germany on the occasion of this ceremonial at Heidelberg, it has occurred to me that in our amazement at such extravagances we are inclined to overlook some of the stark realities of the situation, and that perhaps they were these which either consciously or instinctively led the speakers to give expression to the wild and unbalanced statements which they are reported to have made.

In the mass-hysteria accompanying all revolutionary movements it is invariably the case that some group-associations in the country are singled out for attack and submitted to drastic and exemplary punishment or even total suppression by the new and self-created authorities, as we see in the case of the persecution of the Jewish population in Germany to-day. It was, therefore, by no means improbable that the particular group of the intelligentsia represented by the universities might at any moment be destined to meet with a similar fate, in which the whole of their organisation and activities might be proscribed and swept away at the behest of the new masters in the State. To avert the possibility of such a dire calamity, it is not surprising that there should be found members of the group in question ready to come forward and give expression to assurances of complete sympathy with even the most extreme and unreasonable views and actions of the new rulers.

To us in Britain, who fortunately are not at the moment in danger of becoming the victims of mass-hysteria, such assurances appear as a deplorable negation of some of the most fundamental and sacrosanct articles of our scientific *credo*. Our less fortunate German colleagues, on the other hand, would seem to be faced with much the same situation as was Galileo cited before the Inquisition, and that some of them have had recourse to the opportunist tactics of Henry of Navarre when he declared that "Paris is worth a Mass".

Jan. 29. P. F. F.

Deuterium as an Indicator in Fat Metabolism

It has hitherto not been a simple matter to determine whether the fatty acids in lipines such as lecithin, which are constituents of all active animal cells, play a part in the normal metabolism of fats. One reason for this is that suitable methods for 'labelling' fats which could be administered in the diet and then traced in the body have not been available. With the advent of deuterium a method for marking fats and using them in this way has become possible.

With the object of determining whether the fatty acids which are components of the fats of the diet can be found after absorption combined as lipines in various organs, we have partially saturated linseed oil with deuterium, and administered 2 gm. of the oil daily to an adult rat for seven days. The oil contained deuterium amounting to 4·9 per cent by weight of its total hydrogen content. The rat was then killed, and the ether-soluble substances of the liver and kidneys separated by the acetone method into lipine and glyceride fractions. A sample of fat from adipose tissue in the abdomen was also obtained. Each fraction was then examined for deuterium by burning it in a suitable combustion furnace, collecting the water produced and determining its density. The following figures for the deuterium content as percentage of total hydrogen were obtained:

Liver lipines, 0·98; liver glycerides, 0·97; kidney lipines, 0·63; adipose tissue fat, 0·75.

An estimation of the fat in the fæces, passed during the experiment, showed that absorption of the deuterium-containing fat was almost complete. These results show that the fatty acids containing deuterium have entered largely into the lipines both in the liver and kidney. The natural inference is that the lipines, although they may be important as structural elements in the cell, are probably also actively concerned in the metabolism of fats.

Whilst this work was in progress, Sinclair[1], using elaidic acid for 'marking' purposes, has also shown that the lipines of the liver take up fatty acids which have recently been administered in the food.

For quantitative purposes it would seem more satisfactory to use fat containing deuterium rather than elaidic acid, which is less easy to estimate and is not a natural fatty acid. There is also the possibility that, in the body, elaidic acid may revert to its isomeric form and thus be undetectable. The use of deuterium as an indicator of fat transport has also recently been described by Schoenheimer and Rittenberg[2]. They have, however, made only a general survey and shown that fat containing deuterium when given in food may afterwards be found both in the 'body fat' and the 'organ fat'. It is proposed to continue the experiments in order to get a more accurate picture of the rate of entry of food fat into the lipines of different organs and tissues.

B. CAVANAGH.
H. S. RAPER.

The University,
Manchester.
Jan. 20.

[1] *J. Biol. Chem.*, **111**, 515 (1935).
[2] *J. Biol. Chem.*, **111**, 163 (1935).

Anomalous Absorption of β-Rays

DURING the course of some experiments with a beam of fast β-rays between 1,500 ekv. and 3,000 ekv. passing through an expansion chamber filled with nitrogen at atmospheric pressure and placed in a magnetic field of about 500 gauss, it was frequently noticed that particles with a normal range in air of the order of 10 m. or more were stopped in a single collision in the gas of the chamber, and lost almost all their energy by passing it on to some non-ionising particle.

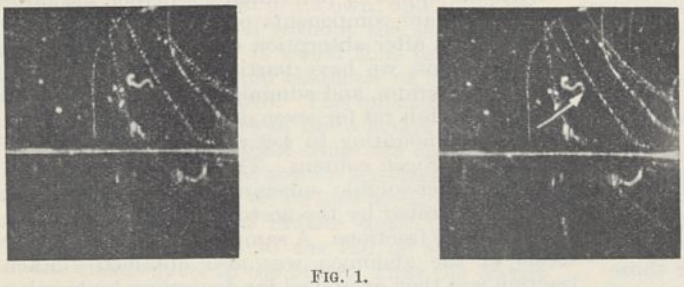


FIG. 1.

An example of this is illustrated in Fig. 1. The non-elastic collision resulting in the absorption of nearly the whole of the energy of the primary particle takes place at the point marked by an arrow. In such cases a characteristic branching at the end of the path can be observed. This is the track of a comparatively slow electron with an energy of 10–20 ekv. which, in this and similar cases, recoils in a backward direction.

The total length of the path of the electronic beam amounts to about 250 metres in nitrogen. The above phenomenon occurs not less than once in every 50 m. of path, and its probability may even be three times as great. The effective cross-section in nitrogen is therefore not less than 5×10^{-24} cm.^{2}.

Serious difficulties are encountered in interpreting this phenomenon. At first, one might be inclined to connect it with a radiative loss of energy. However, the observed value of the effective cross-section exceeds some hundred-fold the corresponding theoretical value as deduced from Bethe and Heitler's data. In addition, and apart from any theoretical calculations, a cross-section of this order in nitrogen would require an excessively great output of the 'stopping' radiation (*Bremsstrahlung*).

In such radiation processes, the effective cross-section should be proportional to Z^2. $\sigma_N = 5 \times 10^{-24}$ cm.^{2} in nitrogen corresponds to $\sigma_{Pb} = 7 \times 10^{-22}$ cm.^{2} in lead. If we assume that this is the mean value of the effective cross-section in the case of complete loss of energy by a β-particle with a velocity ranging from 1,500 ekv. to 3,000 ekv., then it can easily be shown that the absorption in lead of a beam of β-particles with an initial energy of 3,000 ekv. should be accompanied by a hundred per cent yield of photons with an energy between 1,500 ekv. and 3,000 ekv. (In aluminium the corresponding yield would be forty per cent.)

Very little is known about the 'stopping' radiation (*Bremsstrahlung*) at these velocities. So far as can be judged from the data available, however, a yield of the given value is quite out of the question. On the other hand, the photographs obtained leave no doubt as to the existence of the phenomenon itself. The question arises, therefore, whether in these absorption processes we are not dealing with a non-conservation of energy, as in the case of β-ray emission; that is, whether the neutrino does not play a part in these processes, in spite of the fact that this does not follow from the theory of β-disintegration.

It should be added that the scattering of β-rays is also markedly anomalous. The study of the scattering likewise indicates the existence of a new kind of interaction between the light charged particles and the nuclear field which is not accounted for in any of the existing theories.

We intend to publish shortly the numerical data obtained. Here we wish to direct attention to one more fact. The β-rays were also passed through some aluminium and lead plates in the expansion chamber. On comparing the scattering in the gas and in the plates, it was easy to see that, for large angles, the scattering does not follow the Z^2-law, but depends on Z to a far less marked degree.

The results of these investigations were reported in May last to the Academy of Sciences of the U.S.S.R. Leprince-Ringuet[1] has recently published similar results obtained in an argon-filled expansion chamber.

D. SKOBELTZYN.
E. STEPANOWA.

Physical Technical Institute,
Leningrad.
Dec. 12.

[1] L. Leprince-Ringuet, *C.R.*, **201**, 712, 1524 (1935).

Motion of Liquid around an Obstacle during Electro-Deposition

DURING the electro-deposition of copper, it has been observed that if a plate cathode is caused to move at certain steady speeds through the electrolyte so that the latter is flowing across its surface, the copper is sometimes deposited in marked ridges along the lines of flow of the liquid. This is obviously due

to the attainment of steady conditions in the streaming away of the copper-denuded cathodic layer of electrolyte and its replacement by fresh and more concentrated solution, from which deposition is more rapid.

FIG. 1.

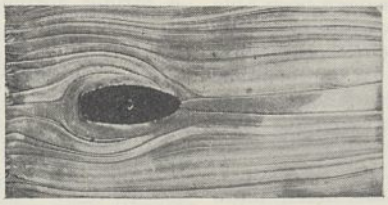


FIG. 2.

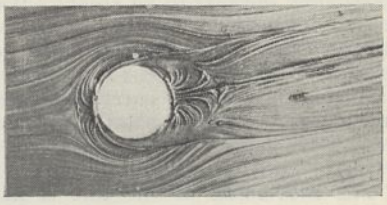


FIG. 3.

The occurrence of these ridges suggested the possibility of obtaining a record of the stream-lines in steady motion of a liquid around an obstacle of any shape.

Accordingly, a copper cathode plate 5 cm. × 2·5 cm., carrying a 1 cm. diameter cylinder of ebonite erect on one surface, was mounted on a vertical arm so that the plane of the plate was normal to the radius of a cylindrical vessel containing a typical 'acid copper sulphate' plating solution. An anode plate of the same size, mounted 5 cm. away on a parallel arm, was fixed parallel to the cathode and the pair were then rotated at an angular velocity of 7·2 radians per second during the passage of the appropriate current. Allowing for the angular velocity of the liquid set up by the drag of the rotating cathode, it was estimated that the liquid was streaming past the obstruction on the plate with a linear velocity of 70 cm. per sec. After five hours' rotation, the pattern shown in Fig. 1 was obtained. The turbulence on the left of the photograph is clearly that due to the leading edge of the plate.

A second plate (Fig. 2) shows the effect of steady motion round a 'stream-line' body. The section chosen was No. 9 of Ogilvie's strut sections[1] of fineness 2·5. Measurements at the National Physical Laboratory show that this particular section has a resistance (in air at 40 miles per hour) of about one sixth that of a circular cylinder of the same diameter.

An improvement of the conditions was then attempted by rotating a copper cylinder about a vertical axis in the centre of the electrolyte, the anode being in this case a copper belt on the circumference of the containing vessel. A cylindrical obstruction made of ebonite was placed on the copper cathode, and the result is shown in Fig. 3. Speed of rotation of this cathode was greater than in the previous cases, but drag conditions have caused much greater angular velocity of electrolyte, so that the linear flow past the obstruction is estimated at 65 cm./sec.

With this arrangement it was found that the lines of flow across the cathode were inclined at an angle of about 10° to the horizontal, the direction of flow being from below upwards. The flow appeared to be quite uniform in regions away from the obstruction, so we should expect the axis of symmetry of the pattern to be inclined, as it actually is.

Apart from hydrodynamical conditions which determine steady flow of the liquid over the plate, the electrochemical factors favouring the formation of marked ridges are also obviously complex. The latter include speed of the cathode, current density, temperature, composition and *p*H value of the electrolyte, all of which are known to influence the nature of the deposit and so affect initial conditions in the cathode layer.

In view of the variety of factors involved, it is scarcely surprising that the exact mechanical and electro-chemical balance necessary to produce a successful stream-line pattern is not by any means obtained in every experiment, even though the individual conditions appear to be fulfilled.

We are indebted to the Admiralty for permission to publish this letter.

E. P. HARRISON.
H. GOLLOP.

H.M.S. *Vernon*,
Portsmouth.
Dec. 16.

[1] Ogilvie, *Aeronautics*, June (1912).'

'Pockeling' of Freshly Swept Surfaces of Solutions

WHEN the surface of a dilute solution of surface active material is freed from insoluble contamination by sweeping with a movable barrier of metal or paper and the surface examined by lightly dusting with talc, both procedures originated by Miss Pockels, we have noted upon the surface a striking effect which is readily recorded with a motion picture camera. Here and there, from time to time, the talc suddenly withdraws from circular patches which may be up to a centimetre or more in diameter. After we had examined this phenomenon for some months, we found that it likewise had been described by Miss Pockels in 1917[1]. She explained it by the unlikely hypothesis that all substances that lower the surface tension of water exist to a certain extent in the form of colloidal particles or micelles, even in very dilute solution, and that when these chance to approach the surface the "pockel" appears. Alternative possibilities are that the "pockels" arise not from micelles but from local concentrations within the liquid due to the fluctuations of ordinary molecular movement, or to dust particles (or possibly talc particles) which have sorbed material within the liquid, or to convection currents within the liquid which is no longer homogeneous because the solute must reconcentrate in the surface to satisfy the theorem of Gibbs. All of these suggestions seem quantitatively inadequate. 'Pockeling' ceases when the system has come completely into equilibrium.

A similar appearance is produced when streamers or small portions of more concentrated solution are brought up to the surface. A different effect is that where a tiny crystal of surface active material remains or moves in a portion of the surface which it is contaminating.

A fifth explanation, which we regard as more satisfactory, is that in sweeping the otherwise clean

surface the adsorbed film is compressed to a rapidly dissolving scum, which provides the local centres of concentrated solution. This explanation is supported by the further observation that when the sweeping is made more sudden and drastic so as to remove all the upper part of the liquid from the vessel altogether, 'pockeling' appears to be absent. We have been able to see with the naked eye the crumpling of the adsorbed film on the surface of the solution of phenyl proprionic acid. It is also supported by the fact that a moving bubble may carry along with it very many times the amount of solute which could find place in a monomolecular film or which would conform with the theorem of Gibbs.

The movement of the talc is made much more visible by providing a black background. This is very simply accomplished by coating the trough with black paraffin—a mixture of carbon black and ordinary paraffin. When the paraffin is in place, the surface is fused by passing a flame over it, causing the carbon particles to sink below the surface, thus preventing contact between the carbon particles and the solution.

Department of Chemistry, Stanford University, California.
D. A. WILSON.
T. F. FORD.

[1] Agnes A. Pockels, *Naturwiss.*, **9**, 137, 149 (1917).

Abnormal Strength of 2 : 6-Dihydroxybenzoic Acids

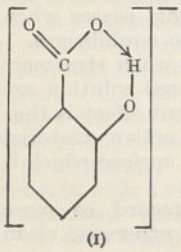
THE work of W. Ostwald[1] showed that the electrolytic dissociation constants of the hydroxybenzoic acids vary greatly with the positions of the hydroxyl groups. Thus the dissociation constants of benzoic acid, and of those mono-, di- and tri-hydroxybenzoic acids, which do not possess a hydroxyl group in the ortho-position to the carboxyl group, have dissociation constants all less than 1×10^{-4}; the dissociation constants of the various hydroxybenzoic acids containing an ortho-hydroxyl group are all of the order of 1×10^{-3}, and 2 : 6-dihydroxybenzoic acid has a dissociation constant of $5{\cdot}0 \times 10^{-2}$ (see Table 1).

Dissociation Constants at 25°.[2]

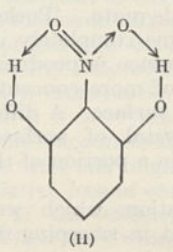
Benzoic acid	$6{\cdot}6 \times 10^{-5}$	Salicylic acid	$1{\cdot}06 \times 10^{-3}$
m-Hydroxybenzoic acid	$8{\cdot}3 \times 10^{-5}$	2 : 3-Dihydroxybenzoic acid	$1{\cdot}14 \times 10^{-3}$
p-Hydroxybenzoic acid	$2{\cdot}9 \times 10^{-5}$	2 : 4- „ „ „	$0{\cdot}52 \times 10^{-3}$
3 : 4-Di „ „ „	$3{\cdot}3 \times 10^{-5}$	2 : 5- „ „ „	$1{\cdot}08 \times 10^{-3}$
3 : 5-Di „ „ „	$9{\cdot}1 \times 10^{-5}$	2 : 3 : 4-Tri „ „	$0{\cdot}55 \times 10^{-3}$
3 : 4 : 5-Tri „ „	$3{\cdot}8 \times 10^{-5}$	2 : 6-Dihydroxy „ „	$5{\cdot}0 \times 10^{-2}$

It will be seen that the constant for 2 : 6-dihydroxybenzoic acid is some fifty times greater than that of salicylic acid, and almost eight hundred times greater than that of benzoic acid. The acid is, indeed, stronger than either phosphoric or sulphurous acids.

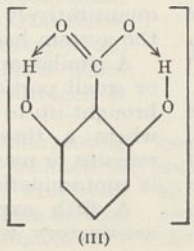
The increased acidity of the salicylic acid derivatives over the other hydroxybenzoic acids is probably due to chelation of the anion[3] (I), which would hinder the return of the proton and thus increase the degree of ionisation.



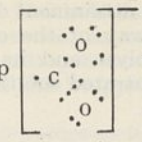
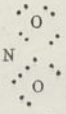
(I)



(II)



(III)

Now the ionised carboxyl group  bears a strong formal resemblance to the nitro-group  , and it has been shown that a nitro-group can chelate with *two* ortho-hydroxyl groups, since 2-nitroresorcinol (II) behaves as a fully chelated compound[3]. It therefore seems reasonable to suggest that an ionised carboxyl group also can chelate with *two* ortho-hydroxyl groups, and to represent the anion of 2 : 6-dihydroxybenzoic acid by the structure (III), in which state neither oxygen atom would readily accept a proton. No attempt has been made in (III) to indicate a resonance formula.

W. Madelung[4] has proposed, on theoretical grounds, a formula closely resembling (III) for the anion of 2 : 6-dihydroxybenzoic acid, but the analogy of the anion with 2-nitroresorcinol affords strong experimental evidence in favour of the formula now advanced. The same type of structure must be assigned to the anions of other 2 : 6-dihydroxybenzoic acids; for example, phloroglucinol carboxylic acid ($k = 2{\cdot}1 \times 10^{-2}$), and paraorsellinic acid ($k = 4{\cdot}1 \times 10^{-2}$).

WILSON BAKER.

Dyson Perrins Laboratory, University, Oxford. Dec. 28.

[1] *Z. phys. Chem.*, **3**, 241 (1899).
[2] Values taken from "Landolt Börnstein", Physikalisch-Chemische Tabellen, vol. 2 (1923).
[3] W. Baker, *J. Chem. Soc.*, 1687 (1934).
[4] *Ann. Chem.*, **427**, 87 (1922).

South and East African Stone Age Typology

IN his recent letter[1], Prof. Dreyer remarks that discoveries in East Africa may perhaps throw light on, and be interpreted with due regard to, problems in South Africa. For similar reasons the investigations in South Africa arouse like hopes among archæologists elsewhere.

As Prof. Dreyer points out, I suggested[2] that the South African Middle Stellenbosch is akin typologically to the East African Early Acheulean. I hasten to assure him that that 'correlation' was not necessarily one of time; I only wished to point out that the Middle Stellenbosch could scarcely be equated with the East African Chellean in type.

I am unable for two reasons to follow Prof. Dreyer's argument that if that correlation is valid then human history must have begun earlier in East than in South Africa. First, the beginnings of human history are far too nebulous in our present state of knowledge for claims of priority or contemporaneity to be made, and we are not even sure that the earliest men were tool makers. Secondly, we do know that man made implements long before any handaxe stage had been reached. Hence, typological differentiation or correlation of fairly advanced *coup de poing* industries scarcely concerns the beginnings of history anywhere.

Nor was it clear, when Prof. Dreyer stated that my correlation was based solely on typology, "deductions from which are vitiated by the

inclusion of very serious assumptions in the line of reasoning", whether he was blaming typology or me. If the former, it is rather a sweeping criticism to apply to a method which every archæologist must use constantly in any study of various members of closely related industries.

Comparative typology between these related groups is the study of the latest stages of advance in shape, size, utility and technical skill in the making of tools of those groups. Though the typological stages may be, and frequently are, modified by local differences in flaking technique, the latter is seldom sufficient to constitute a real difference; for example, the Acheulean of one area may have reached stage *D* at one period; in another area it may also have reached stage *D*, typologically, but here it may be *D* + or *D* − certain differences in technique. The primary value is the same.

If, however, I myself am accused of making unjustifiable assumptions, I can only imagine that the statement to which Prof. Dreyer took exception was that the Clacton-like platforms in the Uganda Early Acheulean were due to the use of a similar type of core technique for detaching flakes; also, that the use of such a core technique in a handaxe industry did not necessarily imply the presence of proto-Levalloisian, but that it might be due to borrowing from Clacton or other flake industries. Before even this can be definitely stated, however, the presence of true Clacton must be proved, and this requires a pure site, unmixed with any handaxe industry.

In Uganda, three stages of Acheulean provide ample evidence that the numerous Clacton-like flakes of all sizes merely represent the waste from cores and handaxes. Personal experiment in obtaining large flakes from coarse-grained, hard and tough rocks shows that the easiest way, usually, was to choose a block, some of the edges of which formed acute angles. Then, either by direct percussion or by striking the core downwards on an anvil stone, flakes, the size of which could be to some extent regulated, were readily detached. These almost always had the 'Clacton angle'. As they also had acute-angled edges, the secondary flakes struck from them in the trimming of handaxes also possessed the 'Clacton angle'.

Now, since the large-core technique was in use in South Africa since Lower Stellenbosch times, it is not surprising that by the time of the Upper Stellenbosch the technique had advanced a stage further, so that, by preparation of the cores, workmen were better able to regulate the size of the primary flakes required, which may account for the peculiar cores of the Victoria West variation.

T. P. O'BRIEN.
African Prehistoric Research Expedition,
c/o Standard Bank of South Africa,
Kampala, Uganda.
Jan. 1.

[1] NATURE, **136**, 872, Nov. 30, 1935.
[2] NATURE, **136**, 475, Sept. 21, 1935.

Amino Acid Content of Plants at Different Stages of Growth

INCREASING attention has lately been paid to the composition of the protein constituents of the green plants. Important work has been done in this field, particularly by Chibnall and Wright. In the present letter we wish to direct attention to an important but rather neglected question in the study of the plant proteins. One of us (A. I. V.) has already referred to this question in the discussion on the chemistry of grass crops at the recent Norwich meeting of the British Association[1].

During recent years, we have followed the changes in the tryptophane and aspartic acid content of green plants and found that the percentage values of these compounds (total N basis) vary considerably during the different stages of growth. Thus, for example, the tryptophane content of peas and clover is very much higher at an early stage, just before blooming, than during the flowering stage. The same is true of the aspartic acid values. They show a second rise first at a late stage of growth when the seeds are already beginning to form. According to the literature, Klein and Tauböck[2] have noted significant variations in the arginine content of plants at different stages of development.

A direct comparison of proteins from different plants is rendered difficult by the fact that the proportions of the different amino acids vary during the development of the plant.

The variations in the amino acid values at different stages of growth can be explained either by assuming: (*a*), that the plants contain several different proteins, each with a definite composition, and that the mutual proportions of these proteins vary throughout the period of growth; or (*b*), that in the growing plant the protein has no fixed composition but that new amino acid groups are continuously being incorporated with the growing protein molecule.

As regards the analytical procedure, we consider it very important that the amino acids should be determined directly from the plant material, since there are no methods available by which the proteins can be completely extracted from the fresh material without changes in the amino acids. The tryptophane and aspartic acid determinations referred to above were made directly from the fresh material.

ARTTURI I. VIRTANEN.
T. LAINE.
Laboratory of the Foundation
for Chemical Research,
Helsingfors.
Jan. 9

[1] A. I. Virtanen, *J. Soc. Chem. Ind.*, **54**, No. 47 (1935).
[2] *Biochem. Z.*, **251**, 10 (1932).

Utilisation of Sugars and Polyhydric Alcohols by the Adult Blowfly

IT is known that houseflies[1] and blowflies[2] can be kept alive perfectly well on a diet consisting of cane-sugar and water alone. Addition of protein is only essential for the development of eggs. At a temperature of 26° C., *Calliphora erythrocephala* on a diet of pure water lives only two to three days, on cane-sugar and water one to two months. If cane-sugar is replaced by other sugars, polysaccharides or polyhydric alcohols, it is found that many substances support adult life equally well. One (sorbitol) is actually much better, others are not so good as cane-sugar; whereas many substances are not utilised at all.

The following is a summary of the results obtained so far:

Monosaccharides: utilised: glucose, fructose, galactose, mannose; not utilised: sorbose.

Disaccharides : utilised : saccharose, maltose, trehalose, melibiose, lactose ; not utilised : cellobiose.

Trisaccharides : utilised : raffinose, melecitose.

Pentoses : utilised : xylose ; not utilised : arabinose, rhamnose.

Glucosides : utilised : α-methyl-*d*-glucoside ; not utilised : β-methyl-*d*-glucoside, helicin, arbutin, salicin.

Polysaccharides : utilised : starch, glycogen ; not utilised : inulin.

Polyhydric alcohols : utilised : mannitol, sorbitol ; not utilised : erythritol, dulcitol, inositol.

All the substances are as effective as cane-sugar ; that is, the duration of adult life exceeded a month, except in the case of xylose, lactose, starch and glycogen, on which the flies live only one to two weeks.

These results differ considerably from those obtained by previous workers on the bee[3,4]. Bees utilise cellobiose, arabinose and xylose very well, but mannose, lactose and melibiose not at all. Galactose is utilised by them to a very small extent only.

These results concerning utilisation of sugars can easily be explained on Weidenhagen's[5] system of carbohydrases by assuming the presence of the following enzymes in the gut of the flies : α-glucosidase (substrate : α-methyl-*d*-glucoside, saccharose, maltose, trehalose, melecitose) ; α-galactosidase (substrate : melibiose, raffinose) ; very probably β-*h*-fructosidase (substrate : saccharose, raffinose) and a weak β-galactosidase (substrate : lactose). β-glucosidase (substrate : β-methyl-*d*-glucoside, cellobiose, phenolglucosides) is clearly not present.

I should like to express my thanks to Prof. W. N. Haworth for certain of the rare sugars used in these experiments.

GOTTFRIED FRAENKEL.

Departments of Zoology,
University College and
Imperial College of Science,
London, S.W.7.
Jan. 7.

[1] Glaser, *J. Exp. Zool.*, **38**, 383 (1923).
[3] Evans, *Bull. Ent. Res.*, **26**, 115 (1935).
[3] Phillips, *J. Agric. Res.*, **35**, 385 (1927).
[4] Vogel, *Z. vergl. Phys.*, **14**, 273 (1931).
[5] Weidenhagen, *Ergeb. Enzymf.*, **1**, 168 (1932).

Points from Foregoing Letters

SIR J. J. THOMSON draws a picture of the quantum of light originating when an electron falls from one energy level within the atom to another. The electron would oscillate about the new level, emitting the energy due to its fall in the form of a photon, consisting of a train of circular lines of (electric) force. The centres of these circles would move along a straight line with the velocity of light and the circles themselves would move at right angles to their plane. The energy in the wave front would be concentrated round the axis and thus confined within a cylindrical pencil, without radial flow of energy extending throughout space.

Dr. B. Cavanagh and Prof. H. S. Raper describe the use of a fat containing deuterium for studying the destination of fatty acids after absorption in the body. They find that lipines of liver and kidney take up the deuterium-containing fatty acids and are therefore probably actively concerned in the metabolism of fats.

Photographs showing electron tracks (1½–3 million electron volts energy) which end abruptly in nitrogen gas (in a magnetic field of 500 gauss) are submitted by Prof. D. Skobeltzyn and E. Stepanowa. Similar results with argon have been described by L. Leprince-Ringuet. The value of the effective capture cross-section calculated cannot be readily explained on present data, and the authors raise the question whether the formation of neutrinos should be postulated in order to account for the apparent non-conservation of energy.

During the electro-deposition of copper, ridges are deposited on the cathode plates if they move at certain speeds through the electrolyte. Photographs of such ridges, giving a record of the stream lines in steady motion of the liquid around differently shaped obstacles, are submitted by Dr. E. P. Harrison and H. Gollop.

The sudden appearance and expansion of circular patches on fresh surfaces of some solutions of soaps or other substances which concentrate at the surface are described by Dr. D. A. Wilson and Dr. T. F. Ford. They explain this effect, first observed by Miss Pockels, as due to the formation of local centres of concentrated scum during the process of sweeping the surface. These bits of scum re-expand upon the fresh surface. Drastic sweeping eliminates this 'pockeling' effect.

The greater acidity of salicylic acid and derivatives over benzoic and other hydroxyacids is explained by Dr. W. Baker as due to chelation (formation of a ring by means of a co-ordinated valence, an atom sharing with another atom in the same molecule two of its electrons). Dr. W. Baker draws an analogy between such suggested linking in 2 : 6-dihydroxybenzoic acid and that admitted in 2-nitroresorcinol.

Two stages in prehistoric human development may belong to the same type without necessarily being simultaneous, writes T. P. O'Brien in answer to Prof. Dreyer's criticism that, if the East African Early Acheulean and Middle Stellenbosch belong to the same type, then human history began later in South than in East Africa. He suggests that flakes with the "Clacton angle" found in early handaxe industries at both places do not necessarily prove the presence of Clactonian or proto-Levalloisian.

The percentage of amino-acids (tryptophane, aspartic acid) in green plants (peas, clover) is found by Prof. A. I. Virtanen and T. Laine to vary at different stages of growth. This, they point out, may mean either that the ratio of various proteins changes during growth or that protein molecules grow continuously by addition of new amino-acid groups.

From the ability of blow-flies to live on different kinds of sugar and sugar compounds or derivatives, Dr. G. Fraenkel deduces the presence of several enzymes in the gut of the fly.

ERRATUM. The half-period of the short-lived radioactive component of silver, referred to in this column last week, should have been 22 sec. instead of 44 sec.

Research Items

Cultural Influence of Islam in India

THE Sir George Birdwood Memorial Lecture by Sir Abdul Qadir on "The Cultural Influences of Islam in India", delivered before the Royal Society of Arts (*J. Roy. Soc. Arts*, Jan. 10, 1936), while not professing to be more than a rapid survey, which might point a way to further research, touched upon a number of topics not without bearing upon the present situation. In certain respects, indeed, it might be held to afford hope of better relations between the Hindu and Moslem communities, when present acerbities cease to exhibit their more extreme manifestations under a new regime. One of the most striking facts to which he directed attention was the influence of the monotheism of Islam on the religion and thought of India. The Central Asiatic dynasties which established kingdoms in India had, he pointed out, come under the influence of Persia and her literature before they came to India. In the time of the Moghals the Persian language, as the language of the court and of literature, had come to be a subject of study by Moslem and non-Moslem alike. Hence the belief in one god, upon which no faith lays greater stress than Islam, began to be perceptible not only in the attitude of orthodox Hindus towards the idols of the temples, but also in such movements as the Arya Samaj, Brahmo-Samaj, and most conspicuously of all, in the Sikh religion founded by Guru Nanak, and the Bhakti movement, of which the best known exponent was Kabir. Sir Abdul also attaches much importance to the position of Urdu and its literature, regarding its development as due to the combined efforts of Hindu and Moslem, which by now has produced a varied and wide literature. The tendency shown in some quarters to regard that language as something imported from outside and foreign to the soil he attributed to a lack of knowledge of its true origin. In his view, the Moslem invasion created a new indigenous language, which was a mixture of Persian and Hindi, and this in course of time has become the most commonly used language in India.

Wintu Ethnography

IN a study of the Wintu, one of the three Wintun-speaking peoples of the Sacramento Valley, California, by Cora Du Bois (*Univ. California Pub. Amer. Archæol. and Ethnol.*, 36, 1), stress is laid on shamanism as the most important socio-religious aspect of their culture. The Wintu lived by hunting, which was pursued either communally or individually, and fishing. Procuring vegetable foods, principally acorns, buckeyes, and tubers, known generally as 'Indian potatoes', was the responsibility of the women. The attitude of the Wintu to their neighbours, on the whole, was one of fear. They believed that the Nomlaki (Wintun) stole souls by casting their shadows on persons; while their neighbours to the north and west were believed to have the power of transforming themselves into dogs and other animals. The relation of the individual with the natural phenomena of his area was exceedingly intimate. Of some thirty place names along the McCloud River in the course of approximately two miles, many are found in the mythology or associated with mythological characters; at other times they are names of sacred places associated with supernatural potency. Shamanism was their chief preoccupation with the supernatural, yet it existed in a society so simple that there was never need for elaboration. The nearest approach to elaboration was the ceremony of shamanistic initiation, which was open to both men and women. An initiation dance was announced by a chief who owned an earth lodge at the behest of the shamans. This took place either in the spring or in late autumn, when all persons desirous of acquiring shamanistic powers presented themselves for initiation. Supernatural experience was attained through the dance, the spirit entering suitable candidates through the ears, after announcing his arrival by a whistling sound above the smoke-hole of the earth lodge.

Birds of Cape York Peninsula

As a result of three expeditions, occupying a total of three years, in Cape York Peninsula, North Queensland, Dr. Donald F. Thomson has compiled a comprehensive account of the birds of the area, and this has been published through a special Government fund ("Birds of Cape York Peninsula", Melbourne: Government Printer. London: Angus and Robertson Ltd. Pp. 82+15 plates. 1*s*. 6*d*. net). The area comprises mangrove zone, salt pans, scrub, savannah-forest and tropical rain-forest. Of the 183 species observed in the Peninsula, including waders and other migratory forms, 79 (43 per cent) are endemic Australian species, while a majority, no less than 104 (57 per cent), have a range extending to New Guinea or beyond. Some of these, to the number of 19, may be regarded as Papuan forms which have extended their range into the Peninsula in comparatively recent times. The general conclusions reached by the author are that the large number of genera and species common to Cape York Peninsula and New Guinea indicate a connexion between these areas in more recent geological times than has been generally supposed, and that the mountain range on the east coast of the Peninsula has been an effective barrier to distribution, since the Papuan elements have persisted in their purest and most concentrated form in a narrow zone on the north-east coast.

Development of the Vertebral Column

DR. HIMADRI KUMAR MOOKERJEE, in his presidential address to the Section of Zoology at the twenty-third Indian Science Congress held at Indore on January 2–8, discussed some results of his study of the development of the backbone among vertebrates. He disagrees with Gadow's classification of vertebral centra, since it fails to express the gradual evolution of vertebral structures; and himself describes, in what appears to be great detail for a general address, the formation of the centrum, of the lower and upper arches, of the ribs and rib-bearing processes, and of the articulating processes. An interesting suggestion is

made as to the origin of the four types of vertebral centra. In the development of any backbone, the vertebral portions of the perichordal tube soon become cartilaginous, whereas the intervertebral portions remain for a long time membranous, and through these intervertebral zones the migratory connective cells enter. At this stage the character of the centrum is determined, and the author considers that the procœlous, opisthocœlous, amphicœlous, and heterocœlous conditions are produced by the various types of movement of the embryos at that particular time, since these movements determine the direction followed by the migratory cells which divide the perichordal tubes into vertebral segments.

Egg-like Synergids

In a communication received by NATURE, A. C. Joshi, of the Botanical Department, Benares Hindu University, reports two further examples of egg-like synergids. The synergids in the embryo-sac of the flowering plants have as a rule a very uniform structure. They possess a large vacuole in their chalazal half, and the nucleus embedded in cytoplasm is found at the micropylar end. Cases in which the position of the vacuole and the nucleus is reversed and the synergids look like the egg-cell are very rare. Two cases are cited by K. Schnarf in his recent book "Embryologie der Angiospermen", namely, *Aconitum Napellus* and *Delphinium elatum*, both belonging to the Ranunculaceæ. Frisendahl has noted such synergids in *Myricaria germanica* (Tamaricaceæ) and Puri has recorded certain cases of embryo-sacs in *Moringa oleifera* in which one or both of the synergids assume the form of the egg due to the migration of the nucleus towards the chalazal side. Joshi now records *Gisekia pharnaceoides*, Linn. (Molluginaceæ) and *Tamarix dioica*, Roxb. (Tamaricaceæ) with egg-like synergids. In *G. pharnaceoides*, up to about 20 per cent of the embryo-sacs have been seen to possess one or both the synergids of this form, and in a few cases synergids were seen with two vacuoles in place of the usual one, one below and the other situated above the nucleus. In *T. dioica* also the egg-like synergids are fairly frequent, and one or both the synergids of an embryo-sac may have this form just as in *Gisekia*.

Proteolytic Enzyme System of Fungi

Many fungi are very active in the decomposition of proteins, and especially is this true of members of that group loosely described as moulds. Investigations of the proteolytic enzyme system of *Aspergillus parasiticus* show that at least four components are present, a proteinase and three peptidases. The latter resemble the peptidases of the mammalian digestive system, being respectively an aminopolypeptidase, a carboxypolypeptidase, and a dipeptidase (M. J. Johnson, *Z. physiol. Chem.*, 224, 163; 1934). The aminopolypeptidase has now been obtained in a purified condition by fractional precipitation with alcohol and adsorption on to aluminium and ferric hydroxides (M. J. Johnson and W. H. Peterson, *J. Biol. Chem.*, 112, 25; 1935). For its action, this enzyme requires a free amino group on the polypeptide as the point of attachment, the peptide group next adjacent to this free amino group then being hydrolysed. Methyl substitution of the free amino group entirely prevents enzyme action. Peptides consisting entirely of glycine, for example, triglycine, are unattacked, as also are dipeptides unless decarboxylated to give the amines. The other peptidases could not be prepared in a purified condition. The system as a whole is capable of splitting peptides in which the free amino group has been substituted by methylation or chlorination, but not if benzoylated. The amounts of the individual peptidases vary greatly in different preparations as judged by the ratios of the rates of hydrolysis of specific substrates.

Siduoka Earthquake of July 11, 1935

The Pacific coast of the Main Island of Japan is penetrated by two inlets, Sagami Bay and Suruga Bay, separated by the Idu peninsula. Siduoka lies on the west side of Suruga Bay, and it is worthy of notice that the great Kwanto earthquake of September 1, 1923, occurred in the district including Sagami Bay, a very destructive earthquake on November 26, 1930, in the northern part of the Idu peninsula, and, lastly, a less violent earthquake still further west on the coast of Suruga Bay on July 11, 1935, the epicentres of all three lying nearly on a straight line. The Siduoka earthquake has been described in six papers (*Bull. Earthquake Res. Inst.*, 13, 942–1018; 1935), with one exception written in Japanese, but with summaries in English. Nine persons were killed, while 814 houses were totally, and 3,077 partly, destroyed. The earthquake occurred at 5.25 p.m. (8.25 a.m., G.M.T.). From the seismograms obtained at ten stations, the epicentre was found to lie in lat. 34° 59·4′ N., long. 138° 26·2′ E., and the focus at a depth of about 9¼ miles. The damage was confined to a small district including Siduoka and Simidu. After the earthquake, four series of precise levellings were carried out along two routes crossing the central area, but the changes of level were in every interval small. The most remarkable feature of the earthquake was the almost entire absence of after-shocks. During the first twelve hours after the earthquake, only one was felt in Siduoka. In the same interval after the Kwanto earthquake, 188 shocks were felt in Tokyo.

North Atlantic Weather

A statistical comparison of the severity of weather in the North Atlantic during the last five winters is made by Captain L. A. Brooke Smith in the *Marine Observer* of January 1936. Such a comparison is not easy to make owing to the number of observing ships at sea varying considerably, which vitiates the value of the number of gale reports received during any one month. In recent years, however, there has been a large number of 'selected' ships on the North Atlantic trade routes, and the noon position of every one has been recorded. It is, of course, possible, though not likely, that on some occasion the ships may have been so spaced that a gale passed unrecorded between any two. A table is given showing graphs of the gale records in western, central and eastern Atlantic respectively. The greatest gale frequency was in the central zone in 1934–35, but the greatest number of days during which weather of hurricane force was reported was in the central zone in 1932–33. In the western zone, March 1931 was a bad month, and in the eastern zone, January 1932 was equally stormy. In the central zone, December 1932 was almost equally bad. Thus it would appear that while conditions during the last five years have been variable, there is no indication of progressive change in any direction.

Thermal Effects of Magnetisation

A COMMUNICATION received by NATURE from Toshiko Okamura, of the Research Institute for Iron, Steel and Other Metals, Sendai, Japan, describes an extensive investigation on the thermal effects of magnetisation of ferromagnetics. Test specimens were built up of a large number of alternate bars of the ferromagnetic substance and of German silver, constituting a series of thermocouples. Changes of temperature of 10^{-6} °C. could be detected. From the experimental results for initial and cyclic magnetisation, it was possible to separate the reversible and irreversible heating effects. For initial magnetisation, the curves giving the irreversible heat evolution for iron, nickel and cobalt were similar in form to the magnetisation curves. For nickel, the reversible change, with an increasing field, was at first an absorption of heat increasing to a maximum, followed by a decrease to zero, and a subsequent evolution of heat. For iron the field for reversal was not reached, while for cobalt there was a continuous increase in the absorption with increasing field. For cyclic magnetisation, on decreasing the field from the maximum, the irreversible heat evolution increased slowly at first, rapidly on passing through the zero field region, and then slowly. The reversible heating curve for nickel showed two symmetrical minima and a central maximum; the curves for iron and cobalt only the central maximum. It is shown that the reversible heating effect is in satisfactory accordance with the thermodynamic equation relating $(\partial T/\partial H)_S$ with $(\partial I/\partial T)_H$, where T, H, S and I are temperature, field, entropy and intensity of magnetisation. An interpretation of the irreversible heating effect is given on the basis of the Honda-Okubo theory of ferromagnetism. Measurements have been made for iron, nickel, cobalt, K.S. magnet steel, iron-nickel alloy and single crystals of iron.

Photon Theory of Scattering

THE experiments of R. S. Shankland (*Phys. Rev.*, Jan. 1, 1936) on the scattering of γ-rays may have wide theoretical consequences. The 'modified scattering' of X-rays had been satisfactorily explained by A. H. Compton on the assumption of a collision between a light quantum and an electron, energy and momentum being conserved. Bothe and Geiger carried out an experiment with point-counters which appeared to show the simultaneous production of a scattered quantum and a recoil electron. The present experiment, similar in principle, was carried out on the scattering of γ-rays with modern counter technique, and no simultaneous electrons and quanta were observed. A beam of γ-rays was limited by lead blocks and fell on a scatterer of air, aluminium, beryllium, paper or paraffin. The recoil electrons were collected by a thin-walled Geiger-Müller counter, and the photons fell on a set of gold-walled counters which counted them with an efficiency of about one per cent. No significant difference in the number of coincidences between these counters was observed for the two cases in which they were placed so as to catch the electrons and photons respectively, or in positions into which coincident particles could not be directed according to the theory. At present, quantum mechanical theory appears to give the same prediction for X-rays as the simple photon view of Compton, it is possible that an extended quantum theoretical calculation may give a less definite angular distribution for the γ-ray case than the photon theory. In any event, the experiment is of crucial importance.

Applications of the Thyratron

THE past few years have seen the extensive development and application of the thyratron, a hot-cathode grid-controlled rectifying valve manufactured by the British Thomson-Houston Co., Ltd. In a paper read before the Institution of Electrical Engineers on January 2, Mr. A. L. Whiteley described the fundamental principles of this form of the thermionic valve and outlined some of its applications. The thyratron was originally developed as a sensitive relay; but has now reached such a stage that it is able to control power of considerable magnitude, and in this form it has been put to several uses in industry. Owing to the absence of any mechanical moving parts, it is particularly adaptable to high-speed circuit interruption, where comparatively large powers can be handled with a rapidity and ease that is difficult to attain by ordinary methods of switch control. A condenser-resister combination in the grid circuit of the thyratron provides a convenient means of measuring out small intervals of time, and this application is utilised in the control of spot-welding operations. Other applications dealt with in the paper include voltage regulation, theatre lighting control and the use of direct-current motors on an alternating current supply. The paper concludes with a summary of the disadvantages of the thyratron, although it is pointed out that some of the objections raised against the use of this device are not well founded.

Damping Influences in Torsional Oscillation

AN important contribution on this subject has been made in a paper to the Institution of Mechanical Engineers read on December 13 by Dr. J. F. Shannon, in which are described his investigations of multi-crank engines when in a state of torsional oscillation. In the design of marine engines and high-speed reciprocating engines, including automobile and aircraft types, it is necessary to take account of the torsional characteristics of the dynamical system. The main part of the research here described was made on a four-cylinder petrol engine, a Geiger torsiograph being used to examine conditions of resonance. Various sources of damping were investigated—hysteresis in the shaft material, and, under different conditions of lubrication, damping at piston, big-end and crankshaft bearings. Of these, the last were shown to be the principal media of the dissipation of vibration energy, and therefore an analysis was made to ascertain the amount of energy which could be disposed of by the oil film under conditions of journal vibration, and its expression in terms of journal displacement. The results are held to justify the experimental conclusions in that it is shown that practically all the vibration energy can be accounted for in this manner. From these data, an overall non-dimensional factor was derived which is practically constant for the range of frequencies investigated. Figures relating to tests of other engines being available, these were similarly reduced to the simple non-dimensional form, showing the factor not to be constant for different systems but to have a mean line, which is offered as a guide in design, closely corresponding with the elastic curve.

American Association for the Advancement of Science

ST. LOUIS MEETING, DECEMBER 30, 1935–JANUARY 4, 1936

ST. LOUIS, Missouri, welcomed the American Association for its ninety-seventh meeting at the close of 1935, and the occasion drew together more than three thousand members from its own ranks and from affiliated societies for a series of addresses, meetings and conferences that extended from December 26 until January 4. The local committee, headed by Dr. George T. Moore, director of the famous Missouri Botanical Garden, had made provision for numerous sessions in the new Municipal Auditorium and on the campuses of Washington University, St. Louis University and of their medical schools. The Engineers' Club provided for the meeting of the Section on Engineering, and some societies used hotel meeting rooms—an indication of the number of separate sessions.

So early as 1764, a settlement was located at this point on the great river, and served as a centre of commerce with native tribes in French territory. This frontier post was in the area included in the Louisiana Purchase and it became the city of St. Louis with that transfer of control. By reason of location in a great bend on the bank of the Mississippi between the mouths of the Missouri and Ohio Rivers, it has grown to be the centre of the largest inland waterways in the world, with great industries developed locally and lines of communication radiating in every direction. Splendid bridges built at an early date to establish connexions with the country east of the great river are conspicuous examples of engineering skill. In addition also to fine parks and public buildings, the city has one of the best art galleries in the United States.

Of special scientific interest is first of all the Missouri Botanical Garden, which houses the largest collection of plant life in the western hemisphere. Founded in 1860 and long known as Shaw's Garden, it was originally the home of a wealthy man of British birth who left it with a large endowment for the enjoyment of the public. The Academy of Science of St. Louis was the leader among such organisations in the Central West; it has promoted important scientific work and published a long series of volumes.

St. Louis had previously served as host for three of the noteworthy meetings of the Association. In August 1878, the twenty-seventh meeting was held there during a season "of unprecedented heat". The records of the Association comment on an epidemic of yellow fever then spreading through the south, despite which the city remained healthy, and not a single case of illness was reported among those at the meeting. T. A. Edison was present and told of recent inventions. Even more noteworthy was the second St. Louis meeting, in December 1903. This was shortly before the Louisiana Purchase Exposition which opened in May 1904. Science played a prominent part in plans for that event, as the Association had been called upon to aid in building a programme for an International Congress of Arts and Sciences, and the December meeting gave opportunity for discussing and perfecting plans which eventuated in a historic Congress and its published proceedings constituting a valuable record of the progress of science. The third St. Louis meeting in December 1919 established the present organisation and procedure, which were necessitated by the growth of the Association and have enabled it to carry on its present work.

The chief address of the opening session this year was that of the retiring president, Dr. E. L. Thorndike, of Columbia University, who spoke on "Science and Values". He showed that the value to civilisation of human wants and their satisfaction is determinable by scientific methods. When the entire annual budget is interpreted "we pay more to maintain self-respect and the good opinion of others . . . than to keep . . . free from the distress of hunger". Man can be influenced to improve his desires and "to find satisfaction in useful work . . . and the welfare of others to a degree that the world has never seen" (see also NATURE, Jan. 25, p. 144).

The Sigma Xi address on the second evening, by John Bellamy Taylor, of the General Electric Company, dealt with "The Electric Eye and the Human Eye" and was accompanied by a series of striking demonstrations. The third evening address was the first to be given by Phi Beta Kappa in connexion with the annual meetings of the Association. President W. A. Neilson, of Smith College, the speaker, had chosen as his title "The American Scholar Today", in which he urged on scientific workers the importance of better approach to the laity and the rights of the intelligent public to share the results of the best in scientific research. Dr. Harold G. Moulton, president of the Brookings Institution, gave the address of the fourth evening, on "The Scientific Method in the Investigation of Economic Problems". The speaker maintained that methods of investigation vary necessarily, and scientific treatment is a matter of spirit not limited to investigators in any particular field. Methods used in natural science often lead to over-simplified and imperfect conclusions when applied on economic problems because of fundamental differences between the two fields which were pointed out.

A series of special afternoon lectures before the Association was opened on December 31 by an address on the pituitary gland and the metabolism of the body. The speaker was Dr. B. A. Houssay, professor in the medical faculty of Buenos Aires, Argentina, who was the guest of the Association. He presented results of his recent researches on the remarkable influence of a pituitary extract on diabetes. Other addresses in this series were by Prof. E. H. Barbour, of Nebraska, on his extensive studies on "The Proboscidea of the Plains", and by Prof. Frederick Slocum, of Wesleyan University, on "The Changing Picture of the Universe".

The winner of the American Association prize at Pittsburgh in 1934, Dr. V. O. Knudsen, of California, by invitation lectured in this series on the absorption of sound in gases. Dr. H. C. Bryant presented before a large popular audience a series of sound films which had been perfected by several agencies to portray

geological processes for educational uses. The twelfth annual Gibbs lecture under the joint auspices of the Association and the American Mathematical Society was given by Dean Vannevar Bush, of the Massachusetts Institute of Technology, on "Mechanical Analysis".

The final address in the afternoon series was a lecture and demonstration by Dr. V. K. Zworykin, of the Radio Corporation of America, on "Electron Optical Systems and Their Applications". In its exterior appearing like a telescope, the device is highly sensitive to infra-red rays, which in it are transformed into electrons and then into a visible image. In immediate service in research on life processes, its uses in peace and war are obvious, numerous and of great importance.

Dr. Karl T. Compton, president of the Association, head of the Massachusetts Institute of Technology and chairman of President Roosevelt's Science Advisory Board, in an address on "What's Next in Science", presented the following four aims of science as a programme of response to the needs of the present:

"Scientific search for industrial and other new outlets for farm products, to do away with present temporary need for crop limitations;

"Scientific improvements in industrial processes, to rid industry of its present self-imposed incubus of tariffs, quotas, and other legislative coddling that handicap efficiency;

"Scientific attack on still-unconquered diseases, particularly the debilitating and disabling, rather than the deadly;

"Finally, research in pure science, as the springboard for forward leaps in the applied sciences."

Within recent years, programmes arranged for meetings of the Association have shown a tendency to multiply joint sessions and symposia as a means for bringing together workers in separate fields and focusing light from diverse sources on problems of common interest. This was conspicuous in the St. Louis programme. Approximately one thousand papers were listed by the sixty sections and societies, but the features that attracted most attention in these special sessions were the joint contributions.

Among the numerous programmes of this type were such as dealt with photo-electricity, land utilisation, botany and human welfare, history of science, genetics and plant breeding, sex hormones, seismology, electric potentials in plants, teaching of chemistry, maturation and learning, and others of similar character. Of marked interest to all was the symposium sponsored by the American Society of Naturalists, which originated the plan and has maintained for many years a programme of invited papers on some topic of active interest to American biological research. The subject this year was "Early Man in America"; the papers discussed climatic changes, recent discoveries of early human cultures and the association of such remains with an extinct fauna. The programme closed after the evening dinner with the presidential address of Dr. John C. Merriam, of the Carnegie Institution of Washington, on the topic "The Extent and Rate of Human Evolution—the Asking of Critical Questions".

The Association Prize for the St. Louis meeting was granted to Dr. P. W. Zimmerman and Dr. A. E. Hitchcock, of the Boyce Thompson Institute, as joint authors of a noteworthy paper on "Responses of Plants to Growth Substances (Phyto-hormones)". This paper, read before the Botanical Society of America, which met with the Association, presented studies on (1) the specific responses of plants to synthetic growth substances, (2) the movement of such substances in the plant, (3) effects of these substances on root growth, and (4) results when plants are treated with growth substances after exposure to light or darkness.

The Science Exhibition was well housed in the commodious Exhibit Hall of the Municipal Auditorium, and was an effective presentation of recent scientific progress. Research work, commercial products and apparatus, and new publications were all well represented. The solar heating apparatus of Dr. C. G. Abbot, secretary of the Smithsonian Institution, the electronic eye of Dr. V. K. Zworykin, of the Radio Corporation of America, new seismological apparatus of the Jesuit Seismological Association, scientific aids used by the Federal Bureau of Investigation, U.S. Department of Justice, and the historical exhibit of the St. Louis Academy of Science deserve mention as noteworthy items in a long series among which selection was difficult.

The attention given to sessions at St. Louis by newspapers of the country was conspicuously greater than in previous years. While attributable in good part to greater public interest, this was aided by broader organisation of the Association press service and fuller participation of various public press services and prominent newspapers represented there. For the first time, an Association radio programme was organised by the general secretary of the Association, Dr. O. W. Caldwell, including four national broadcasts and others of more limited range. This must be regarded as a noteworthy extension of the influence of the Association and its meetings.

The addresses of the retiring vice-presidents, given at various times, included the following:

Mathematics, Prof. R. D. Carmichael, of the University of Illinois, on "Linear Differential Equations of Infinite Order";

Physics, Dr. Henry G. Gale, of the University of Chicago, on "The Diffraction Grating";

Chemistry, Prof. Joel H. Hildebrand, of the University of California, on "Dipole Attraction and Hydrogen Bond Formation in Their Relation to Solubility";

Astronomy, Prof. Frederick Slocum, of Wesleyan University, on "The Changing Picture of the Universe";

Geology and Geography, Rev. James B. Macelwane, S.J., of St. Louis University, on "Problems and Progress on the Geologico-Seismological Frontier";

Zoology, Dr. Oscar Riddle, of the Carnegie Institution of Washington, on "The Confusion of Tongues";

Botany, Dr. B. O. Dodge, of the New York Botanical Garden, on "Reproduction and Inheritance in Ascomycetes";

Anthropology, Prof. Melville J. Herskovits, of Northwestern University, on "Applied Anthropology and the American Anthropologist";

Psychology, Prof. John E. Anderson, of the University of Minnesota, on "Child Development and the Interpretation of Behavior";

Education, Prof. Guy T. Buswell, of the University of Chicago, on "Some Contributions of the Study of Eye Movements to the Psychology of Perception";

Social and Economic Sciences, Mr. Carl Snyder, of the Federal Reserve Bank, New York City, on "The Role of Capitalism in Civilisation";

Historical and Philological Sciences, Dr. Solon J. Buck, director of publications of the National Archives, on "The National Archives and the Advancement of Science";

Engineering, Dr. Charles E. Skinner, of the Westinghouse Electric and Manufacturing Company, on "Civilisation's Debt to the Engineer";

Medical Sciences, Dr. Stanhope Bayne-Jones, of Yale University School of Medicine, on "Bacterial Poisons and Their Antidotes";

Agriculture, Dean Jacob G. Lipman, of Rutgers University, on "The Conservation of our Land Resources".

The following officers were elected for the year 1936: *President*, Edwin G. Conklin, of Princeton University; *Elected Council Members*, Austin H. Clark, of the United States National Museum, and Arthur H. Compton, of the University of Chicago; *Members of the Executive Committee*, Karl T. Compton, of Massachusetts Institute of Technology, and Richard C. Tolman, of California Institute of Technology; *Members of the Board of Trustees of Science Service*, Burton E. Livingston, of Johns Hopkins University; *Member of the Finance Committee*, Arthur L. Day, of the Geophysical Laboratory, Carnegie Institution of Washington; *Members of the Committee on Grants*, Sam F. Trelease, of Columbia University, and Joel Stebbins, of the University of Wisconsin; *Secretary of the Section on Agriculture*, M. F. Morgan, of Connecticut Agricultural Experiment Station.

Vice-Presidents of the Sections:

G. C. Evans, of the University of California (Mathematics);

George B. Pegram, of Columbia University (Physics);

Irving Langmuir, of the General Electric Company, Schenectady, N.Y. (Chemistry);

Frederick H. Seares, of Mt. Wilson Observatory (Astronomy);

George R. Mansfield, of the United States Geological Survey (Geology and Geography);

Ross G. Harrison, of Yale University (Zoological Sciences);

J. M. Greenman, of Missouri Botanical Garden (Botanical Sciences);

Ralph Linton, of the University of Wisconsin (Anthropology);

Edward S. Robinson, of Yale University (Psychology);

Harold G. Moulton of Brookings Institution, Washington, D.C. (Social and Economic Sciences);

E. H. Wilkins, of Oberlin College (Historical and Philological Sciences);

W. E. Wickenden, of Case School of Applied Science (Engineering);

Joseph T. Wearn, of Western Reserve University (Medical Sciences);

P. E. Brown, of Iowa State College (Agriculture);

E. S. Evenden, of Columbia University (Education).

HENRY B. WARD.

New Spectrographic Apparatus

MESSRS. ADAM HILGER, Ltd., have forwarded to us some interesting leaflets on recent developments in spectrographic apparatus. The alignment or collimation of the light source with the axis of the collimator is of great importance when any quantitative measurements of a photometric character have to be made. Several of the spectrographs are now constructed with an accessory bar the axis of which is strictly parallel to that of the collimator. Photometer lenses and even light sources can be mounted on this 'optical bench', and the dangers of imperfect collimation are much reduced. When these instruments are used in routine testing, the time saved can be very considerable.

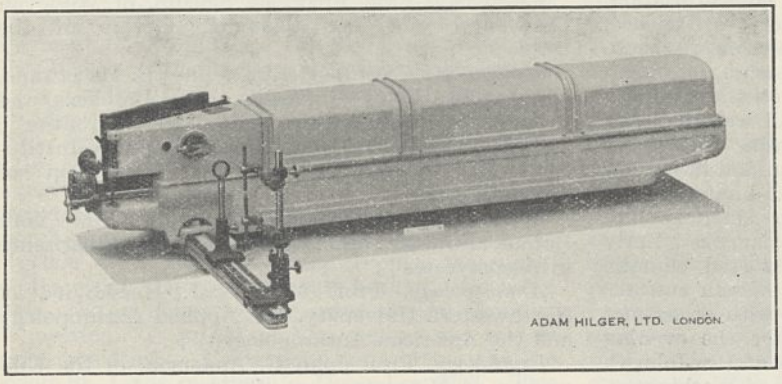


FIG. 1.

An entirely new departure in spectrographic apparatus is the construction of a fully automatic adjustment spectrograph. By simply rotating a handle, a glass optical train replaces one of quartz. In addition, any desired spectral range can be obtained on the plate, the focus and plate tilt being automatically set. It thus becomes quite practical to photograph on the same plate an ultra-violet region with the quartz train together with a region in the near infra-red with the glass optical parts. The enormous saving of time thus effected will be well appreciated by the many users of the prototype instrument, the Hilger *E*.1. It is now actually much easier to take a spectrogram with this instrument than to take an ordinary photograph with a box camera.

Concurrently with this simplification of the mechanical operations in taking a spectrum plate, there has been a steady improvement in the standard of definition of the prisms and lenses. This is strikingly shown in the enlargements of the iron triplet at 3100 A. taken with the modern equivalents of the *E*.2, *E*.1, and a 3-metre quartz

spectrograph (Publication 228/2). Readers of NATURE may be interested to compare these with the test plate photographs of their own older instruments.

Fig. 1 shows the general construction of the new automatic spectrograph (*E*. 478) fitted with an accessory bar carrying a condenser and an arc source. Since a reflecting prism is mounted immediately behind the slit, the bar in this case is perpendicular to the optical axis of the instrument. It will be

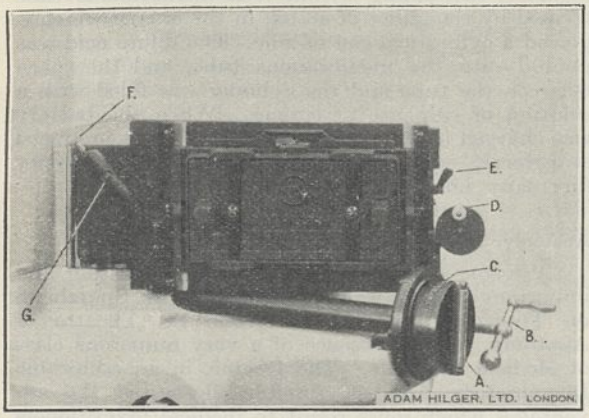


FIG. 2.

observed that the familiar wooden box is replaced by a heavy gauge, three sectioned steel covering closely fitting into a rigid steel girder. The disturbing effects of temperature variation on the air column as well as on the optical parts are considerably reduced by this method of construction. The higher standard of definition attainable with 'all metal' spectrographs must, in a great measure, be attributed to this cause.

Fig. 2 shows the plate holder and the various controls, all conveniently grouped together at this

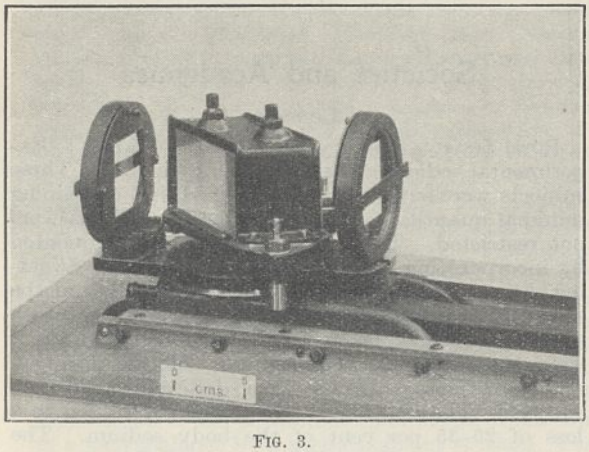


FIG. 3.

end. By turning the handle *A* through approximately 180°, the optical trains are interchanged. At the same time, the long lever shown at the front of Fig. 3 comes into operation, and by means of a system of cams, the spectrograph is automatically adjusted for the wave-length range shown by the drum *C*. This range can be altered as required by rotating the handle *B*, the spectrograph adjustments being automatically performed as it is rotated. The raising and lowering of the plate holder is obtained by an improved mechanism and is controlled by the handle *D*. The lever *E* affords means of bringing a transparent scale in contact with the photographic plate so that it is photographed on the plate together with the desired spectrum. The knurled head *F* controls the width of the aperture available for exposure, the actual value being indicated on the scale *G*.

Fig. 3 shows the simplicity of the design for interchanging the quartz and optical trains. The prisms are mounted, back to back, in a common casing with a metallic division between them. Each system has its own lens, the one in operation being on the right of the figure. When the handle *A* of Fig. 2 is rotated, the entire prism and lens system rotate, the second system coming into operation in exactly the correct position as determined by a definite stop.

This is the first completely automatic double train spectrograph that has been designed. In the course of time, other methods of performing the necessary operations will be evolved, but there is no doubt that the present mechanism is sufficiently sturdy to give many years of accurate service without attention

W. E. W.

Educational Topics and Events

CAMBRIDGE.—An election to the Sheepshanks exhibition for proficiency in astronomy will be held in the Easter term. Any member of the University under the standing of M.A., or being a research student under the standing of Ph.D., may be a candidate. The holder is required to engage in astronomical research to the satisfaction of the Council of Trinity College. Candidates are invited to send in their applications before February 14 to Prof. F. J. M. Stratton at Gonville and Caius College.

At Peterhouse, P. Ullyott has been elected fellow and director of studies in natural sciences.

LONDON.—The title of reader in pharmacological chemistry in the University has been conferred on Dr. H. R. Ing, in respect of the post held by him at University College, and the title of reader in mechanical engineering in the University on Mr. G. A. Wedgwood, in respect of the post held by him at Queen Mary College.

IT was announced on February 3 that Mr. Ramsay MacDonald (National Government) has been elected member of Parliament for the Scottish Combined Universities in the by-election caused by the death of Mr. Noel Skelton, Under-Secretary for Scotland.

DR. RAYMOND WALTERS, president of the University of Cincinnati, in an article on "The Statistics of Registration in American Universities and Colleges, 1935" (*School and Society*, 42, No. 1094, December 14, 1935, p. 801) points out that with one out of every twelve students having spare-time employment through federal appropriation, numbers in colleges and universities in the United States were 6·6 per cent greater than in 1934, which in turn exceeded 1933 by 5 per cent. The totals of approved institutions for 1935 were 588 colleges and universities, with an enrolment of 1,071,320 students, of whom 705,989 were full-time.

Science News a Century Ago

Giraffes for the Zoological Society

AT a meeting of the Zoological Society held on February 9, 1836, a letter was read which had been received from M. Thibaut at Malta, giving an account of the capture and condition of four giraffes which he had procured for the Society. He started from Cairo on April 15, 1834, and arrived at Dongola on July 14, 1834, whence he proceeded by caravan to the deserts of Cordova. On August 16 the Arab hunters succeeded in tracking a full-grown female accompanied by a young one. They soon overtook the former on their fleet coursers, and killed it. The next day they captured the young one. It was necessary to keep it some distance from the caravan for three or four days in order progressively to accustom it to society, when it began to take food, principally of camels' milk. M. Thibaut remained three months in the desert and captured four other giraffes. Difficulty was experienced in transporting them to Cairo and to Malta, but since they had arrived at the latter place every attention was being paid them by Mr. Boucher, the Consul-General. (*Athenæum.*)

Commodore Barron's Steam Ram

THOUGH Captain John Ross in his "Treatise on Navigation by Steam", 1828, had pointed out that a steam man-of-war could disable an opponent by ramming her, the first description of a steam ram was probably that given by Commodore James Barron, U.S.N., on February 11, 1836. His proposed vessel, which he called a "prow-ship", was to have a triple hull. The middle vessel was to be 150 ft. long, 20 ft. wide, and the side vessels 125 ft. long and 20 ft. wide. The prow of the middle hull was to be of solid timbers with iron plates 3 or 4 inches thick affixed to them. The vessel was to be driven by paddle wheels placed between the hulls, the power being supplied by three 120-horse power engines; the speed of the vessel was to be about 8 or 10 knots. "The object of this vessel," said the inventor, "is to destroy men-of-war by running into them with such impetuosity as to break down their sides sufficiently to admit water in such quantities as would defy all possible efforts to prevent immediate sinking. . . . Ancient as well as modern history furnished us with many proofs of the decided effects of this mode of attack. . . . The instances of destruction occasioned to vessels by one running into another are too numerous to admit of a doubt that if the plan recommended above should be adopted on a proper scale, it could never fail of effecting its object." According to Admiral G. N. Preble, U.S.N., a model of the prow-ship was exhibited in 1836 in the rotunda of the Capitol at Washington, and was afterwards removed for preservation to the Naval Academy, Annapolis.

Description of the Daniell's Cell

ON February 11 and 18, 1836, a paper was read before the Royal Society entitled "On Voltaic Combination", the paper being in the form of a letter addressed to Faraday by J. F. Daniell, professor of chemistry in King's College, London. The author, after expressing his obligations to Faraday for the important light which his research in electricity had thrown on chemical science, proceeded to state that he had obtained further confirmation of that great principle discussed and established by Faraday, namely, the definite chemical action of electricity, and had thus been led to the construction of a voltaic arrangement which furnished a constant current of electricity for any required length of time. After describing various experiments, Daniell said that his *constant battery* consisted of a hollow copper cylinder, containing within it a membranous tube formed by the gullet of an ox, in the axis of which is placed a cylindrical rod of zinc. The dilute acid was poured into the membranous tube, and the space between the tube and the cylinder was filled with a solution of sulphate of copper. When the battery was charged in the manner he described, it produced a perfectly equal and steady current of electricity for many hours together.

Anatomy, Physiology and Pathology of the Brain

"A COURSE of Lectures on these interesting and important subjects was commenced by Dr. Spurzheim on Thursday last, in the Webb St. Theatre of Anatomy, in the presence of a very numerous class of Medical Students. The Doctor, in an admirable Introductory Address, forcibly illustrated the advantages which must result to medical practitioners from their being acquainted with the structure of the brain, and with its healthy and diseased functions, and commented in a spirited manner on the *insane* practice which an ignorance of these subjects leads people to adopt, with a view to cure *insanity*.

"The lecture was exceedingly well received, and appeared to give great satisfaction. We have no doubt that all classes of medical men will feel it a duty to attend these valuable Discourses." (*Lancet*, February 11, 1836.)

Societies and Academies

LONDON

Royal Society, January 30. R. A. MCCANCE: Experimental sodium chloride deficiency in man. Three subjects were subjected to a weighed diet containing minimal quantities of sodium chloride. Fluids were not restricted. The protein intake was augmented by incorporating 'ashless' casein in the diet. Sweating was carried out in a radiant heat bath, and the sweat was collected quantitatively on mackintosh sheeting. Urine, fæces and insensible perspiration were also collected. The sodium, chloride, nitrogen and potassium balances were determined on two subjects. The deficiency, which was severe, led to a loss of 25–35 per cent of the body sodium. The symptoms were loss of the sense of flavour, considerable weakness and fatigue, a sense of constriction in the chest on the least exertion, and cramps. The subjects at first lost weight *pari passu* with sodium, but later the weight ceased to fall and thereafter fluctuated without reference to the sodium. Many of the symptoms and signs and also the blood changes closely reproduced clinical or experimental Addison's disease, but there were points of difference also, for example, no fall of blood pressure. As sodium chloride was restored, the weight rose, the nitrogen balance became positive, the blood urea fell, and

health was regained. D. Y. SOLANDT : The measurement of accommodation in nerve. Experiments are outlined by which A. V. Hill's theory concerning the time constant of 'accommodation' in the electrical excitation of nerve is verified. The predicted linear relation between relative threshold and time-constant of exponential rise of current was found for certain motor nerves of frogs, fishes, crabs, lobsters and man. The slope of this line is the reciprocal of λ, the time-constant of 'accommodation'. Measures of λ were thus obtained on a variety of nerves under various conditions. The sciatic nerves of normal 'winter' frogs showed an average value of $\lambda = 35$ msec. ; the average value for human ulnar nerve was 58 msec. Increasing the concentration of calcium or potassium in the environment of frog's nerve was found to lower λ. Decreasing the calcium ion concentration raised λ until, in the absence of calcium, it approached infinity. No other treatment (excepting changes in temperature) was found by which λ could be raised. The effect of calcium on λ is much greater than potassium. This shows that the time-constants of 'accommodation' and of 'excitation' are independent.

PARIS

Academy of Sciences, December 30 (*C.R.*, **201**, 1445–1528). JULIEN COSTANTIN : The Dauzère variety, a mutation of the Roquelaure (Gers) potato. The combined action of high altitude and fungi modifies the physiological properties of the tubers. In the case of the Roquelaure variety, the symbiotic fungi have created a new variety which has been stable for about twenty-five years. GABRIEL BERTRAND and LAZARE SILBERSTEIN : The comparative amounts of sulphur and phosphorus in plants cultivated in the same soil. Experimental results proving the importance of sulphur compared with that of phosphorus in the development of plants. The ratio of sulphur to phosphorus ranges from 0·38 to 4·0. For about half the plants examined, the ratio was greater than unity. NICOLAS KRYLOFF and NICOLAS BOGOLIOUBOFF : Invariant measurements and transitivity. J. SOULA : Certain indefinitely derivable functions. L. KANTOROVITCH : A space of functions with limited variation and the differentiation of a series term by term. LOUIS GABEAUD : The appearance of a shock wave in an aerodynamic field with subsonic velocities. ADRIEN FOCH : The numerical evaluation of the turbulence of aerodynamic blowers. MLLE. MARIE BLOCH and JEAN DUFAY : The analysis and interpretation of the nebular spectrum of Nova Herculis. Lines identified included those of hydrogen, helium, oxygen, carbon and nitrogen. The spectrum corresponded with that of the planetary nebulæ. EMILE SEVIN : The geometrical relations presented by material particles. PAUL SANTO RINI : The registration of the position of equilibrium of the beam of a microbalance by a high-frequency method. JEAN VILLEY : Tuyères with non-isentropic flow. PIERRE JACQUET : A new method of obtaining perfectly polished metal surfaces. Description of a method applicable to copper and certain copper alloys based on the anodic attack of the metal in a concentrated aqueous solution of orthophosphoric or pyrophosphoric acid. Three photomicrographs are reproduced of copper polished with emery, alumina and by the proposed method. FRED VLÈS : The relations between the electro-chemical constants, the infra-red spectrum and the reactional properties. ERWIN HEINTZ : The infra-red spectrum of the amino-acids and of the polypeptides. ALBERT ARNULF and BERNARD LYOT : A spectrograph with large aperture applicable to the ultra-violet. JEAN MOLNAR : A photochemical decomposition of the nitrophenols. EUGÈNE COTTÉ : The inflammation of fire-damp by the filaments of incandescent electric bulbs. Many experiments lead to the conclusion that the filaments of ordinary electric light bulbs are a possible danger in atmospheres containing marsh gas, but the results obtained by Couriot and Meunier in 1898 are opposed to this view. Experiments now described show that whether explosion takes place or not when a bulb is broken depends on the size of the hole and the dimensions of the bulb. PAUL CORRIEZ : The electrical resistivity and magnetic susceptibility of sugar carbon after undergoing various thermal treatments. Sugar carbon, after heating to various temperatures between 1,000° C. and 2,000° C., shows a decrease in resistance and an increase in magnetic susceptibility as the temperature is higher. ETIENNE CANALS, PIERRE PEYROT and ROGER NOËL : The fluorescence of some pure substances. Measurements of the fluorescence of seven fatty alcohols and benzyl alcohol are given. All the alcohols examined were fluorescent, the benzyl alcohol being much more fluorescent than the fatty alcohols. FÉLIX FRANÇOIS : The system antimony iodide – sodium iodide – water. ANDRÉ CHRÉTIEN and GEORGES VARGA : The system stannic chloride – hydrochloric acid. JACQUES BOURCART : The marine Quaternary in the Gulf of Cadiz. GÉRARD WATERLOT : The tectonic of the north-east edge of the Poitevin Marais. ROBERT LAFFITTE : The Danian and the Nummulitic in western Aurès. J. DEVAUX : The temperature of atmospheric ozone. From measurements in the infra-red spectrum it is concluded that the temperature of atmospheric ozone, supposed uniform, is low, much below 0° C. AUGUSTE and RENÉ SARTORY and JACQUES MEYER : Study of the organism isolated from a primary sporotrichosic arthritis with vertebral metastasis. The organism isolated appeared to be new and was named *Sporotrichum* (*Rhinocladium*) *verticilloides*. CHARLES HAMANT : Hydrocyanic acid and nitrates in the course of the germination of *Sorghum*. JEAN LE CALVEZ : The gametes of some Foraminifera. HENRI NOUVEL : The founder Nematogen of *Dicyemennea eledones* and its larva. W. KOPACZEWSKI and STANISLAS MARCZEWSKI : Interchangeable anaphylactic phenomena. JEAN LOISELEUR : The mode of action of radioactive bodies on the proteins. JACQUES MONOD : The rate of growth as a function of the concentration of food in a population of *Glaucoma piriformis* in a pure culture. MLLE. YVONNE GARREAU : Some organic salts of a diaminoquinone disulphonic acid. R. GUILLEMET : The catalysed fermentation of some fructoholosides. ALBERT GORIS and HENRI CANAL : The synthesis of 2′.6′.dioxy-4′.methoxy-β-phenyl-propiophenone. The ketone prepared synthetically has been proved to be identical with that isolated from the essence of *Populus balsamifera*. MME. ANDRÉE ROCHE and JEAN ROCHE : The variations of osmotic pressure and the size of the hæmocyanin molecules in the course of prolonged fasting (estivation or hibernation) in certain species of *Helix*. MME. HÉLÈNE SPARROW : Attempts at vaccination with Rickettsias of the marine I virus of Tunis. CHARLES NICOLLE : Remarks on the preceding note. JEAN CUILLÉ, PAUL LOUIS CHELLE and FRANCIS BERLUREAU : The existence in France of a new hæmatozoa of the ox, *Eperythrozoon Wenyoni*.

Forthcoming Events

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

Monday, February 10

ROYAL SOCIETY OF ARTS, at 5.—Major-General Sir Robert McCarrison: "Nutrition and the Nation" (Cantor Lectures. Succeeding lectures on February 17 and 24).

UNIVERSITY OF LEEDS, at 5.15.—Dr. Stanley Kemp, F.R.S.: "Some Recent Results in Antarctic Oceanography".*

Tuesday, February 11

UNIVERSITY COLLEGE, LONDON (CHEMICAL AND PHYSICAL SOCIETY), at 5.—Prof. Niels Bohr: "Space and Time in Atomic Physics".

PHARMACEUTICAL SOCIETY, at 8.30.—Prof. E. C. Dodds: "Chemical and Pharmacological Aspects of the Hormones".

Wednesday, February 12

BRITISH CAST IRON RESEARCH ASSOCIATION, at 2.30.—(in the James Watt Memorial Institute, 37a, Great Charles Street, Birmingham).—Major F. A. Freeth, F.R.S.: "The Phase Rule applied to Metals and Alloys".*

QUEEN MARY COLLEGE, LONDON, at 4.—Prof. F. E. Fritsch, F.R.S.: "Special Aspects of Algal Morphology" (succeeding lectures on February 19, 26, March 4 and 11).*

CHEMICAL SOCIETY, at 5.30.—(at the Royal Institution, Albemarle Street, W.1).—Lord Rutherford, F.R.S.: "Radioactivity and Atomic Theory" (Sixteenth Faraday Lecture).

Friday, February 14

ASSOCIATION OF APPLIED BIOLOGISTS, at 2.30.—Annual General Meeting to be held in the Metallurgical Lecture Theatre of the Imperial College, South Kensington, S.W.7.

Dr. T. Goodey: "Some Applied Biological Aspects of Problems relating to Plant Parasitic Nematodes" (Presidential Address).

ROYAL SOCIETY OF ARTS (INDIAN SECTION), at 4.30.—Lady Hartog: "The Education of Women in India".

ROYAL ASTRONOMICAL SOCIETY, at 5.—Annual General Meeting.

J. H. Reynolds: "The Galactic Nebulæ" (Presidential Address).

INSTITUTE OF FUEL, at 7.—(at British Industries House, Marble Arch, W.1).—Discussion on "The Economic and National Aspects of the Production of Oil from Coal", to be opened by Prof. W. A. Bone, F.R.S. Other speakers include Lord Strabolgi, Prof. C. H. Lander, Prof. F. G. Donnan, F.R.S., H. T. Tizard, F.R.S., and Kenneth Gordon.

ROYAL INSTITUTION, at 9.—Sir Edward Denison Ross: "Turkestan Unveiled".

Official Publications Received

Great Britain and Ireland

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1636 (T. 3613 and Ae. Tech. 936): Tests on Aerofoil Flaps in the Compressed Air Tunnel. By Dr. R. Jones, A. H. Bell and E. Smyth. Pp. 16+10 plates. 1*s.* 6*d.* net. No. 1674 (T. 3601): Tables for use in an Improved Method of Airscrew Strip Theory Calculation. By C. N. H. Lock and D. Yeatman. Pp. 27+14 plates. 2*s.* net. (London: H.M. Stationery Office.) [271

Saorstat Eireann: Roinn Talmhaiochta (Department of Agriculture): Brainse Iascaigh (Fisheries Branch). Statistics of Salmon, Sea Trout and Eels captured during the Years 1927, 1929, 1931 and 1933. (P. No. 1838.) Pp. 16. 3*d.* Statistical Tables of the Sea and Inland Fisheries, together with Abstract of Current By-Laws, Orders, etc., for the Years 1931, 1932 and 1933. (P. No. 1751.) Pp. iii+62. 1*s.* (Dublin: Government Publications Sale Office.) [291

Other Countries

Ministerio de Instrucción Pública y Bellas Artes. Anuario del Observatorio Astronómico de Madrid para 1936. Pp. 285. (Madrid: Observatorio Astronómico.) [201

Indian Forest Records, New Series. Vol. 1, No. 8: On the Biology of the Ichneumonidæ (Hymenoptera). By C. F. C. Beeson and S. N. Chatterjee. Pp. ii+151–168. 8 annas; 10*d.* Vol. 1, No. 10: Entomological Investigations on the Spike Disease of Sandal (25) Lepidoptera. By N. C. Chatterjee. Pp. ii+185–204. 8 annas; 10*d.* (Delhi: Manager of Publications.) [201

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 132: Investigations on the Origin of the Sound emitted by Revolving Airscrews. 2: Further Studies on Pressure-Variations in the neighbourhood of the Airscrew Blade. By Jûichi Obata, Yahei Yosida and Umezirô Yosida. Pp. 419–440+plates 8–17. (Tôkyô: Kôgyô Tosho Kabushiki Kaisha.) 55 sen. [201

Veröffentlichungen des Geobotanischen Institutes Rübel in Zürich. Heft 12: Ergebnisse der Internationalen Pflanzengeographischen Erkursion durch Mittelitalien 1934. Redigiert von E. Rübel. Pp. 239. (Bern: Hans Huber.) [201

Conseil Permanent International pour l'Exploration de la Mer. Bulletin statistique des pêches maritimes des Pays du nord et de l'ouest de l'Europe. Rédigé par D'Arcy Wentworth Thompson. Vol. 23, pour l'année 1933. Pp. xxiv+51. (Copenhague: Andr. Fred. Høst et fils.) 3.00 kr. [211

Polska Akademja Umiejętności. Starunia. Nr. 1: Mchy dyluwjum w Staruni (Diluvial Mosses from Starunia). By B. Szafran. Pp. 17+1 plate. 2 zł. Nr. 2: Flora mchów Staruni pod względem edaficznym i klimatycznym (Die Moose von Starunia als Vegetations- und Klimazeugen). By Helmut Gans. Pp. 6. 1 zł. Nr. 3: Szarańczaki z warstw dyluwjalnych Staruni (Die Orthopteren aus der diluvialen Nashornschicht von Starunia, polnische Karpathen). By Dr. Friedrich Zeuner. Pp. 17+1 plate. 2 zł. Nr. 4: Dwuskrzydłe z warstw dyluwjalnych Staruni (Dipteren aus den diluvialen Schichten von Starunia). By Fr. Lengersdorf. Pp. 8. 1 zł. Nr. 5: Szczątki drobniejszych kręgowców, wydobyte z iłów dyluwjalnych Staruni (Knochenfragmente der in Starunia zusammen mit dem Wollnashorn gefundenen kleineren Wirbeltiere). By Dr. Theodor Kornos. Pp. 4. 1 zł. Nr. 6: Jezierze (*Najas*) w dyluwjum polskiem (*Najas* in the Polish Diluvium). By Marja Gawłowska. Pp. 13+2 plates. 2 zł. Nr. 7: Studja nad szczątkami dyluwjalnemi roślin z rodziny *Nymphæaceæ* (Studies on Diluvial Plant Remains of the Family *Nymphæaceæ*). By Andrzej Środoń. Pp. 10+1 plate. 2 zł. (Kraków: Polska Akademja Umiejętności.) [221

Polska Akademja Umiejętności. Wydawnictwa śląskie, Prace geologiczne, Nr. 2: Utwory czwartorzędowe pogórza Cieszyńskiego (Über die quartärbildungen im teschener Hügellande). By Marjam Książkiewicz. Pp. ii+16+1 map. (Kraków: Polska Akademja Umiejętności). [221

Académie Polonaise des Sciences et des Lettres. Comité des publications Silésiennes, Travaux géologiques, No. 1: Les mégaspores du bassin houiller polonais. Par Jan Zerndt. 1ére Partie. Pp. ii+56+32 plates. (Kraków: Polska Akademja Umiejętności.) [221

U.S. Department of Agriculture. Circular No. 365: The Camphor Scale. By A. W. Cressman and H. K. Plank. Pp. 20. 5 cents. Circular No. 373: Fumigation of Fresh Fruit to destroy the Adult Japanese Beetle. By Max R. Osburn and J. William Lipp. Pp. 30. 5 cents. (Washington, D.C.: Government Printing Office.) [231

U.S. Department of the Interior: Office of Education. Bulletin, 1935, No. 5: Bibliography of Research Studies in Education, 1933–1934. By Ruth A. Gray. Pp. xiv+328. (Washington, D.C.: Government Printing Office.) 25 cents. [231

University of Queensland: John Murtagh Macrossan Lectures, 1935. The Ionosphere and its Influence upon the Propagation of Radio Waves. By Prof. F. P. V. Madsen. Pp. 48. (Sydney: Simmons, Ltd., Glebe.) [271

Bulletin of the Raffles Museum, Singapore, Straits Settlements. No. 11: A Handlist of Malaysian Birds; a Systematic List of the Birds of the Malay Peninsula, Sumatra, Borneo and Java, including the Adjacent Small Islands. By Frederick Nutter Chasen. Pp. xx+389. (Singapore: Government Printing Office.) 9 dollars; 21*s.* [271

Smithsonian Miscellaneous Collections. Vol. 91, No. 23: Reports on the Collections obtained by the First Johnson-Smithsonian Deep-Sea Expedition to the Puerto Rican Deep. A New Genus of Opisthognathid Fishes. By George S. Myers. (Publication 3347.) Pp. 5. (Washington, D.C.: Smithsonian Institution.) [271

Ethnological Studies, 1935. Edited by Dr. Walter Kaudern. Pp. 182. (Göteborg: Gothenburg Museum.) 15.00 kr. [271

U.S. Department of Agriculture. Technical Bulletin No. 487: Bollweevil Control with Calcium Arsenate on Field Plots in Madison Parish, La., from 1920 to 1934. By M. T. Young. Pp. 24. (Washington, D.C.: Government Printing Office.) 5 cents. [271

Annual Report of the Public Health Commissioner with the Government of India for 1933. Vol. 1, with Appendices. Pp. ix+400. (Delhi: Manager of Publications.) 6.4 rupees; 10*s.* [301

Catalogues

Tombac Flexible Metallic Tubing and Bellows. (List B. 9.) Pp. 2. (London: W. Edwards and Co.)

Colorimetry and Nephelometry. (Section E.33.) Pp. E.15. (Delft: P. J. Kipp en Zonen.)

A Catalogue of Books on Biology, General Zoology, including Conchology, Crustacea, Entomology, Ichthyology, Mammalia, Ornithology and Reptilia, Palæontology and Geology, from three Private Libraries recently Purchased. (No. 514.) Pp. 92. (London: Bernard Quaritch, Ltd.)

Catalogue of Books in various branches of Natural History, including two recently purchased libraries of Botanical Books in which are many Local Floras, British and Foreign. (No. 242.) Pp. 32. (London: Dulau and Co., Ltd.)

Quickfit Scientific Glassware. Pp. 24. Supplement No. 1. Pp. 6. (London: Quickfit and Quartz, Ltd.)