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Intellectual Freedom

As years count, little more than a generation has passed since Huxley died. Prof. A. V. Hill's Huxley Memorial lecture on "The International Status and Obligations of Science" (see NATURE, Dec. 23, pp. 952–954), while stressing the world's debt to Huxley for his vindication of intellectual freedom, reminded us, if any reminder were needed, that since the War, in far less than a generation, indeed in a period of a little more than the last ten years, we have seen the making of a new world, the world of the dictator, in which the spirit is as alien to that of Huxley's day as was the spirit of the Middle Ages.

In retrospect it is easily possible to attach too great significance to the opposition encountered by the scientific ideas propounded by Huxley and the school of thought of which he stands as the representative. The nineteenth century was an age of great expansions. By an almost daily experience its horizons were enlarged. The extension of commerce and industry made possible by the growth of population and new markets opened up by travel, exploration and settlement, the increase of political power among the people, and the spread of education confirmed society in a dynamic attitude towards the problems of life. To this attitude the concepts of an evolutionary philosophy and the scientific ideas of Darwin and Huxley were more nearly akin than the static appeal to authority of those by whom they were opposed. It was an age which believed in the possibility of progress, in the possibility of a continuous and progressive amelioration in the conditions of life and above all in the potentialities of man himself. Backward, barbarous and uncivilised peoples, all, it was thought, might be raised to the status of the most advanced in course of time, given education and training.

To a generation which came to maturity in the latter half of the nineteenth century, freedom of thought was the natural corollary of the complete emancipation of the individual, which had been the prevailing tendency of preceding years, and was, it was then thought, the goal of future progress. The removal of disabilities due to birth, status or religion by movements, such as, for example, Catholic emancipation and the throwing open of the universities, particularly the admission of non-conformists, seemed to be the counterpart of the abrogation of authority and the freeing of inquiry in the sphere of the intellect, which had

been initiated by Bacon, himself a product of the spirit of the Reformation, in the application of scientific method and experimental investigation to the problems of natural science, and of which the final stage, apparently, lay open with the acceptance of evolutionary doctrines and the annihilation of the concept of fixed species as god-created entities. As in the political world the efforts of conservatism were directed towards tempering progressive measures by a compromise with established institutions which would not bar forward movement, so in matters intellectual, when once the complete verbal inspiration of the Bible was recognised to be no longer tenable, the efforts of the keenest minds among the orthodox were directed towards the reconciliation of science and religion, rather than to an endeavour to mark off a forbidden territory by chains of authority, which, it was seen, advanced thought would either pass by or overleap.

This was a world of which Huxley was both a product and a formative influence. He taught a public which was ripe to give hearing to his doctrine. It is unnecessary to labour the point by further analysis of the complex interweave of social and intellectual movement of that day. There are, however, two tendencies, or factors, to which reference may be made for their bearing on present problems. These are the international status of science and the relation of science to politics, and questions of policy in connexion with social problems.

On the general question of the international standing of science little need be added to the references to the position in the past which were made by Prof. Hill in his address. Science and learning and, in a lesser degree, art, as he showed, in the past have transcended national boundaries and have been accorded international status. On the other hand, in recent times, the free interchange of ideas which is the end and justification of the claim of science to be regarded as free of all frontiers, has been, in Great Britain at least, one form of expression of the belief in the ultimate unity and solidarity of mankind as a whole, which underlies the intellectual internationalism of the medieval church, and in the Protestant world of later times has inspired humanitarian movements such as the emancipation of the slaves and intervention on behalf of oppressed peoples on various occasions.

The question of the relation of science to politics and socio-political problems opens up a field which offers opportunity for wide divergence of opinion, as is shown in the correspondence between Prof. Hill and Prof. J. B. S. Haldane which has appeared in our columns (see NATURE, Jan. 13, pp. 65–66). Prof. Hill's contention that science holds a privileged position in consequence, and on the condition of, its detached attitude towards matters which are the subject of political or social controversy and partisanship is unquestionably sound in so far as it affects the objects and conditions of pure scientific research. The object of the research worker is the attainment of truth, of the teacher of science the inculcation of the methods of attaining that object and the demonstration of the progress which has been made towards it. In neither case must there be bias due to extraneous influence or any attempt to sway the judgment of those under instruction, whether it be a class or the wider audience of the general public, a body of opinion of increasing importance in these days of broadcasting.

On the other hand, the scientific worker is a citizen, and as such it is his civic duty to bring his special knowledge to bear on the problems which present themselves to him as a member of the State. Further, as a specialist he may be called in to minister to the ills of the body politic. He alone has the specialised knowledge which can apply the results of research carried out in an academic atmosphere of detachment to the practical problems of life. Moreover, as the State in the performance of its function of ensuring for its members the best possible conditions of life, work and even of amusement, substitutes for regulations framed by rule of thumb, legislation which is in accord with the most recent dicta of science, the aid of the man of science is invoked with greater frequency and over a wider field. He may even be asked to frame a policy, or he may feel called upon of his own initiative to point out the way of future progress. He becomes a propagandist in the better sense. In the earlier days of the Rothamsted Experimental Station, for example, it would on occasion have been difficult to draw the line between agricultural instruction and propaganda.

To a great extent the application of scientific methods and scientific ideas to the problems of government and administration has been an outcome of the theory of State intervention, of which the wide extension is the outstanding contribution of the nineteenth century to political thought and practice. It is true that on occasion science has

found government departments somewhat difficult to persuade that the course of action dictated by scientific considerations was expedient or advisable. Yet on the whole, the fact that State regulation is a necessity which impinges on every side of the life of the community and affects it in multitudinous detail, in the long run has ensured that these regulations should be framed in the light of the results of scientific research. Whatever may be the defects of bureaucratic government, it does afford greater opportunity for the rational application of scientific method to domestic problems, unattainable in a pure democracy, failing the Utopian condition of a scientifically educated public and an executive fully and continuously abreast of the development of science and its practical applications.

The War marked the close of an epoch—a period, in which, it has been attempted to show, the political atmosphere fostered freedom of scientific inquiry, the free interchange of scientific ideas and personnel on an international basis, and an increasing application of scientific methods and results to conditions in every department of the citizen's daily life.

From the welter which followed on the conclusion of peace, we are only now beginning to emerge, and that only in so far as the conditions on which recovery will be attempted are becoming defined. Impressed by the results achieved by national discipline during the War, perhaps remembering how, at first under Bismarck's guidance and then under the Kaiser, the German States were welded into the most powerful national organisation of modern times, the foremost peoples of the world are placing themselves under the control of the organised State, consolidated on a national basis, of which the political and economic segregation is emphasised at every turn, but more particularly by tariffs, exchanges and trade balances, States in which an all-powerful emotional appeal is afforded by devotion to a political theory as in Russia, the call of race or nationality, as in Germany, or of loyalty to a leader who exercises a dictatorial power as in Italy or the United States of America.

With the merits and demerits of a political system, strictly as such, we have no concern in these columns, except in so far as it may become the subject of scientific sociological investigation. But it is of vital interest to science that what may be the relation of political theory and practice under the organised State, founded on a nationalist basis, to scientific inquiry should be clearly apprehended. The atmosphere of political freedom of Huxley's day, in which scientific inquiry grew to its full stature, has vanished. Is science to go back under a system of State control to swaddling clothes?

To the social reformer and the scientific worker who hates the waste of life, time and energy under rule of thumb and tradition, the organised State under dictatorial power, whether wielded by a cabinet or an individual, presents many attractions. It abrogates government by the Press, and the otherwise uninstructed vote of the mass. In it the man of science rightly sees no more than an extension of the bureaucratic regime of State control which in the past has been instrumental in applying the progressive concepts of science to social amelioration. No doubt future generations will rise up to call General Göring blessed, because he has decreed a reserve for the preservation of the wild animals of northern Europe, yet had his verdict gone the other way, who could now prevail? And those who applaud the work of archæological exploration and restoration which the Duce has promoted to the glory of the Italian nation may be pardoned if they feel some qualms lest the claims of some period or subject less complimentary to the Italian genius be overlooked. Who or what is to ensure that the organised State in the exercise of its power of control shall not dictate to science what subjects may or may not be matter for inquiry, and the direction that inquiry shall take? The Dayton trial has not yet sunk into oblivion, and to-day in Germany the whole State organisation and the fabric of society rest on a pseudo-scientific theory of Aryan supremacy, once formulated for political reasons and long ago exploded outside her national boundaries, but internally not to be questioned. To conform to that illusion Germany has closed her frontiers; she has evicted some of her greatest scientific investigators, with thousands of the rank and file, content, as it has been put, that her science should lag behind that of the rest of the world, provided that it were German; and finally, in the full spirit of the Hebrew Scriptures, if repudiating them in form, she seeks to evolve a German God, barely refraining from invoking by name Wodan, the God of Battles, who has risen again.

Since the above was written, we have received the circular on the teaching of history in Germany of which a translation appears in this issue (p. 288). It is perhaps worth while to place this on record,

lest it should appear that in directing attention to the danger that authority under the organised State might seek to prescribe for science the line to be taken in teaching and research, NATURE may appear to have issued a warning after the event.

There is much in the political situation of the day, even in Great Britain, which justifies Prof. Hill's fears for the future of intellectual freedom.

Physiology and Behaviour of Primates

(1) *Functional Affinities of Man, Monkeys and Apes: a Study of the Bearings of Physiology and Behaviour on the Taxonomy and Phylogeny of Lemurs, Monkeys, Apes and Man.* By Dr. S. Zuckerman. Pp. xviii+203+12 plates. (London: Kegan Paul and Co., Ltd., 1933.) 10*s*. 6*d*. net.

(2) *Behavior Mechanisms in Monkeys.* By Heinrich Klüver. (Behavior Research Fund Monographs.) Pp. xvii+387+9 plates. (Chicago: University of Chicago Press; London: Cambridge University Press, 1933.) 22*s*. net.

(1) DR. ZUCKERMAN, whose previous volume on the "Social Life of Monkeys and Apes" (1932) was favourably received, has in this new work collected together the somewhat scattered knowledge relating to the 'functional' characteristics of the various types of primates, and considered its bearings upon the classification and phylogeny of the group. He deals among other things with the mechanisms of reproduction, blood reactions, the physiology of the sense-organs, and behaviour in relation to cortical differentiation.

In general, the indications supplied by these functional characters are consistent with the orthodox view of the relationships of the primates, as expressed in the commonly accepted taxonomy of the order. They do not, however, throw any very clear light upon problems of phylogeny. Zuckerman has clearly performed a useful service in bringing together much information which is not easily accessible to the taxonomist and morphologist. The book is well documented and has a good bibliography. It is illustrated by 24 plate figures of apes, monkeys and lemurs, from photographs by F. W. Bond.

It is interesting to note that Zuckerman refers with approval to the work of St. George Mivart in the 'seventies, who in spite of his anti-Darwinian attitude expressed some very sound views on primate relationships. Mivart's contention that there is little difference in respect of mental powers between monkeys and apes is one which receives some support from recent psychological research.

(2) Thus in Dr. Klüver's book on the behaviour of monkeys, we find that some species, particularly of the genus *Cebus*, can utilise tools almost as effectively as Köhler's chimpanzees. This was also the conclusion of Bierens de Haan on the basis of his experiments with *Cebus hypoleucus* (1931). Actually we do not yet know enough about the behaviour of apes and monkeys to be able to rank them in order of 'intelligence', but it is significant that the more carefully and sympathetically they are studied the more complex and adaptable their behaviour appears.

Klüver's book is a contribution of the first importance to this fascinating study. It is admirably characterised by Dr. K. S. Lashley in his introduction as follows:

"Dr. Klüver's monograph sets a new standard for analytic studies of behaviour. He has proposed the question, Just what properties in complex sensory situations are significant for the animal's reactions? and has carried out the investigation with unique thoroughness. As a result, he presents for the first time something approaching a complete picture of the perceptual world of an animal. This perceptual organisation is surprisingly like that of man. Not only are the animals sensitive to the same physical stimuli but for them also the relational properties of the situations are the same. As with man, reactions are but little dependent upon the simple physical properties of the stimulus but rather upon abstract relations which may subsist in physically unlike situations."

These valuable conclusions as to the importance of bare relations in determining responses were obtained by the "method of equivalent stimuli".

The general problem set was to pull in one of two (or more) boxes, which were differentiated from one another by some physical characteristic, as for example weight. The monkey was first trained to pull in, say, the heavier of two boxes of given weights; when training was complete the weights of the boxes were altered throughout a wide range, and it was found that the monkey almost invariably chose the heavier of the pair quite irrespective of the absolute weights. Then the appearance of the boxes was altered in various ways, but the response to the bare relation 'heavier than' was still maintained. This type of experiment, using the pulling-in technique, was extended to many other characteristics, such as shapes and colours, and most interesting results obtained.

The investigations dealt with both New World

and Old World monkeys and also with a lemur; the experiments were admirably devised and controlled, and they are reported in full detail.

Scarcely less important than the experimental results is Klüver's extremely able and thorough discussion of their theoretical bearing, and his very full and careful treatment of the general principles of interpretation of animal behaviour. We agree with Lashley's opinion that this discussion is "one of the most important recent contributions to theoretical psychology".

Real progress is at last being made in the study of animal behaviour, through a combination of direct and accurate observation, simple experimentation, and careful logical analysis, independent of all preconceived theory, and Klüver's book greatly furthers this good work.

E. S. R.

Decompositions into Fifth Powers

British Association for the Advancement of Science. Mathematical Tables. Vol. 3: *Minimum Decompositions into Fifth Powers.* Prepared by Prof. L. E. Dickson. (Published under the supervision of the British Association Committee for the Calculation of Mathematical Tables.) Pp. vi+368. (London: British Association, 1933.) 10*s*.

SINCE 1931, when the British Association started to publish mathematical tables in volume form, three sets of tables have appeared. The first comprised tables of general utility: trigonometric, hyperbolic, exponential, gamma and other functions. The second issue contained Emden functions and had therefore a less popular appeal, since the tables were designed to aid in certain astrophysical researches, and the cost of printing was undertaken by the International Astronomical Union. The present (third) volume, while not perhaps of such a specialised character, deals with a subject which from its nature must interest directly but a small body of scientific workers.

By the generous bequest of Lieut.-Col. A. J. C. Cunningham, the British Association has funds available to assist in the production of tables connected with the theory of numbers. The scope of application of this fund would appear to be limited on one hand by the necessity of finding suitable material, and on the other by finding research workers both willing and able to produce work of the required character. In this respect the Committee is indeed fortunate in having the opportunity to undertake the printing of vol. 3, the subject of which could not more clearly come under the terms of the Cunningham bequest.

The actual matter of the present table concerns the solution of the Diophantine equation:

$$x_1^5 + x_2^5 + \ldots + x_s^5 = n,$$

where n is a given integer less than 300,000 and where s is to be a minimum. The method of tabulation will be apparent from the following extract:

10399	0	0	1	3		10
10406	3	2	2	0	1	11

This indicates that

$$10399 = 0 \times 2^5 + 0 \times 3^5 + 1 \times 4^5 + 3 \times 5^5.$$

Thus when $n = 10399$, $x_1 = 4$, $x_2 = x_3 = x_4 = 5$ and $s = 1 + 3 = 4$. The number 10 at the end of the first row indicates that the largest integer, 10405, which precedes the next tabular entry, 10406, requires ten fifth powers, namely, the four already given for 10399 and six units, so that

$$10405 = 6 \times 1^5 + 1 \times 4^5 + 3 \times 5^5.$$

From 150,000 onwards the decompositions are omitted, the minimum number of decompositions being indicated as explained above. Thereafter the actual decompositions can be readily found by trial, subtracting 9^5, 10^5, or 11^5 and consulting the previous part of the table.

One purpose of a table of this character is to produce experimental data in connexion with Waring's problem (in this case for fifth powers). In this problem there are two numbers of interest, m_5 and M_5; m_5 is the smallest number such that every integer is the sum of m_5 or fewer fifth powers, and M_5 is the smallest number such that from a certain point onwards every integer is the sum of M_5 or fewer fifth powers. That such numbers exist has been proved by Hilbert for the general case of kth powers, but their actual values for $k = 5$ is not known. It is known that $37 \leqslant M_5 \leqslant 53$, the last number being due to Hardy and Littlewood. Using the present tables, Prof. Dickson has proved that all integers with fewer than 484 figures are sums of 37 or fewer fifth powers and that all integers with fewer than 1,177 figures are sums of 41 or fewer fifth powers. An inspection of the table tempts one to surmise the possible existence of a number $a_5 < 15$, such that almost all integers are the sums of a_5 or fewer fifth powers.

The table is reproduced photographically from

typescript and is very clear. The author states that the elaborate checks required more time than the construction of the table.

The existence of the British Association tables might become more widely known if it were possible to have them permanently listed in a publisher's catalogue. L. M. MILNE-THOMSON.

Recent Research in Metallurgy

The Journal of the Institute of Metals. (1) Vol. 50 : *Metallurgical Abstracts and Index to Volumes 48, 49 and 50 of the Journal.* Pp. vi+962. (2) Vol. 51. Edited by G. Shaw Scott. Pp. 363+28 plates. 31*s.* 6*d.* (3) Vol. 52. Edited by G. Shaw Scott. Pp. 255+50 plates. 31*s.* 6*d.* (London : Institute of Metals, 1933.)

(1) THIS volume contains the general and non-ferrous metallurgical abstracts which have already been published during 1932 in the monthly *Journal*. These abstracts not only provide the worker in physical metallurgy with an invaluable guide to the literature of the subject, but also constitute a very useful aid to the physicist or physical chemist whose interests lie in this direction. As usual, the literature has been surveyed accurately over a broad front, but whether the latter is rather too broad is open to question. The Institute's desire to cater for all types of its membership can be appreciated, but considerable space is taken up by abstracts of articles which are merely recapitulations of existing knowledge and practice. A noticeable omission is a list of the periodicals abstracted.

Although the monthly issue of these abstracts undoubtedly constitutes a great improvement on the score of rapidity of publication, considerable delay now seems to occur in their re-issue as a single volume.

(2) Some thirteen papers presented at the March 1933 meeting of the Institute of Metals are collected in this volume of proceedings, together with Prof. Portevin's May lecture on "The Phenomena of Quenching and Tempering in Alloys". Prof. Portevin deals in a thought-provoking manner with the general principles and mechanism of precipitation hardening due to differences of solid solubility at high and low temperatures, and shows that these phenomena, far from being exceptional, are extremely common. These considerations open a new field of research in the application to existing alloys of the principles of precipitation hardening.

Three papers by N. P. Allen and his co-workers deal in a fundamental manner with the practical problems of unsoundness in ingots of copper and copper-nickel alloys. The recently developed tellurium-lead alloy forms the subject of one communication, and a further paper records the effects of progressive rolling reductions on the physical properties of zinc strip. Two papers deal with the electrical conductivity of aluminium wire used for transmission lines, whilst other topics include the fatigue-resisting properties of aluminium alloys at elevated temperatures and the interpretation of the tensile test with reference to lead alloys. Particular mention should be made of a paper by Bradley and Jones on the re-examination of the copper-aluminium system by the X-ray powder method.

(3) The autumn meeting last year constituted the twenty-fifth anniversary of the foundation of the Institute of Metals, and was appropriately held in Birmingham, the original home of the Institute. This volume of proceedings contains the fourteen papers presented on this occasion, together with Mr. W. R. Barclay's Autumn Lecture on "Twenty-Five Years' Progress in Metallurgical Plant", which is illustrated with an excellent series of photographs of melting, rolling, and auxiliary equipment. Probably the most interesting of the papers is Dr. Rosenhain's review, prepared at the request of the Council, of progress in non-ferrous metallurgy during the life-time of the Institute. Much metallurgical history has been made in this period, and Dr. Rosenhain briefly surveys a number of developments, including the improved equilibrium diagram technique, the study of deformation and fatigue, the application of X-ray methods, and the development of light alloys and of special cutting alloys, with many of which he and his students have been intimately connected.

Research on precipitation hardening is represented by two papers, both dealing with copper-nickel-aluminium alloys, and a further contribution from Allen concerns the distribution of porosity in aluminium and copper ingots. Other papers deal with the preparation of lead alloys for microscopic examination, the protection of magnesium alloys, the annealing of copper wire and the corrosion-fatigue characteristics of an aluminium specimen consisting of two crystals. The papers and ensuing discussions testify to the value of the past twenty-five years' work of the Institute in the stimulation of the study of alloys.

L. B. H.

Short Reviews

Recent Advances in Agricultural Plant Breeding. By Dr. H. Hunter and Dr. H. Martin Leake. Pp. x+361+16 plates. (London: J. and A. Churchill, 1933.) 15*s.*

DURING the past generation the expansion of plant-breeding work on agricultural plants has been so rapid that it is impossible to present even a condensed comprehensive review within the limits of a single volume. Recognising this, the authors have confined their attention to the results of the more important investigations which have emerged from the academic stage and have resulted in improved varieties that have passed into general use. Indications are given of the general direction of progress and of some of the main problems awaiting solution.

Attempted improvements are often determined by commercial requirements, which may vary not only from one country to another, but also within each country itself. Further improvement in plants is relative to the environment, as soil fertility and climate, and is not an absolute condition; for example, a new variety that gives excellent results in one area, or under certain manurial treatment, may show no advantage elsewhere or under different cultural conditions. The extreme difficulty is recognised of arriving at a truly homozygous unit giving a completely stable plant, and the indications adduced from practice are that stability is in reality a relative term, but that some varieties are more stable than others.

Work in temperate regions is chiefly on food crops, with species and varieties long under domestication. The range of sub-tropical and tropical crops is much wider, and many of them are much nearer their wild forebears, thus raising very different problems in improvement. Under tropical conditions, also, environmental conditions encourage disease so much that the evolution of disease-resisting types takes precedence even of yield and quality improvement.

The survey is suggestive and its usefulness is increased by the provision of illustrations and numerous references associated with the individual crops.

Geology. By Prof. William H. Emmons, Prof. George A. Thiel, Prof. Clinton R. Stauffer and Prof. Ira S. Allison. Pp. xii+514. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1932.) 24*s.* net.

THE collaboration of four professors in the production of an introductory textbook of their subject must be a rare event. In this present instance the experiment, if it may be called such, has been successful, for the result is a lucid and logical exposition of the principles of geology. The greater part of the work deals with geological processes and is uniformly excellent. American examples are mainly employed for illustration, but the subjects are usually so magnificent that such a choice is right.

The last half a dozen chapters of the book are concerned with the origins of mountains, metamorphism, rock structures, conditions within the earth, earth history and kindred subjects. Here the treatment is not quite so successful. The account of the origin and structure of mountains, for example, is sketchy, and the references, especially to the Alps, distinctly inadequate. Again, the grand unity of metamorphic processes —the only guiding light in this uncharted sea— is obscured by a needless subdivision of the subject. Further, the planetesimal theory of the origin of the solar system is presented without critical examination. But, in spite of this, the book is certainly a good modern introduction to the subject and would be useful as a supplementary text for British students. In the main it is written in a pleasing easy style that is remarkably uniform throughout the volume. The illustrations, nearly five hundred in number, are well chosen and well reproduced.

Basic Units in Mechanical Drawing. By Prof. Randolph Philip Hœlscher and Prof. Arthur Beverly Mays. Book 1. Pp. viii+289. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1933.) 10*s.* net.

THE preface sufficiently indicates the design of the book, and the accompanying text throughout bears testimony to the realisation of that design. The authors are to be congratulated on being able to present the results of their practical experience in an eminently practical form. Nor can the diagrams, which are so liberally furnished, be over-praised.

The jejune qualities so frequently apparent in books of this nature are herein totally absent. If a demurring criticism is due, it is in respect to the somewhat mechanical system of lettering advocated; preferably lettering should be introduced upon a freehand mode of treatment.

P. L. M.

Collision Processes in Gases. By Dr. F. L. Arnot. (Methuen's Monographs on Physical Subjects.) Pp. viii+104. (London: Methuen and Co., Ltd., 1933.) 3*s.* net.

THIS useful little volume deals with that group of collision phenomena in gases in which the processes may be treated as individual events. It is divided into two parts. The main section deals with collisions between electrons and atoms and the brief second part gives some account of collisions between photons and atoms, and between normal, excited and ionised atoms.

The book is lucidly and critically written and may be unreservedly commended. A. F.

Thomas Young

By SIR JOSEPH LARMOR, F.R.S.

IT is a welcome feature of the times that interest in the great pioneers who created the science of mathematical physics in Great Britain shows signs of revival. The recent publication of a biographical sketch of Thomas Young by Mr. Frank Oldham* is an indication. At the time of his decease (1829) at the age of fifty-six years, the task of collecting and editing Young's later scientific writings passed into the hands of George Peacock, Dean of Ely and Lowndean professor at Cambridge: and though through pressure of business at Cambridge and Ely he took twenty years over the work, the result in two volumes on physical science, with a third on hieroglyphical research, and the indispensable standard biography as a fourth, is, or ought to be, in a proper scheme of things, one of the permanent classics of natural knowledge. It reveals the editor, known as one of the introducers of the formal Continental analysis into Cambridge, as an adept critic in general Natural Philosophy of the Newtonian type as well.

In those early days scientific people did not write numerous treatises, and as a result, into their work, as intended for permanence, they put their most sustained thought. The nascent separate sciences had moreover then to be systematised, and they were not seldom, just as now, knocking up against mutual discrepancies that demanded both unrelaxing effort and a safe provisional judgment. Even in pure theory the preparation of the immortal "Mécanique Analytique", a systematising treatise of no great length or abstruseness, built on historical foundations, occupied a long time, and is said to have so exhausted Lagrange that he had to desert mathematical science for several years. We may contrast with this the stupendous achievement of Isaac Newton, who, in spite of irritations from which he was far from immune, managed under stimulus to prepare the "Principia", in part doubtless from material which already he had by him in some form, in eighteen months. The formal legacy of British physical theorists of about a century and a half ago, especially in the Scottish universities, mainly developing out of their formal courses of lectures to large audiences, and thus not infrequently posthumous as in the cases of Black and Robison, produced a species of literature tending, except in the hands of masters, to be either superficial or dull. The greatest and most original of all general lecture courses was Young's "Lectures of Natural Philosophy and the Mechanical Arts", over which there was certainly no delay, as the two massive and very complete yet concise quarto volumes were published (1807) at the age of thirty-four years a few years after the course was delivered.

Was it the very universality of Young's range of interests that saved him from premature mental exhaustion? One of the three volumes of the 'miscellaneous works', edited for Peacock by his friend John Leitch, is taken up with philological studies, largely exhibiting his connexion with the early history of the cardinal advance in wide fields of knowledge rendered possible by the deciphering of the Egyptian hieroglyphics, which was first brought into Young's keen attention by the problem presented by a tri-lingual inscription on the Rosetta stone. The controversy as to the rival merits of Young and his contemporary Champollion of Grenoble, who seems to have come later into the field, doubtless far more learned in the cognate Coptic and other sources, has fluctuated ever since. The writer of the biographical sketch which suggested the present notice follows Leitch's account, and also Peacock's in an independent and trenchant analysis in the "Biography" (pp. 258–344), in assigning the main credit to Young: but one has a feeling that in that decision they are not in the swim. The claim asserted for Young on his monument in the Abbey is that he was the first to penetrate the obscurity that veiled for ages the problem of the hieroglyphics of Egypt: and, however the complete final solution be apportioned, this statement appears to hold good. On reference to the last edition of the "Encyclopædia Britannica" one finds the balance struck emphatically for Champollion, in agreement as is there stated with universal authority: this may be right enough so far as the general reader can know, but even a cursory inspection of Peacock's account of progress indicates that there is more that might properly be said: indeed, the name of Young is not even mentioned either under the heading "Hieroglyphics" or under the personal notice of Champollion. Even more remarkable, surely by one of the workings of fortune which the Greeks named Nemesis, in compensation for his supreme classical contributions to the original "Encyclopedia", the name of Young occurs only in a secondary way in the general index to the new volumes; yet one of his own most notable works is the long series of scientific biographies which he contributed with much research to the Supplement of the early publication.

Young is still perhaps popularly known mainly from the episode of his personal collisions with the youthful Brougham, who was afterwards for some time Lord Chancellor of England. The latter, then editor of the *Edinburgh Review*, from its political and literary connexions an influential organ of opinion, avenged himself for some slighting incidental criticism of his own writings, of a kind to which Young was perhaps too much addicted, and at the same time acquired for himself a unique species of scientific renown which has clung to him, by gibbeting, in eloquent and even scurrilous terms, the revival of the wave-theory of light and

* "Thomas Young, F.R.S., Philosopher and Physician." By Frank Oldham. Pp. 159+2 plates. (London: Edward Arnold and Co., 1933.) 6s. net.

its brilliant developments in many directions through Young's recognition of the principle of interference of trains of waves, which ought to have been so obvious to a real student. His satire is commonly held to have diverted men from any attentive consideration of the new discoveries, by discrediting their author, and so as is said managed to postpone the progress of optical science for twenty years. But that is possibly ascribing to him too much credit: Young had already become and for long remained Foreign Secretary of the Royal Society, and maintained his repute with his colleagues there, though at that time they were scarcely mathematical enough to become deeply concerned in his own researches. He was moreover to receive a remuneration for the copyright of his "Lectures" handsome for that time, ultimately however owing to bankruptcy unpaid: though the book was to contain a very elaborate and expensive reprint of the great memoirs that were supposed to be discredited.

Young's dignified rejoinder to Brougham's abuse, published as a pamphlet, is a valuable personal record of his mode of work, though the provocation by itself had scarcely called for such serious notice: he complains that only one copy of it was sold, but possibly its main function may have been for private distribution to his competent scientific friends. Lord Brougham himself had less equivocal merits in other directions, especially in educational zeal, after he had been ejected from political life by his temper. He appears to have been prime mover in establishing the "Society for Promoting Useful Knowledge", which succeeded in engaging some of the best scientific intellect of the time in works of general interest yet precise scientific value; for example, it produced a series of biographies which have now fallen into undeserved oblivion, and even succeeded in circulating in periodical instalments, almost in modern fashion, standard treatises of the highest rank, such as De Morgan's "Differential and Integral Calculus". How far the "Encyclopædia Metropolitana", the high-water mark of the science of its time, and the ancillary more popular volumes such as Sir John Herschel's once famous "Introduction to the Study of Natural Philosophy", so helpful to the nascent inductive logic, may have been a further outcome, we may not stop to inquire. Indeed the general public neglect of which Young complained must largely have been his own fault, through his persistence in anonymous publication in brief notes, in the interest as he thought of his medical practice, which would naturally detract from the attention which was his due. His speculations, as lying outside the range of the main interests of his colleagues, and of the public of the time, had appealed coldly to them: and he appears moreover to have been a silent man,—he relates in a family letter that he was stimulated by a remark at an annual meeting of the Royal Society that "no one had heard him make a speech". The resurrection of his public fame in a later generation was largely the result of a judgment opening out to a wider audience, by Helmholtz, who had first encountered his early keen *aperçus* in the course of his own activity in the physiology of vision. Helmholtz characterised him as largely misunderstood because he was too far in advance of his times, a modified version of the perhaps natural explanation that his habits of exact thought were too concise and interwoven to permit him to give explanations at length without distracting his own attention from the concatenation of his ideas. He relates that his ideas on light gradually arose from study and experiment on the phenomena of waves of sound, which occupied him and mystified his neighbours during his three years residence at Emmanuel College in Cambridge, keeping terms with a view to a medical degree. The customary rather silent appreciation of his matured genius by his own British school, men such as Airy and Maxwell and Rayleigh, has not been wanting.

In another episode in his unfortunately controversial career, in relation to yet another of the fundamental physical doctrines, the principles of atomic interaction in relation to capillary phenomena, the part of Brougham was played to some extent, though with amends later, by none other than the illustrious Laplace. As an offset to mathematical genius and great industry, the world has been accustomed to accept, possibly to exaggerate, Laplace's propensity to annex information for his systematic treatises from where he could find it, and modify it at will, without any great scruples regarding original discoverers. If he did take over Young's ideas, he made a more artistic work of them: though a student with physical instincts will probably still prefer to try to absorb the wide and often sufficient simple *aperçus* of Young before passing on to the special analytical elaboration of Laplace. An illustration of the contrast is that, in a domain where Laplace is perforce silent, Young's more flexible, if somewhat obscure, train of thoughts on the relation of surface tension to molecular interaction at sensible range, manages to give him a provisional estimate, lightly held however, of the diameters and range of activity of atoms, perhaps the earliest effective attempt in that direction, as Lord Rayleigh remarked, one which though real now appears in the detailed lights of modern science to be about a hundred times too small: the brief systematic expansion of such estimates of atomic size, as probed in all directions at the hands of Lord Kelvin, became a remembered incident when it appeared long after. Yet though Laplace's propensity to taking new general ideas for granted, especially when not fully developed, strongly irritated Young, with his memory of previous experience at the hands of Brougham, it had not, to take a different type of instance, prevented most friendly rivalry and combined continuous co-operations for years between Laplace and Lagrange, calm amid the turbulence of the times, in establishing and confirming the very delicate amenities of the planetary system, and incidentally

indicating, starting therefrom, much of the modern analytical structure of general dynamical science. The simplicity and dignity of Lagrange's character appear indeed to have placed him entirely outside the reach of priorities or envy.

Young's work collided with the dogmatism of Laplace also in another domain. A particularly attractive and engaging episode in the history of science is the friendly rivalry of Young with his youthful French contemporary Fresnel, in exploring the mysteries of double refraction by crystals, which it is a great merit of Peacock's biography to have brought out from the original letters. A sentiment relating to these problems, with which Young had wound up an earlier exhaustive classical article "Chromatics" ("Encyc. Brit." 1817: 'Works', 1, 342), merits quotation as not inapplicable to cognate mystifications in the modern world of physical speculation, especially as its pessimism was so soon to be wholly dissipated:—

"and the greatest difficulty of all, which is to assign a sufficient reason for the reflection or non-reflection of a polarized ray, will probably long remain to mortify the vanity of an ambitious philosophy, completely unresolved by any theory".

However, Laplace had proceeded to annihilate in advance both Fresnel and Young by an elaborate deduction of double refraction from the orbital dynamics of Newtonian light-corpuscles, by an application of the general Lagrangian doctrine of Least Action: a most astonishing analytical performance, which was promptly demolished with some heat by Young, by the acumen of simple direct reasoning, and in the first instance in the popular *Quarterly Review* of all places. Here again contemplative insight asserted its mastery, as regards general ideas, over merely formal algebraic development. But this remonstrance in turn betrayed Young into a characteristic depreciation (vol. 2, p. 567, deprecated by Peacock), with scarcely a word of recognition of the beauty of the processes, of the method of variations, Lagrange's earliest and most fruitful discovery, which has largely been the path of analytical progress in modern physical science.

"The steps of the method are generally simple and easily understood, at least they may and ought to be rendered so: but the merit of the invention is none the less because it admits of a very ready application and because it might have occurred to a less distinguished mathematician."

There are many other indications of Young's intuitional acquaintance, often lucid and informing, with the nascent general Continental analysis, which he was even at some pains to dissemble.

About half the second volume of the "Lectures" is occupied by a catalogue of the mathematical and physical sciences of the eighteenth century, which had completely occupied its author for three years: he obviously had examined at first hand all the works of the masters, as is evidenced by the rapid remarks, often very illuminating, sometimes deprecatory of the delay in reaching concrete results, which he appends. For his instincts were Newtonian, aiming directly at a general view of the order of Nature. But though the modes of thought born out of direct wide contemplation of Nature appeared to advantage as against the mode of early translation into abstract algebra, yet the Newtonian procedure in its other aspect, inevitable in his day, of special calculations *ad hoc*, failed, at times conspicuously as Young's work was often to illustrate, in elegance and in interest even when effective in reaching a result. Such provisional procedure could never have originated the brilliant indirect algebraic analysis, going far beyond immediate objects, and opening up novel intuitional fields of thought, which had perforce to be constructed gradually, long after Newton, for the progress to minuter detail of the relations of dynamical astronomy, the most coherent and exact of the sciences and historically a pattern for them all. No such authoritative catalogue, even of the select classical works of modern science, of personal origin, is likely to appear again.

This example of the impatience of Young contrasts with the eager personal appreciation of the algorithm of variations, in personal correspondence with Lagrange, then less than twenty years of age, by Euler, the greatest analyst of modern times, who had been himself engaged not very effectually, also on a physical basis, with the same range of problems. Of course, like all fruitful ideas, this principle reduces to a manageable simplicity once it is carefully systematised. Thus in arithmetic the supreme discovery of the Hindu philosophers, of a decimal scale, nine digits and a zero, with values determined by position, which now every child must learn, became, when passed on to the Western world through the Arabs, the starting point which rendered possible all progress in scientific calculation: and the doings of Pascal with a Torricellian vacuum tube on the Puy de Dôme promoted, perhaps completed, the consolidation into common form of the originally intricate Archimedean notion of fluid pressure. So too the mere notational scheme, or algorithm, of the variational method was a new jumping-off point for the mathematical physical analysis from which it had derived its inspiration: though the formal Calculus of Variations may be now wandering, in hope doubtless of ultimate consolidation, into complexities of functionality far removed from the smoothness which is sufficient for applications to atomic structures, unless as in quantal theory finite variations have to come into account. It is not surprising that Young was strenuous as to the superiority for educational purposes of logical study and illustration of general elementary principles taken over a wide range, prior to any undue premature absorption into specialisations for which a life-time would later be available. Thermodynamic concepts are an uncompleted modern instance of the transition from abstruse to elementary.

This is scarcely a suitable occasion to refer to

Young's extensive professional writings in the nascent sciences of medicine, which, perhaps not unjustly on the whole, have become neglected. But his Croonian lecture, unearthed from them by Peacock, as delivered to the Royal Society soon after he had got the two volumes of "Lectures" off his hands, dealing with propagation in the arteries, in relation to the elastic pulsation through the perhaps perfect elasticity which surely must in the final causes of the organic world subserve some function, was a subject of pure hydraulic science in which he became, afterwards at any rate, very competent, with regard to which the last word has perhaps scarcely yet been said.

Young was also closely and most effectively, yet as usual most concisely, concerned with the problems of geophysics, such as the tides and the figure of the earth, also with the statistical doctrines of insurances and the duration of life: the former from his prominent official connexion with the Board of Longitude, the latter from his position as adviser to a life insurance society.

A judgment, near the end of his life ("Biography", p. 483) on the merits, as regards fruitful discovery, of various modes of intellectual training and investigation, is characteristic and perhaps still authoritative. Dr. Young's opinion was

"that it was probably most advantageous to mankind, that the researches of some enquirers should be concentrated within a given compass, but that others should pass more rapidly through a wider range—that the faculties of the mind were then exercised, and probably rendered stronger, by going beyond the rudiments and overcoming the great elementary difficulties, of a variety of studies, than by employing the same number of hours in any one pursuit—that the doctrine of the division of labour, however applicable to material products, was not so to intellect, and that it went to reduce the dignity of man in the scale of rational existences".

His own astonishing scientific record, combined with very remarkable erudition in classical literature and general philology, and even with an assiduous cultivation of the Graces which in early life tended to make up for the austerities of a Quaker training, forms a remarkable example, surely nearly unique, of what can be achieved by mental industry, working largely inward on itself; and, one may add, it offers an incentive to the biographical exploration, as a chapter in the newer psychology, of the methods of thought of the pioneers in discovery, which in our nation has been none too keen.

Infra-Red Photographs of Racial Types

By PROF. C. G. SELIGMAN, F.R.S.

MORE than a year ago, I received from Mr. L. Bloch, of the Ilford Research Laboratories, a number of photographs—'couples' of dark-skinned subjects, all or mostly negroes—taken by ordinary and by infra-red light. The difference in appearance is very remarkable: on one hand the normal photograph, on the other such striking modification in colour of face and often pattern of clothing that a close examination is necessary to realise that the two prints are photographs of the same subject. The most remarkable feature is that under the infra-red rays the normal dark skin of the negro appears of a waxy white pallor. This is so striking and renders the two photographs of the same face so unlike each other that the suggestion was made that the infra-red photographs exhibited Mongoloid characters not obvious in the prints taken under normal conditions. This, however, is not so, nor are any Mongolian characters observable in the infra-red prints of a much longer series of negroes and other 'coloured' men which have recently been submitted to me. The idea perhaps originated in the somewhat deep-set appearance of the eyes seen in many subjects in the infra-red prints. Examination shows that this is an expression of the obliteration in the infra-red photographs of a considerable amount of the finer facial modelling, due largely to the loss of shadows and the finer gradations of tint. Those who have not a series of photographs for reference will best appreciate the change by examining a photograph published by Dr. S. O. Rawling*, in which oranges, apples, tomatoes, and dark cherries, on a plate with a polychrome design, appear as if the whole were modelled in pale-coloured wax, no trace of the design being visible.

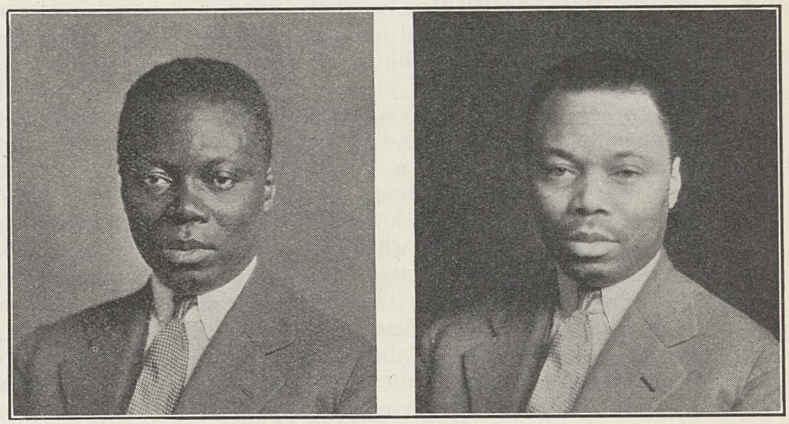

FIG. 1. Photographs with panchromatic (left) and infra-red (right) materials of a West African Negro (Temne). Note the waxy pallor of skin and lightening of irides; there is absence of the finer modelling but the unirrupted hairshafts show up through the superficial layers of skin.

There are two interesting and curious features

* "Infra-red Photography" (1933), p. 34.

in these infra-red photographs of coloured men, though neither is of racial significance (Fig. 1). Owing to the general lightening of colour, even the darkest eyes appear light; their irides as seen in the infra-red print appear of the same colour as blue-grey eyes in normal photographs. The other peculiar feature is that it is often possible to trace the appearance of a beard and moustache in prints of clean-shaven men, due to the human skin having its maximum transmission in the region of the infra-red, so that the hair follicles with their contained hair shafts show up as darker shading.

FIG. 2. Photographs with panchromatic (left) and infra-red (right) materials of a white girl (Nordic type); hair, very fair; eyes, blue-grey; complexion, very fair; wearing blue and white striped jumper.

In the photographs of the white race, relatively few in number, some of these results are reversed (Fig. 2). There is the same waxy pallor of the skin in the infra-red prints, and freckles are obliterated, but the eye colour changes in the opposite sense. Instead of being lightened, eyes described as blue appear dark, so as to suggest deep hazel or medium brown. On the other hand, in an infra-red print of a man whose eyes are described as brown, the irides are if anything a shade lighter than in the normal photograph, thus approaching the lightened colour of infra-red prints of the eyes of the dark races. The normally dark eyes of a Japanese appear in the infra-red print about the same shade as the blue-grey eyes of a typical Nordic. In Europeans the less dark shades of hair may appear considerably lightened, just as the leaves of trees present a white, almost frosted, appearance in infra-red photographs.

To sum up: the differences in the normal and infra-red photographs of the varieties of *Homo*, though striking at first sight, do not appear to present any features likely to be of use to the anthropologist; they are, indeed, of photographic rather than anatomical interest.

Heavy Hydrogen*

By SIR J. J. THOMSON, O.M., F.R.S.

THIS lecture is on reminiscences connected with the Royal Institution, so that accounts of quite recent discoveries would not be within its scope. There is one subject, however, which is now attracting a good deal of attention—heavy hydrogen—which satisfies both conditions; it is a reminiscence and it is connected with the Royal Institution. In 1911 I gave a Friday evening discourse "On a New Method of Chemical Analysis". By this method each kind of gaseous particle in a vessel through which an electric discharge is passing produces its own parabolic curve on a photographic plate. Thus if the vessel contained a mixture of hydrogen, oxygen and nitrogen, there would be six parabolas corresponding to the atoms and molecules of hydrogen, oxygen, and nitrogen respectively, along with others due to each of the compounds formed by these elements. The mass of the particle which produces any parabola can be determined from the position of the parabola.

Using this method, I detected the presence of a parabola which must have been produced by a particle of mass 3 (the mass of the hydrogen atom being taken as the unit). I obtained it first when the gas in the discharge tube was hydrogen prepared in the ordinary way, but its appearance was very capricious, and only occurred in a small percentage of the experiments. I found, however, that if instead of using ordinary hydrogen, I used the gas given off by certain solids when bombarded with cathode rays, the (3) parabola appeared with great regularity. The amount of the gas producing it varied with the nature of the solid bombarded, but there were few minerals or salts among those I tried which did not give traces of it; potash (KOH) is a very convenient source and a specimen of black mica given to me by Sir James Dewar gave an exceptionally large supply.

I obtained the active gas also by deflagrating a very thin wire by passing a very large current through it, or even by raising a wire to bright incandescence. This indicates that the bombardment by cathode rays does not manufacture the gas but merely liberates it from the solid.

I made a very large number of experiments on the gas obtained in this way, the results of which were published in the *Philosophical Magazine* and summarised in my book "Rays of Positive Electricity" (Longman). One important property of this gas is that it can be stored after bombardment and tested long after it has been produced, showing

* From a Friday evening discourse delivered at the Royal Institution on February 9.

that it is a stable gas and can exist in an uncharged state. In fact, the persistence with which it clings to the walls of the discharge tube and the cathode makes experiments troublesome, as when once the tube has been used for this gas, it will continue, after the gas has been pumped out and replaced by another of a different kind, to show the (3) parabola; long sparking with oxygen in the tube is required to get rid of it.

I made many tests of the chemical properties of this gas and found that under them it behaved like ordinary molecular hydrogen. Thus, for example, it disappeared after vigorous sparking in the presence of oxygen, or when passed slowly over red hot copper oxide; again like hydrogen it can pass through red hot palladium; and there was evidence that when an electric discharge was passed through it, some of its molecules were split up into a positively charged hydrogen molecule and a negatively charged hydrogen atom.

Through the kindness of Lord Rutherford, I have had the opportunity of examining by the positive ray method samples of 80 per cent concentration of heavy hydrogen prepared by recent methods. Very interesting photographs obtained with heavy hydrogen of less concentration have been published by Prof. P. Zeeman. So far as I can see, the heavy hydrogen behaves in just the same way as the form of hydrogen obtained by bombarding solids. With these high concentrations, so much heavy hydrogen adheres to the walls of the tube, that instead of trying to get rid of it by bombarding with oxygen, it saves time to make a new tube for each experiment. Again, with the highly concentrated gas, I found, as Prof. Zeeman had done, parabolas corresponding to H_4 and H_5; in my early experiments a parabola (4) was frequently seen along with H_3. I ascribed it to helium and probably some of it was due to this source, but now I think part of it was due to H_4; on a few occasions, too, I observed a line corresponding to H_5. The evidence seems to me to leave little doubt that the gas I called H_3 more than twenty years ago is the same as that which is now called heavy hydrogen.

I said in "Rays of Positive Electricity" that from my experiments I suspected that there might be two kinds of H_3; this surmise is confirmed by the fact that many chemists who have experimented on tri-atomic hydrogen have come to the conclusion that it has a life of only a minute or so, and can only exist when charged with electricity. So far as I know, they all used hydrogen prepared in the usual way and not that obtained by bombarding solids; there is not the slightest doubt that the H_3 obtained in this way is stable and can exist uncharged.

I think the effect of the solid is due to its adsorbing a mixture of gases including H_2 and H_3, and that when it is bombarded, relatively more H_3 than H_2 comes off from the adsorbed layers. Thus the mixture that comes out is richer in H_3 than the mixture in the gas adsorbed by the solid.

Obituary

Sir William Hardy, F.R.S.

THOSE who enjoyed Hardy's friendship, and even those who could hope for no more than occasional contact with him, will deeply feel the loss of a strong and vital personality radiating an influence which stimulated effort, cured discouragement and could reawaken flagging enthusiasms. Hardy entered into everything he did with zest, and this seems to be the word which adequately describes his own attitude to life. He met each successive experience with fresh interest, and brought his whole nature to the appreciation of whatever it offered of value. His enjoyment of intellectual pleasures was itself almost sensuous, while his delight in the beauties of Nature, or in the appeal of fine pictures and music, was always mingled with—and, for him, intensified by—the intellectual reactions they evoked. Life's minor pleasures appealed to him and he loved a good wine, and a good story, in the telling or the hearing, and he enjoyed both best in good company.

Surpassing Hardy's many other enthusiasms was —as all his friends knew—a passion for the sea and the adventures it provides for all good sailormen like himself. Research stood high among his pleasures; he would literally smack his lips over some happy occurrence in a test tube, but probably the highest note in the gamut of his enjoyment was evoked by a boat with full sails, a spice of danger, and with the good ship answering to his hand on the helm.

Some insistence upon this lusty side of Hardy's temperament is essential to any proper understanding of him as a man; but while he savoured all pleasures so keenly, his outlook was far indeed from that of the mere hedonist; his life was full of serious purpose, and no less full of accomplishment and service.

I myself came first to know Hardy in 1898, when he was in his thirty-fourth year. His scientific training had been that of a biologist, and at this time he was on Michael Foster's staff in the Physiological Laboratory at Cambridge. He was, in particular, responsible for the teaching of histology to the advanced class, and had engaged in histological research. He had published, alone and with others, several papers describing highly original work on wandering-cells, and *inter alia* on the nature of the attack of oxyphil blood cells on bacteria.

Just before I became a member of the Cambridge staff, Hardy had convinced himself that current histological methods were employed with too little discrimination, and that many of the structures supposed to be characteristic of protoplasm were no more than artefacts produced by the action of

reagents during the preparation of tissues for the microscope. Once assured that this might well be the case, he set himself with characteristic energy to investigate the matter. He was thus led to study aspects of the colloidal state in relations but then little known, and to deal with problems remote from his previous experience. He worked with the simplest of equipments, yet he rapidly brought significant facts to light. I was fortunate enough to occupy a room adjacent to his, and witnessed the progress of his research and the joy it gave him.

In 1899 Hardy published two classical papers "On the Structure of Cell Protoplasm" and "On the Coagulation of Proteid by Electricity". These titles do not convey the full significance of the work they describe. The clarity with which the existence of two types of colloidal dispersion was demonstrated, and the precision the work gave to the relation between electrolytes and colloids with its dependence upon ionic and micellar charges, together with other points of much importance described in these publications, made them extraordinarily influential. They stimulated work by scores of others and greatly accelerated the progress of colloidal chemistry.

Hardy retained to the end of his life an interest in this and kindred aspects of knowledge. He was specially curious as to the nature of the protein equilibrium in blood, and in the precise nature and meaning of the globulin fraction. Had he lived to deliver his address as president of the British Association, I believe that part of it, at least, was to be devoted to the results of his later thought on such questions.

The period of Hardy's researches to which I have been referring was of much significance to him. It led to his general interest in physical chemistry, and determined a direction for much of his later thought and work, his highly original dealings with the influence of chemical constitution on surface tension, for example, and the later developments which followed upon them.

In his earlier days as a physiologist, Hardy did not especially concern himself with metabolic phenomena, or with nutritional questions. The formation and management of the Royal Society Food (War) Committee, which fell to him as the biological secretary of the Society, awakened his interest in such matters and prepared him for the important work he was to do in later years as chairman of the Food Investigation Board.

Hardy's mind was but little trammelled by tradition, or even by the orthodox views of the day. His thought always worked on original lines. He was indeed no industrious reader of current scientific literature, seeking rather for the known facts whenever he wanted them for a specific purpose. This circumstance, and the great variety of his interests, together with his constant choice of the simplest possible technique in research, displayed qualities more often possessed by brilliant amateurs than by professional workers in scientific fields. One of the reasons for the success of his highly personal work was the freshness of mind that he brought to every problem, and the ingenuity with which he contrived his own simple, but adequate, experimental methods.

Hardy's genius had free play in the laboratory, and pure science has doubtless suffered from the fact that his latest years gave but little opportunity of displaying it there. One would be rash indeed, however, to suggest that he should have been spared from the administrative duties which he fulfilled so admirably and so greatly to the advantage of his country.

F. GOWLAND HOPKINS.

BY the death, on January 23, of Sir William Bate Hardy, at his home in Cambridge, in his seventieth year, science has lost a great captain and Great Britain a great public servant.

Hardy was educated at Framlingham and at Gonville and Caius College, Cambridge, where he was elected to a fellowship in 1892. He was Shuttleworth scholar in 1889, and Thurstonian prizeman in 1900. He was first and foremost a biologist, taking zoology in the Tripos, and then turning to physiology, and particularly to histology, a subject which he taught and in which he did research in Michael Foster's laboratory. To the end of his life he never lost his love of the microscope, and it is not many years since that he spent uncomfortable hours at a temperature of $-12°$ C. in one of the cold chambers at the Low Temperature Research Station, following through the microscope the process of freezing in gels.

From histology Hardy passed to the study of the colloidal state, a field then new and one in which he did pioneer work. No event in later life gave him more pleasure than to take part in the meeting at Cambridge in 1930 called by the Faraday Society to discuss the biological aspects of colloidal science. His scientific interests constantly broadened, and turning to the problems involved in action at surfaces, he entered the field of lubrication, and became a recognised authority on boundary conditions, contributing an article on the subject to the "Dictionary of Applied Physics". He was also Chairman of the Lubrication Research Committee of the Department of Scientific and Industrial Research.

The work for which Hardy was best known was, however, that which he did from 1917 onwards in the service of the Department of Scientific and Industrial Research as first chairman of the Food Investigation Board and as Director of Food Investigation. Here he found a new field that gave full scope for the exercise of his truly remarkable powers as leader and inspirer of a team of research workers, as advocate of the need for more science in industry and as apostle of co-operation in research between the members of the British Commonwealth of Nations. It was appropriate that the direction of the work should

be in the hands of a biologist, for Hardy was never tired of stressing the logical priority of biology over engineering where the transport and storage of food is concerned.

Research, to Hardy, meant essentially the untrammelled research of the university laboratory, carried out to satisfy that intellectual curiosity that he himself displayed so pre-eminently, and he never wavered in his conviction that no solution of a practical problem was worth while unless it was based on an adequate knowledge of the fundamental science that lay behind it, and therefore that it is the man with a sound training in academic research who is best fitted to unravel the practical problem and reach that solution. The work described in the annual reports of the Food Investigation Board, and in the numerous other publications that came from his three research stations, the Low Temperature Research Station, the Torry Research Station and the Ditton Laboratory, bears witness to this insistence on fundamental research; and the success he had in solving practical problems and in gaining the confidence of the whole food industry were his complete justification. Such achievements as the gas-storage of fruit, the long-range transport of chilled beef and the brine-freezing of fish were not fortuitous, but rather the inevitable outcome of much patient work of a fundamental character.

Hardy, however, was not one-sided. While he unerringly picked men capable of academic research, and saw that they had the opportunity and the means of doing it, he equally insisted that they learn the practical details of the industry they served, for he knew that only so could they gain the confidence of industry and, when the time came, apply their academic knowledge to the greatest advantage.

To-day, when the storage and transport of foodstuffs is so rapidly being put on a sound scientific basis, and when new developments are taking place in all directions, it is fascinating to go back and read the original memorandum which he, Sir John Farmer and Sir William Bayliss prepared in 1917 for the Advisory Council for Scientific and Industrial Research. One marvels that one man in so few years could achieve so much, and one realises Hardy's tremendous power. The original membership of the Food Investigation Board was strong; it comprised Sir Kenneth Anderson, Sir Joseph Broodbank (Hardy's successor in the chair), Sir Walter Fletcher, Sir Thomas Mackenzie, Sir Richard Threlfall and Prof. T. B. Wood. What they thought of him may be illustrated by a remark of Threlfall's—"Hardy, you must treat us like your umbrella—to be kept rolled up out of the way, and brought out only when a storm comes".

Hardy's other great interest in later years was marine research. On his advice, the Development Commissioners appointed an advisory committee for fisheries research under his chairmanship. This committee drew up a programme which was adopted by the Commissioners, whilst at the same time the committee was made permanent and for nine years Hardy remained its chairman. The breadth of his view and his practical knowledge, as well as his personal familiarity with the special difficulties of work at sea, were of inestimable value. His penetrating understanding of their work and his constant help and sympathy were a source of inspiration to the biologists and hydrologists engaged in the investigations. Especially he realised that no practical results could be looked for until a large amount of fundamental research had been done, not only on the life-histories of the marketable fishes themselves, but also on the physical and biological conditions under which they lived. Not only the changes in the chemical constitution of the sea-water from season to season and from year to year, the variations in tides and currents, the influence of light, must be known, but also the inter-relations of the whole flora and fauna which form the fundamental food of the fishes require detailed study. This work throughout had his earnest support and sympathy.

Many honours came Hardy's way, and he wore them with the simplicity that characterised his whole life. In the academic sphere, he was elected a fellow of the Royal Society in 1902, served as secretary from 1915 until 1925, and was Royal medallist and Croonian and Bakerian lecturer of the Society. Oxford conferred on him the honorary degree of D.Sc., and Aberdeen, Birmingham and Edinburgh that of LL.D. In 1931 he was invited to the United States of America and delivered the Abraham Flexner lectures at Vanderbilt University. At the time of his death he was president of the British Association for the Advancement of Science. In the wider sphere he was a member of the Economic Advisory Council, and of the Advisory Council for Scientific and Industrial Research, president of the British Association of Refrigeration, a Trustee of the National Portrait Gallery, and a member of the Governing Body of Charterhouse and of the Leverhulme Trust Committee. He was knighted in 1925.

Hardy's lay interests were as varied as his scientific interests. Salt-water sailing was a passion with him, and he owned a succession of small yachts which he sailed regularly. He was a good naturalist, with a wide and intimate knowledge of plants and birds. Music and archæology also claimed his time. Bridges' "Testament of Beauty" became his constant companion on its publication, and he was an enthusiastic 'Janeite'.

Hardy was a big man in every way. Big in body, with a fine head and big, capable, sensitive hands—craftsman's hands; instinctively one knew him incapable of anything small or mean. With this bigness went utter simplicity and honesty of purpose, an inexhaustible fund of enthusiasm and great warmth of heart; such a combination was irresistible.

He married in 1898 Alice Mary, daughter of Mr. G. B. Finch, who survives him, with his son and his two daughters.

News and Views

The King of the Belgians and Progressive Science

A GREAT figure of the War has passed away with the death on February 17 of Albert I, King of the Belgians, at the early age of fifty-eight years. For nearly twenty-five years he guided his people faithfully, carrying them with him through the War years, urging them on and directing their progress during the not less uncertain years following the Peace of Versailles. His work in the political field has been set forth in many places. We are concerned here with his interest in science and scientific research, of which he was a convincing advocate. He played an active part in the development of scientific institutions in Belgium. The protection of flora and fauna, particularly of tropical regions, early attracted his attention, and in 1909, after a visit to the Congo, he put forward a plea for protective measures which culminated with the creation, in 1929, of the Parc National Albert, a nature reserve of nearly 1,400 square miles. So recently as 1932, King Albert visited the Kivu Park with Prof. V. Van Straelen in order to see for himself the effectiveness of the protective measures.

KING ALBERT'S name will also be associated with the "Fonds national de la recherche scientifique" in Belgium. Speaking at the one hundred and tenth anniversary of the well-known Cockerill iron and steel works at Seraing in the autumn of 1927, the King declared emphatically that pure science is indispensable to industry, and that the nation which neglects science and the savant is marked for decadence. The appeal had an immediate effect. A great gathering was held at the Palais des Académies, Brussels, which was attended by the King, Ministers of State, and representatives of industry, finance, politics, science and the universities. Again King Albert made a powerful plea for science, poor herself but the creator of riches, for security and independence for scientific workers in order that they might devote themselves entirely to their studies; then he announced the creation of the "Fonds national", to which he invited industrial and financial interests to contribute. King Albert was well known in Great Britain, and on a recent visit, his enthusiasm for scientific research led him to spend an afternoon examining the treasures of the Royal Institution, after which he enjoyed a 'laboratory' tea with Sir William Bragg and members of the staff, and watched some experiments with liquid air in illustration of the late Sir James Dewar's work.

History Made in Germany

IN another column of this issue of NATURE (see p. 298) is a translation of an official circular, issued to all education authorities in Germany by the Minister of the Interior, on the teaching of prehistory and history, which contains 'directive ideas' to be followed in historical instruction and to serve as a standard in the adoption of textbooks. The directions in the circular deal first with certain 'points of view' which "hitherto have been considered inadequately, if at all", and secondly, give an outline of the manner in which the theory of Nordic racial and cultural supremacy is to be applied in dealing with the course of events from the earliest times to the present day. The study of 'race' and 'culture' are to be made to subserve the German nationalist idea, while the heroic legends will quicken the emotional appeal of leadership in present-day 'national assertion'. From the point of view of prehistoric and historical science, the contents of this document are astonishing. It is scarcely necessary to point out that the racial and cultural unities which are to be made the basis of the modern German nationalist State are non-existent in point of fact, but rest on misstatement or misinterpretation. If, however, these 'directive ideas' appear too biased, too frankly propagandist, to call for critical examination from the point of view of ethnology, archæological science, or history, they must none the less be regarded as symptoms of a grave condition of thought. The circular suggests that Germany is prepared to abandon all standards of intellectual honesty in pursuit of a political ideal, which, it may be noted, it is hoped to impose on all 'Nordic' peoples.

Prof. Harold C. Urey

PROF. HAROLD C. UREY, of Columbia University, has been awarded the Willard Gibbs medal of the Chicago Section of the American Chemical Society for his discovery of 'heavy water'. Prof. Urey, at the age of forty-one years, is the youngest man ever to receive this honour. He was born in Walkerton, Ind., on April 29, 1893. In 1917 he was graduated from the University of Montana with the degree of bachelor of science in zoology. In 1923 he received the Ph.D. degree in chemistry from the University of California. He received an American-Scandinavian fellowship for research in 1923–24, studying under Prof. N. Bohr at Copenhagen. He was assistant in chemistry at Johns Hopkins University in 1924–29, and has been associate professor of chemistry at Columbia since 1929. The Willard Gibbs medal, founded by William A. Converse in 1911, was named after Josiah Willard Gibbs, professor of mathematical physics at Yale University from 1871 until 1903, who, although not primarily a chemist, did much to advance the science of chemistry. It is awarded annually by the Chicago Section of the American Chemical Society to a scientific worker "whose work in either pure or applied science has received worldwide recognition". The award is determined by a national jury of men of science. The first Gibbs medallist was Svante Arrhenius of Sweden.

Constitution of the Stars

THE fourth Rickman Godlee lecture was delivered at University College, London, by Sir Arthur Eddington on February 16. Lord Dawson of Penn presided, and paid a tribute to Rickman Godlee's great pioneer work in the surgery of the brain and

to his wide range of interests in scientific work and in affairs. Sir Arthur Eddington took as his subject the "Constitution of the Stars". He reminded the audience that the problem of the constitution of the stars was first set forth in a paper, with a somewhat strange and comprehensive title, published by Lane in 1869. Since then, many attempts have been made to compute the temperatures existing deep inside the huge celestial furnaces. Thus, in the case of the sun, whilst the measured temperature of the photosphere is six thousand degrees, the computed temperature at the centre is twenty million degrees. This central region is now considered to be constituted of swarms of protons and stripped atoms moving at speeds of hundreds of miles per second, of swarms of electrons moving at ten thousand miles per second, and an enormous quantity of X-radiation which is mainly responsible for the permanent shape of the sun. Because of its nature, the energy of this radiation can only leak away slowly, by a stepping-down process.

OWING to excessive ionisation, the average mass per particle in the middle of the sun is only two units, unless a considerable quantity of hydrogen is present. We have to know the average mass per particle in order to calculate the temperature at the centre. Sir Arthur said that he first made a reservation concerning the effect of hydrogen in 1927. It is now possible to measure the mass and the absolute brightness of a star and to say with some degree of certainty how much hydrogen it contains. In 1934, a further reservation is necessary because of the discovery of the neutron, for if neutrons were present to the extent of five per cent in the constitution, the material heat of the sun would be rapidly lost by conduction. However, it is felt that the properties of neutrons are not yet sufficiently established to make predictions, and, in any event, they can probably only exist inside atomic nuclei when near the centre of the sun. Sir Arthur also discussed the significance of recent experiments on artificial disintegration, which suggest a means by which the energy of the sun is replenished, namely, by the absorption of protons in atomic nuclei. This means that the temperature of the centre cannot rise much above ten million degrees so long as appreciable amounts of hydrogen are present.

REFERRING to the "gaseous mass" postulated in Lane's paper, Sir Arthur Eddington pointed our that the sun obeys laws deduced for perfect gases, because of the huge compressibility of the stripped atoms inside the furnace. Densities some thousands of times greater than that of the earth are thus possible, and, indeed, are actually found to exist, for example, in the case of the dark companion of Sirius. Moreover, an application of the Pauli exclusion principle shows that such extremely dense matter must be cold, as is the companion of Sirius. Thus, although we seem farther away than ever from a solution of the problem of the evolution of the universe, Sir Arthur suggested that, since we are now able to formulate problems which were not even suspected ten years ago, we can more adequately measure our progress by the problems we are able to present for solution rather than by those we are able to solve.

Oil from Coal in Great Britain

OIL from coal was the subject of a debate in the House of Commons on February 8, when the British Hydrocarbon Oils Production Bill was read for the second time. The Bill proposes to give a preference of 4*d*.–9*d*. a gallon on oil derived from British coal, peat and shale. The exact amount of the preference will depend on the customs duty payable on imported material, or on the difference between it and any excise duty. The duration of the preference will depend on its amount: at the minimum rate of 4*d*. a gallon it will operate for nine years, or, at 9*d*. a gallon, for four years. The Secretary for Mines (Mr. E. Brown) reported that the Government announcement of policy has already been followed by industrial developments. Imperial Chemical Industries have started the erection of a plant at Billingham for the annual production of 100,000 tons (30,000,000 gallons) of motor spirit by the hydrogenation of coal. A substantial increase is also shown in the amount of benzol obtained last year from gas works and coke ovens, as well as in the quantity of motor spirit from shale oil and low temperature carbonisation processes. More than 10,000 men have been put into employment already in connexion with the Billingham plant, and, in operation, it will absorb 1,280 men, and, in addition, some 1,200 miners for the production of 350,000 tons of coal a year. The actual cost to the Treasury of the production of 100,000 tons of oil under the new preference will, it is estimated, be about £1,000,000.

Economic Issues in Hydrogenation

THE debate on the Bill referred to above brought forward a number of criticisms of the scheme. The opinion was voiced that the enterprise should be State-owned and directed, and also that the developments should be planned so as to assist the more depressed mining areas. It was also pointed out that hydrogenation has been in progress for a number of years in Germany, where very cheap lignite is available. In spite of a similar preference granted in that country, the synthetic petrol manufactured there in 1933 was less than the amount which is to be produced in Great Britain under the new scheme. Both the technical and the economic success of the process were, in fact, questioned. The motor-car industry is also faced with developments in heavy-oil engines of the Diesel type, which may in time displace light-oil engines and lessen the demand for petrol. A strong case was put forward, however, for the founding of this new industry as a means of utilising British coal resources more efficiently, and also for the covering of the requirements of national defence.

Research on Foul Brood Diseases of Bees

BY co-operation between the bee keepers of England and the Agricultural Research Council,

financial arrangements have been made to carry out at the Rothamsted Experimental Station, an investigation of foul brood diseases of bees, which have hitherto caused considerable trouble and loss. Dr. H. L. A. Tarr has been appointed investigator. Dr. Tarr is a graduate of the University of British Columbia and McGill University, and since 1931 he has been working at bacteriological problems in the Biochemical School at the University of Cambridge. Foul brood diseases were investigated in England nearly fifty years ago by Cheshire and Cheyne, and in more recent years by workers in the United States, Canada and on the Continent, but in spite of all that has been done, little is known about the cause of the diseases and still less as to how to avoid or cure them. The bee keepers, through the British Bee Keepers Association, have now agreed to raise half the money necessary for the investigations, and the Agricultural Research Council has undertaken to contribute the other half. As a result, a sum of £500 a year is now available for the study of foul brood. It is hoped that the work will continue for a period of at least three years, starting early in March 1934 under the general direction of Dr. C. B. Williams, head of the Department of Entomology at Rothamsted, with the co-operation of Mr. D. M. T. Morland, apiarist. Some of the more purely bacteriological side of the work will be carried out at the Lister Institute in London. Rothamsted Experimental Station will be advised on the practical side of the work by a small expert committee of bee keepers. Further contributions towards the cost of the investigations will be welcome.

National Importance of Scientific Research

REVIEWING the organisation of industrial research in Great Britain and other countries in an article in the *Draughtsman* of December entitled "Research and Industry", Mr. G. Windred concludes that we are at present by no means in a leading position, due perhaps to the curtailment of research expenditure in almost every direction, consequent upon the reduction of Government expenditure and the unwillingness of commercial organisations to spend capital. Mr. Windred states that industry, as a whole, is not prepared to apply scientific research methods until their possibilities have been clearly demonstrated. "Such demonstration can be effected only with the aid of research experience which must involve considerable expenditure, such as other countries have in general been willing to provide". The author reminds us that in the various departments of pure science, Great Britain holds a premier position which must prove of great assistance in the work of applying scientific principles to industrial improvement, and pleads for increased opportunities for industrial research. Assuredly, in this era of world-wide industrial progress, we can no longer afford to suffer the accusation that, however important are our fundamental discoveries in pure science, we yield pride of place to others in their application.

PUBLIC interest in the national importance of scientific research has recently been stimulated in Germany by a series of publications which are intended to awaken all classes to a realisation of the material benefits involved, and to counteract the tendency for too stringent economy in scientific work. These publications, which are written in non-technical language, are sponsored by scientific and educational associations of high standing. In the United States there are said to be more than 1,500 well-established research organisations, and the expenditure of American industry in support of these research laboratories has been assessed for the year 1931 at no less than 235 million dollars. The activities of the Mellon Institute of Industrial Research of the University of Pittsburgh are too well known and appreciated in Great Britain to require more than a passing reference. As regards Russia, Mr. Windred has no doubt that the plans for scientific reconstruction in that country have the strongest scientific arguments in their favour. He devotes considerable attention to the work of the British Science Guild, which was founded in 1905 by Sir Norman Lockyer. The following statement, which the Guild has included in the announcement of its aims, objects and activities, is so manifestly pertinent to the conditions of to-day that it deserves the widest possible publicity: "The most urgent practical need to-day is the promotion of the spirit of unity among all classes through the alliance of Science, Invention and Labour, working as a single force for national development and common welfare. Science discovers; Invention applies; Industry produces. No nation can occupy a place in the van of modern civilisation unless the three legs of this tripod form strong and secure supports for all its constructive activities".

Recent Advances in Microscopy

MR. CONRAD BECK, in his presidential address to the Royal Microscopical Society on January 17, pointed out that the resolution of the microscope had reached at least 100,000 lines to the inch in the middle of last century, and this limit was extended by steady advances to nearly 140,000 by the end of the century, but the limit is now placed at a figure that is less than 1/300,000 in. In referring to dark ground illumination, he stated that while it was used with low and moderate powers almost from the time achromatic microscopes were first made, it is only in recent years that the refined apparatus required to use it with high power lenses has been produced. He remarked that this technique does not render differential staining less important and expressed his satisfaction that the Council of the Society has appointed a committee to study the stains and reagents used for microscopic research, and he suggested that, in addition to other matters, consideration should be given to the introduction of differential stains, particularly designed for dark ground illumination. As an example, he cited the anthrax bacillus which, stained with methylene blue, appears blood-red by dark ground, and hence there might be stains which would differentiate structure viewed by this means to a greater extent than can be done with transmitted light.

DARK ground illumination has not only doubled the resolution of the microscope, but also has more than doubled the visibility of small objects. The use of quartz lenses corrected for ultra-violet light involves photographing images, but as no direct method of focusing is satisfactory an indirect method has been devised. An object-glass was made suitable for visual observation with approximately the same focal length as the quartz lens and a perfect method of interchanging the two has been worked out. A slow motion fine adjustment that can be moved a definite amount with certainty to compensate for the small predetermined difference in focus, and capable of moving the lens with an accuracy of $\frac{1}{20}\mu$, is the chief factor in the success of the technique. In concluding, Mr. Beck referred to the high cost of the apparatus necessary and asked whether this type of work should not be carried on in endowed institutions, just as is modern astronomical work.

Boilers for Critical Pressure

A NOTABLE paper was read to the Institution of Electrical Engineers on February 15 by F. Ohlmüller on the Benson boiler and its development for use in power stations. Dr. Mark Benson came to Great Britain some years ago and with the help of the English Electric Co. carried out experiments on a 500 h.p. steam turbine built for the purpose of working with steam evaporating at the critical pressure (3,200 lb. per sq. in.). At this pressure the latent heat of water is zero. The water being heated to the critical temperature (706° F.) turns completely and instantaneously into steam. Unlike ordinary boilers there is no separation of steam from water. In the present design of the boiler, dry steam is produced with certainty in steel tubes. At the outset, many difficulties had to be overcome. The manufacturing rights are now the property of the Siemens-Schuckert Co. of Berlin. They have overcome the trouble experienced with the tubes at Rugby. They now manufacture tubular boilers for use both at the critical and at subcritical pressures. Tests showed that the burning out of the tubes was due to the precipitation of salts contained in the feed water on the parts of the tubes where the water changes into steam. This occurs in the zone where evaporation terminates and superheating begins. The remedy is to change the zone of deposit to a region of lower flue-gas temperature.

HITHERTO the pressure in steam boilers has been regarded as a constant dependent on its construction. The Benson boiler operates with high efficiency not only at the highest possible pressure and at lower pressures, but also with varying pressures, and this seems to open a new field of usefulness. In warships, for example, the fuel consumption must be low at cruising speeds but for temporary maximum speeds, amounting to a multiple of the cruising speed, the quantity of fuel consumed is of minor importance. For cruising purposes, therefore, a relatively low pressure of 300 lb. per sq. in. may be used, and by increasing the pressure, ten times the power output can be obtained. With merchant ships a uniform speed is usually required, but for manœuvring in ports and estuaries a variation of the boiler pressure offers the most economical means of varying the ship's speed. The Benson boiler seems very useful for many purposes. For stationary steam plants with widely variable load (peak load stations) and locomotives, it can be operated at pressures varying with the load. A cheap and simple turbine only is required and an approximately constant thermal efficiency at all loads is obtained. In erecting many generating stations, industrial plants and thermal stations, difficulties often arise owing to the uncertainty about the future load. With this new boiler an increase in the output whenever necessary can be obtained simply by raising the pressure of the steam, as the cost of adapting the turbine and piping to the new conditions is small.

Negro-Indian Crosses in Mexico

SPANISH settlers in Mexico and Central America appear to have taken an interest in the results of racial intermixture from early days. Several series of paintings in oils of seventeenth century date are in existence, of which each picture depicts a family of mixed breed, both parents and children, Spanish-Indian, Spanish-Negro and Indian-Negro, the characters being faithfully presented. The number of pictures in each series is usually five or six. One of the best is, or was, in the possession of the Hulse family, the tradition being that it was part of the dower of Dorothy Woodrow, who married the first baronet towards the end of the seventeenth century. The series was supposed to have been captured from the Spanish in a naval engagement; but some at least of the pictures obviously must be of later date. It is interesting to note that the evidence of cross-breeding as shown in physical characters is still to be observed in the descendants of these early admixtures.

A JOINT Mexican and Italian expedition which is now engaged in observation of the natives of the coast of Guerrero, southern Mexico, reports, according to a communication issued through Science Service, Washington, D.C., that not only do the inhabitants of this area show the traces of their descent from the Negro blood of colonial days in a complexion which is appreciably darker than that of the general run of the Indian population, but also the two communities of Indian and Negro blood hold aloof from one another, and show marked differences in temperament and custom. The natives themselves make use of no less than five terms to distinguish the degree to which the hair of the head shows the Negro character. The tight-kinked African hair is called 'cuculuxtle', an Aztec Indian word; hair tightly curled in ringlets, which shows a slight dilution of Negro blood, is 'chino'; the looser waves produced by a greater proportion of Indian blood is 'crespos'; and the 'pele quebrado', 'broken hair', is Indian hair which is only slightly waved.

Institute of Plant Industry, U.S.S.R.

A LIST of publications of the Institute of Plant Industry, U.S.S.R. from 1908 until 1931, compiled

by Windelbandt (Bibliographical Contributions No. 2, Institute of Plant Industry, Leningrad) supplies a long-felt want amongst applied botanists. Reorganisation and changes of title, which have at various times affected the Institute and its publications, have made it difficult for many to check the completeness of their sets of publications. The Institute of Plant Industry, as it is known to-day, uniting the activities of numerous research institutions and field stations, has evolved from the Bureau of Applied Botany founded in 1894. The serial numbering of the original *Bulletin* is maintained, and this list takes the *Bulletin of Applied Botany, Genetics and Plant Breeding* to the point where it is split up into three series, one of which is subdivided into thirteen sections. The list is published in Russian and in one other language, generally English or German, according to the language in which the summary or translation is issued. While German was used up to 1914, most translations now appear in English. An indication is also given in cases where the articles appear only in Russian, and also if the number is out of print. The list, which includes supplements and seed catalogues, has a wide interest. A large amount of work of a fundamental nature is included as well as the ordinary routine crop experimental work. The crops include tea, oil- and rubber-bearing plants, etc., in addition to the usual crops found in Europe.

Pelotherapy

Peloid, from the Greek πηλος (= mud), was adopted by the International Society of Medical Hydrology at its recent annual meeting in Switzerland as a generic name applicable to any naturally produced medium such as is used in medical practice as a cataplasm for external treatment. Such media are known in the various countries as boue, fango, gyttja, liman, moor, mud, peat, schlamm, etc., these names being used in confusion for both specific media and in a generic sense. The new word, with its derivatives *pelology* and *pelotherapy*, will avoid this confusion and allow the local terms to be defined and used in their restricted sense. The Society appointed an International Standard Measurements Committee, with Dr. S. Judd Lewis as chairman, to investigate the properties of these peloids, and they are now classified into groups as : (1) purely mineral ; (2) alluvial and marine, characterised by the organic matter being of the thallophyte type, as is the case with those permeated with algal, diatomaceous, bacterial and similar structures : (3) an intermediate group of terrestrial peloids ; (4) those of mainly vascular-vegetable origin, such as moors or peats from (*a*) mosses, (*b*) phanerogams, etc. ; (5) peloids mainly of marine vegetable origin ; (6) peloids derived from petroleum deposits ; and a detached group, 10, for 'artificial' or 'factitious peloids'. The Committee has now to consider the components—saline, mineral (geological), organic (for example, humus), vegetable structures, micro-organisms, etc. ; the physical properties—heat conductivity, heat capacity, plasticity, colloidal properties, radioactivity, etc. ; and the clinical indications.

First International Congress of Electro-Radio-Biology

WE have received a notice that the International Society of Radio-Biology, having its headquarters in Venice, is preparing to organise the First International Congress of Electro-Radio-Biology, which it is hoped will take place in that city in September next. It may be that there is room for an international society dealing with this subject, but a very considerable part of the programme would appear to come within the purview of the International Congress of Radiology which meets in Zurich in July of this year. It appears from the memorandum issued that a number of representatives from different countries will give lectures and speeches at this proposed Congress, but we regret to say that we do not see the name of a single British representative ; but other names, it is stated, will be added in successive communications, so that should the Congress take place, we hope to see some representatives from Great Britain take an appropriate part. Those who desire more detailed information are invited to apply to the temporary head office of the International Society of Radio-Biology, addressing their correspondence to : Dr. Giocondo Protti, Venice (Italy), Canal Grande—S. Gregorio 173.

A Map of the British Isles, 1603

IN the University of Göttingen there is apparently the only copy of a map of the British Isles published in 1603 by John Woutneel and engraved by William Kip. It is a large sheet cut into four and came into the possession of the University in 1735. A photostat of the map is now in the British Museum. In the *Geographical Journal* of December, Mr. E. Lynam gives some account of this map. Woutneel was a Flemish bookseller living in London and Kip was a Dutch engraver who engraved the thirty-four maps in Camden's "Britannia" (1607). England and Wales on Woutneel's map are copied from the second edition (1594) of the Hondius map and show different spellings and more names, some of which are taken from Saxton. Scotland is copied from the Ortelius map of 1573. Ireland is based mainly on the 1594 map, but seems to contain some original work. Mr. Lynam does not believe that this map was the general map of an atlas that embraced the anonymous county maps of 1602–3, which do not appear to be Kip's work. It is not a good map. Mistakes are numerous and there is evidence of hasty copying but it is notable for the marking, not always correct, of battlefields, and its fine engraving. It will be of interest to discover if other copies are in existence.

Biochemical Research in India

THE Society of Biological Chemists, India, now in its third year, publishes annually "Biochemical and Allied Research in India" ; the number for 1932 has recently been issued. This publication takes the form of a review of research work published during the year, by Indians and other workers in that country, usually in Indian journals. The subject matter is dealt with under the following headings :

enzymes, agricultural chemistry, food and nutrition of farm animals, dairy chemistry, general microbiology, vegetable physiology, phytopathology, pharmaceutical and medicinal chemistry, nutrition and vitamins, and the chemistry of sanitation with special reference to sewage and to water. The journal is edited for the Society by a committee and the names of the reviewers are appended at the end of each section. Upwards of three hundred papers are referred to, indicating the vitality of research into biochemical problems in India. Although many of the results obtained are chiefly applicable to conditions in that country, much of the work is of a wider interest and must be taken into consideration by workers on similar problems in other parts of the world. This journal forms a ready means of keeping in touch with biochemical research in India.

Birds of Hawaii

A REPORT that Hui Manu, the bird society of the Honolulu and Sandwich Islands, has decided to undertake a scheme for breeding and distributing many of the vanishing birds of the Hawaiian archipelago, is of interest, for these Pacific islands are perhaps the most isolated of all oceanic groups. Rothschild ("Avifauna of Hawaii and nearby Islands", 1893–1900) records 47 species from Hawaii, 34 of which breed, and from the neighbouring islands, Laysan 40, Kawai and Nishan 41, Oahu 28, Molokai 21, Maui 26 and Lanai 18. The introduction of many birds foreign to the islands, and particularly the European house-sparrow (*Passer domesticus*) now one of the commonest birds of the islands, has seriously affected the native avifauna, while Wetmore (*Nat. Geog. Mag.*, 18, 77; 1925), in a survey of the bird-life of the group, recorded considerable damage from the introduction of rats and rabbits. It was in 1909, through the interest of President Roosevelt, that the Hawaiian Bird Reservation was set up under the control of the United States Department of Agriculture. Amongst the fifty odd species recorded in the group, Heilprin states all the passeres and five of the aquatic and wading birds are peculiar.

North East Coast Institution of Engineers and Shipbuilders

AT a meeting of the Council of the North East Coast Institution of Engineers and Shipbuilders held on February 12, Mr. Summers Hunter, formerly chairman of the North-Eastern Marine Engineering Co., Ltd., presented the warrant of the College of Arms granting armorial bearings to the Institution. Mr. Summers Hunter has been connected with the Institution for nearly fifty years as a president, and also an honorary fellow. He is also a past president of the Institution and of the Institute of Marine Engineers. The arms of the bearings are an ancient ship with sails set, surmounted by a tower triple-towered between two wheels, symbolical of engineering. The crest is a sun encircled by a chain, representing the harnessing of the forces of Nature for the use of man. The motto is "By Science, Industry and Honour".

Announcements

THE first educational tour of the Institute of Metals will be made to Belgium on April 8–14, when student members will have an opportunity of visiting six large metallurgical establishments and of seeing something of Brussels (including its University) and Bruges. The cost per head will be £6 10*s*. Students desirous of participating should communicate before March 12 with the Secretary, Mr. G. Shaw Scott, 36 Victoria Street, London, S.W.1.

AT the annual general meeting of the Quekett Microscopical Club held on February 13, the following officers were elected for 1934–35: *President*, J. Milton Offord; *Vice-Presidents*, C. D. Soar, J. Ramsbottom, E. A. Robins and J. T. Holder; *Hon. Treasurer*, C. H. Bestow; *Hon. Secretary*, W. S. Warton; *Hon. Reporter*, A. Morley Jones; *Hon. Librarian*, C. H. Caffyn; *Hon. Curator*, C. J. Sidwell; *Hon. Editor*, W. P. Sollis; *New Members of the Committee*, Percy C. Palmer, C. Harvey, E. J. Stream, A. W. Sheppard.

WE much regret that the name of the author of the article entitled "Reference Chart for the Apparent Motions of the Sun, Moon and Planets" in NATURE of January 6, p. 33, was spelt incorrectly. The author's name should have been printed "Dr. B. K. Vaidya".

THE encyclopædic "Handbuch der biologischen Arbeitsmethoden" edited by Prof. Abderhalden includes, among its most recent parts, one written by Dr. F. Zacher. This instalment deals with the behaviour and development of insects affecting stored products. It can be recommended as an up-to-date work of reference written by a leading European authority on the subject.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A chief librarian for the County Borough of Southport—The Town Clerk, Town Hall, Southport (Feb. 26). A principal assistant (technical) in the Chief Engineer's Department of the London County Council—The Clerk of the Council, The County Hall, Westminster Bridge, London, S.E. (March 2). A City engineer and surveyor to the City of Bradford—The Town Clerk, Town Clerk's Office, Bradford (March 10). An assistant keeper on the higher technical staff of the Science Division of the Science Museum—The Director, Science Museum, South Kensington, London, S.W.7 (March 10). A vice-principal and head of the Mathematics Department at the Leeds College of Technology—The Director of Education, Education Offices, Leeds (March 10). A mechanical engineer as assistant to the chief engineer of the Dublin Port and Docks Board—The Secretary, Port and Docks Office, Dublin (March 14). Two lecturers to share the teaching of mathematics, physics, biology, chemistry and geography at the Cambridge Training College for Women—The Principal (March 14). A chief engineer at the British Drug Houses, Ltd., Graham Street, London, N.1—The Managing Director.

Letters to the Editor

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

International Status and Obligations of Science

IN his Huxley Memorial Lecture, extracts from which were published in NATURE of December 23, Prof. A. V. Hill has made detailed statements regarding the treatment of German scientists by the National-Socialist Government. These statements are not in accordance with the truth. As a scientist, whose duty it is to discover and proclaim the truth, I venture to place on record the following facts as against the inaccurate assertions of Prof. Hill.

The National-Socialist Government has introduced no measure which is directed against the freedom of scientific teaching and research; on the contrary, they wish to restore this freedom of research wherever it has been restricted by preceding governments. Measures brought in by the National-Socialist Government, which have affected Jewish scientists and scholars, are due only to the attempt to curtail the unjustifiable great influence exercised by the Jews. In Germany there were hospitals and scientific institutes in which the Jews had created a monopoly for themselves and in which they had taken possession of almost all academic posts. There were in addition, in all spheres of public life in Germany, Jews who had come into the country after the War from the east. This immigration had been tolerated and even encouraged by the Marxist government of Germany. Only a very small part of the 600,000 Jews who earn their living in Germany has been affected by the National-Socialist measures. No Jewish civil servant was affected who had been in office before August 1, 1914, or had served at the front for Germany or her allies or whose father or son had fallen in the War.

Prof. Hill asserts that something more than a thousand scholars and scientific workers have been dismissed, among them some of the most eminent in Germany. In reality not half this number have left their posts, and among these there are many Jewish and slightly fewer non-Jewish scientists who have voluntarily given up their posts. Examples are the physicists Einstein, Franck, Born, Schrödinger and in addition Landau, Fränkel (mathematician), Fränkel (gynæcologist), Prausnitz (hygienist), and others. Prof. Hill says that there are 100,000 people in concentration camps in Germany and that they are there only because they wished to have freedom of thought and speech. The truth is that there are not even 10,000 in the concentration camps and they have been sent there, not because of their desire for freedom of thought and speech, but because they have been guilty of high treason or of actions directed against the community. It must also be said that no women and children are imprisoned in the concentration camps in order to bring pressure to bear upon their husbands and fathers.

It would be a good thing to keep political agitation and scientific research apart. This is in the interests of science as well as in the interests of international scientific co-operation. But when a scientist does mix politics with science, he should at any rate fulfil the first duty of a scientist, which is conscientiously to ascertain the facts before coming to a conclusion.

J. STARK.

Physikalisch-Technische Reichanstalt,
Berlin-Charlottenburg.
Feb. 2.

WITH Prof. Stark's political Anti-Semitism I need not deal: to an unrepentant Englishman (without any Hebrew ancestry or Marxist allegiance) it appears absurd.

It is a fact, in spite of what he says, that many Jews, or part-Jews, have been dismissed from their posts in universities, although they served in the line in the German armies in the late War. There are dozens of such in the lists of the Academic Assistance Council: whether they were "Beamte" or not is a quibble. Nor is there sense or justice in dismissing persons who were not "Beamte" before August 1, 1914.

Doubtless there are many grades of "dismissal", and in a technical sense certainly some of the persons in our lists were not "entlassen". They have found it impossible, nevertheless, to carry on their work in Germany. Men of high standing do not, without cause, beg their colleagues in foreign countries for help. Whether they were "dismissed", or "retired", or "given leave", or merely forbidden to take pupils or to enter libraries or laboratories is another quibble: the result is the same. It is inconsistent with that "freedom of scientific teaching and research" which the German Government apparently is seeking to restore.

As regards "high treason" and concentration camps, in England we do not call liberalism or even socialism by that name. The statement about women and children is a 'red herring'—I never said or suggested anything of the kind.

No doubt in Germany, after this reply, my works in the *Journal of Physiology* and elsewhere will be burned.

May I take this opportunity of saying that the Academic Assistance Council (Burlington House, W.1) urgently needs funds—for in spite of all the quibbles, scholars and scientists are still being dismissed.

A. V. HILL.

University College,
Gower Street,
London, W.C.1.
Feb. 10.

Cytochrome and the Supposed Direct Spectroscopic Observation of Oxidase

IT has been shown previously[1] that some of the bands of the absorption spectrum, described by Warburg and his co-workers[2,3], in *Acetobacter* (*Bacterium pasteurianum*) and ascribed by them to the oxidase or oxygen transporting enzyme, do not belong to this enzyme but to cytochrome. It was also shown that similar absorption bands are visible not only in organisms with a very active oxidation, such as *Acetobacter* or *Azotobacter*, but also in organisms having a much lower respiratory activity, such as brewers' yeast, *Bacillus proteus*, *B. coli*, and *B. dysenteriæ*.

The study of micro-organisms reveals certain variations in the structure and properties of cyto-

chrome. While in the majority of cases the absorption spectrum of cytochrome is similar to that found in bakers' yeast (1, Fig. 1) in other cases (2–6, Fig. 1) the bands *b* and *c* may be replaced by one band (b_1); or band *a*, usually lying at about 603mμ, may be shifted either towards the short wave end (a_1, 586 mμ or 590 mμ) or towards the long wave end (a_2, 628 mμ or 630 mμ) of the spectrum.

In *B. proteus* and *B. coli*, in addition to bands b_1, at 560 mμ and d_1 at 530 mμ, a very faint shading a_1 can be perceived at about 590 mμ and a band a_2 is clearly visible at 628 mμ. (This position having been determined with the reversion spectroscope is more correct than 630 mμ given previously.) On shaking the suspensions of these bacteria with air, the bands b_1 and d_1, are replaced by two very faint and diffuse bands at about 566 mμ and 535 mμ, while the band a_2, as was previously shown in *Azotobacter*[1], is replaced by a narrow band at 645 mμ (9, Fig. 1) which in the absence of oxygen, or on reduction with sodium hydrosulphite, moves back to 628 mμ.

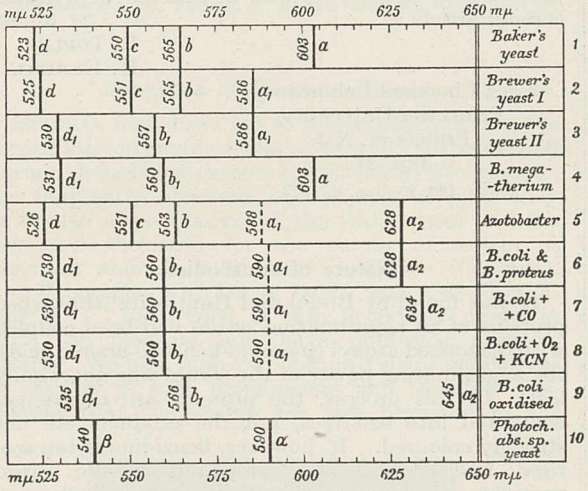

FIG. 1. 1–9, positions of the absorption bands of cytochrome in cells of different organisms. Dotted line marks the faint shadings. 10, position of α- and β-bands of the photochemical absorption spectrum in yeast and *Acetobacter* according to Warburg and his co-workers.

The bands at 628 mμ and 645 mμ represent, therefore, the α-bands of the reduced and oxidised component a_2. On shaking the suspensions of these bacteria with air in presence of potassium cyanide (8, Fig. 1) the component b_1 remains in the reduced form, while the band at 645 mμ disappears completely, as was recently shown to be the case in *Azotobacter*[4], or is more probably replaced by a diffuse band in the green, too feeble to be detected in the thick suspension of bacteria. The effect of potassium cyanide on the absorption spectra of these bacteria differs therefore markedly from its effect on *B. pasteurianum*. In the latter, according to Warburg and his co-workers, potassium cyanide in presence of oxygen is responsible for the appearance of a band at 639 mμ.

When the suspensions of these bacteria (*B. coli*, *B. proteus* and *Azotobacter*) are saturated with carbon monoxide, no change can be noticed in the yellow region of the spectrum (at about 590–593 mμ) where, under similar conditions, a narrow band appears in *B. pasteurianum*[2,3]. The band in the red (a_2), on the other hand, in presence of carbon monoxide is shifted from 628 mμ to 634 mμ (7, Fig. 1). The carbon monoxide compound of the component a_2 has therefore its α-band (634 mμ) at least 400 A. nearer the red end of the spectrum than the α-band of the photochemical absorption spectrum (590 mμ) obtained with yeast or with *B. pasteurianum* and ascribed to the oxygen transporting enzyme.

That the band in the red (a_2) does not belong to this enzyme is shown by its peculiar distribution in cells of various organisms. While this band is visible in a 4 mm. layer of a 50 per cent suspension of *B. coli*, it is invisible in a cake 8 mm. thick of bakers' yeast, the respiratory activity of which is, if anything, higher than that of *B. coli*. Moreover, in a mixture of a suspension of *B. coli* with that of bakers' yeast, both bands *a* (of yeast) and a_2 (of *B. coli*) can be seen simultaneously, which shows that the band a_2, if present, would not be masked by the band *a*. It should be noted, however, that the bands a_1 (586 mμ or 590 mμ) and a_2 (628 mμ or 630 mμ) have been seen so far only in cells where the typical band *a* (603 mμ) was missing.

The components of cytochrome, as was shown previously, are hæmochromogen compounds which differ from artificial compounds like pyridine-hæmochromogen in that they do not usually react directly with molecular oxygen or carbon monoxide. These differences are, however, not constant. In fact, the components of cytochrome, being more or less labile, are easily modified under the influence of various factors and acquire the properties of artificial hæmochromogens in reacting with molecular oxygen and carbon monoxide.

Of all the components of cytochrome, the component *a* is perhaps the most labile. It is not surprising, therefore, that some of its derivatives such as a_1 in *B. pasteurianum* or a_2 in *B. coli*, *B. proteus* and *Azotobacter*, exhibit the above mentioned properties of the artificial hæmochromogen compounds.

It may be stated in conclusion that all the absorption bands of hæmatin compounds seen by the direct spectroscopic examination of cells of different organisms belong either to free hæmatin or to the different components of cytochrome, and that no band seen so far can be ascribed to the oxidase or the oxygen transporting enzyme.

D. KEILIN.

Molteno Institute,
University of Cambridge.
Jan. 3.

[1] Keilin, D., NATURE, **132**, 783, Nov. 18, 1933.
[2] Warburg, O. and Negelein, E., *Bioch. Z.*, **262**, 237; 1933.
[3] Warburg, O., Negelein, E. and Haas, E., *ibid.*, **266**, 1; 1933.
[4] Negelein, E. and Gerischer, W., *Naturwiss.*, **21**, 884; 1933.

Chemical Separation of the Isotopes of Hydrogen

IN their note on this subject[1] Messrs. A. and L. Farkas have reported the following values for the ratio, α, of the specific rates ($H^1 : H^2$) at which the isotopes are discharged when the metals indicated undergo solution in water: Na, 1·2; Ca, 1·5; Al, 2; Zn, 4. Excepting the statement that sulphuric acid (0·1 *N*) was present during the dissolution of zinc, no indication is given concerning the conditions under which these experiments were performed.

Similar experiments have been in progress here, which will be fully described in a paper shortly to be submitted to the Chemical Society, and the purpose of this note is merely to suggest that the figures recorded by Messrs. A. and L. Farkas are not to be regarded as characteristic constants of the metals. It would seem from a comparison of their results

with ours that the value of α for any given metal must depend in some unknown way on the experimental conditions. For example, instead of 1·2 for sodium, we find 2·9, and this figure appears insensitive to the variations of conditions we have tried (2·8, 2·8, 3·0, 2·9 for media ranging from strongly alkaline to strongly acidic). Our ratios for calcium, 1·3–1·6, and aluminium, 4·0–4·9, seem to show a more definite dependence on conditions, the higher value in each case relating to reaction in an alkaline medium. The case of zinc requires special comment because pure zinc is scarcely soluble in dilute sulphuric acid, and, when impure zinc dissolves, the hydrogen is probably liberated at least partly at the impurities. The most nearly pure zinc we could get to dissolve, containing only a minute trace of carbon, gave the value 5·6, but commercial zinc gave a higher value, 6·8, and zinc-copper couples, prepared from pure (insoluble) zinc and varying quantities of deposited copper, yielded values ranging to 8·0. It seems possible that the use of metallic couples may prove a useful auxiliary method of concentrating the heavier isotope of hydrogen.

Our isotopic analyses have in all cases been carried out by determinations of the density of water, and in this connexion we would acknowledge the receipt of valuable help from Mr. J. N. E. Day. We should mention that our experiments include the study of a number of other metals and also of some compounds which, on reaction with water, give volatile hydrides.

E. D. Hughes.
C. K. Ingold.
C. L. Wilson.

University College,
London, W.C.1.
Feb. 13.

[1] Nature, **133**, 139, Jan. 27, 1934.

Electrolytic Concentration of the Heavy Hydrogen Isotope

Messrs. R. P. Bell and J. H. Wolfenden[1] have recently given their experience in concentrating the hydrogen isotope, namely, that nickel, platinum and copper are about equally efficient as cathodes, and in general the efficiency is surprisingly insensitive to the conditions of electrolysis. Broadly speaking, this is also the conclusion we have reached in a study of the electrolytic separation. There are, however, real differences between different metallic cathodes.

It is a convenience to have a name for the quantity α defined by $d \log H = \alpha\, d \log D$, and we propose the term "electrolytic separation coefficient" (this α is the inverse of the one used by Bell and Wolfenden).

The electrolytic separation coefficients of the metals which we have examined all lie between 7·9 and 2·8, the series in descending order being :

Smooth Pt, Pb, Fe, Cu, Ag, Ni, W, Pt black, Ga liquid, Hg.

The coefficient is slightly lower in acid than in alkaline solution. In agreement with Bell and Wolfenden, moderate changes in current density do not make much difference. The position of lead relative to platinum and to mercury is remarkable.

With regard to the application of the over-voltage theory of Gurney, we should like to refer to one point. The theory in its original form implied that the atoms of H (or D) formed by neutralisation of the H_3O^+ (or H_2DO^+) ions are at a very high energy level, namely, the energy of free atoms further increased by the large positive potential energy possessed by the group H_3O at the moment of neutralisation. This involves a very high activation energy, and calculation shows that even if the whole of the applied over-voltage is drawn upon to reduce the activation required, no reasonable amount of current would pass from the solution to the cathode. It must, therefore, be supposed that the activation energy (known to be of the order of 10,000 calories from Bowden's measurements) is not so high as corresponds to the production of free atoms, because of the forces acting between hydrogen atoms and the metal atoms of the cathode surface. These forces modify both the potential energy curves $H^+—H_2O$ and $H—H_2O$; and since the isotopic separation depends on the steepness of these curves, different metals would give different electrolytic separation coefficients. But it seems to us that serious difficulties lie in the way of accepting the over-voltage mechanism proposed by Gurney, which we discuss in a forthcoming article.

B. Topley.
H. Eyring.

Frick Chemical Laboratory,
Princeton University,
Princeton, N.J.
Jan. 21.

[1] Nature, **133**, 25, Jan. 6, 1934.

Nature of Antibodies

It was found by Breinl and Haurowitz[1] that when proteins of an agglutinating serum had been coupled with diazotised atoxyl (*p*-amino-benzene-arsinic acid), the agglutinating power of the serum was not wholly lost. In this process, the proteins are themselves converted into azo-dyes, but the products are not strongly coloured. If, however, benzidine is tetrazotised, and coupled to *R* salt and to the serum proteins, according to the method of Heidelberger, Kendall and Soo Hoo[2], a deep red compound is formed, and the agglutinin again is not wholly destroyed.

If the agglutinins of the serum are proteins, this coloured product should be adsorbed specifically by homologous bacteria. Actually the protein dyes thus formed are readily adsorbed non-specifically. Nevertheless, if weak solutions are used, a striking quantitative difference can be shown between the degree of adsorption by homologous and heterologous bacteria. For example, two tubes (*A* and *B*) were put up. *A* contained a suspension of typhoid bacilli, eight minimal agglutinating doses of typhoid-agglutinin-dye (prepared from the euglobulin of typhoid agglutinating serum) and untreated cholera agglutinating serum. *B* contained a suspension of cholera vibrio in place of typhoid bacilli, the other constituents being the same as in *A*. After agglutination was complete, the agglutinated bacteria deposited in *A* were pink, while those in *B* were colourless. In the converse experiment, using cholera-agglutinin-dye, the cholera vibrios were coloured, the typhoid bacilli uncoloured.

This specific adsorption of the dye from the homologous coloured agglutinin is compatible with the theory that the agglutinins are proteins, but still leaves room for the alternatives : (1) that the agglutinin is attached to protein and not removed

when the protein is coupled to the diazo compound, and (2) that the agglutinin is a non-protein aromatic substance which will form an azo-dye.

Supposing that the dye taken up specifically by the bacteria is protein-dye, the amount can be estimated colorimetrically. In example *A*, 1 ml. of standard agglutinable suspension took up 2×10^{-6} gm.; of the eight minimal agglutinating doses added, less than one dose was left in the supernatant fluid. The minimal agglutinating amount for 1 ml. of suspension is therefore about 2×10^{-7} gm.; an amount less than that required to form a continuous layer on the surface of the bacteria. If this estimate is correct, it is not surprising that preparations of agglutinin should have been prepared in which protein could not be detected.

JOHN MARRACK.

Hale Clinical Laboratory,
London Hospital.
Jan. 18.

[1] Breinl, F. and Haurowitz, F., *Z. Immun. Forsch.*, **77**, 176; 1932.
[2] Heidelberger, M., Kendall, F. E. and Soo Hoo, C. M., *J. Exp. Med.*, **58**, 137; 1933.

Progestin in Placental Extract

SEVERAL facts have led to the supposition that the corpus luteum hormone, called progestin by Allen and Corner, should be present in the placenta; for example, the frequently observed continuance of pregnancy in women after removal of the two ovaries and the increased threshold for the action of œstrin in pregnant animals, even after castration (Courrier).

Collaborating with Dr. A. Luchs, two of us (P. d. F. and M. T.) have tried in vain to extract progestin from the placenta and have published negative results[1]. We had, however, obtained slight indications of activity of such preparations and therefore considered that the search for this hormone in the placenta should be continued. W. M. Allen and R. K. Meyer[2] have recently described a method for the quantitative separation of progestin from œstrin and emphasised the importance of their method for the isolation of progestin from sources which are very rich in œstrin.

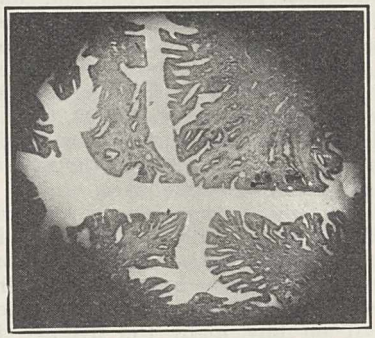

FIG. 1. Proliferation of rabbit uterus after treatment with placental extract.

Using their method, we have now demonstrated the presence of progestin in two lots of placenta. The first batch was extracted from full term human placenta and tested on an infantile rabbit (activated with œstrin after Clauberg's method) and gave distinct proliferation in a dose corresponding to 600 gm. of fresh tissue (Fig. 1). The second batch was prepared from placenta of pregnant cows and tested on an adult castrated rabbit (6,800 gm.) and on an infantile activated rabbit (500 gm.). Both animals showed distinct proliferation of the endometrium in doses of 1,500 gm. and 500 gm. respectively of fresh tissue. The output of hormone is still rather low and our investigation is now being extended to a quantitative study of human and animal placenta obtained during pregnancy for other reasons than abortion.

A. A. ADLER.
P. DE FREMERY.
M. TAUSK.

Organon Laboratories,
Oss, Holland.
Dec. 29.

[1] *Pflügers Arch.*, **231**, 341; 1932.
[2] *Amer. J. Physiol.*, **106**, 55; 1933.

Fine Structure of the $K\alpha$ Line of Beryllium

THE $K\alpha$ line of beryllium, occurring at the very long wave-length of 115·7 A., was measured by Söderman[1], who found it to consist of a broad band 10 A. wide. In view of the recently discovered fine structure of the carbon $K\alpha$ line, I have re-investigated the beryllium soft X-ray spectrum, and, as the spectrogram (Fig. 1) shows, have found it to consist of two diffuse components. That at the longer wave-length is the stronger. The separation is 5·3 A. or 4·8 electron-volts. The measurement of the long-wave component is, however, difficult, as it coincides with the fifth order of oxygen $K\alpha$. A comparison of the width of the component with that of the fourth order of oxygen $K\alpha$ shows that it is too wide to be due to the oxygen line.

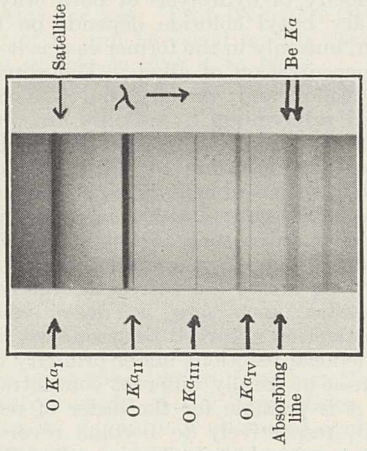

FIG. 1.

There are two possible explanations of the duplicity of Be $K\alpha$. The first is suggested by the carbon $K\alpha$ structure[2]. The carbon line consists of two (or possibly more) components. The stronger of these is attributed to the C $K\alpha_{1,2}$ line and the weaker, short-wave component is probably the ordinary satellite $K\alpha_3$. A simple calculation of the expected separation agrees with the observed value. A similar calculation for beryllium also is in rough agreement with the separation given above. The second possible explanation arises out of the fact that the surface of the beryllium is heavily oxidised in my experiments, and it is

possible that, whilst one of the components obtained is due to oxidised beryllium, the other is due to the pure metal. This possibility is now being investigated.

Two other points of interest are observable in the spectrogram. First, a faint absorption line appears at the short-wave edge of beryllium $K\alpha$. This absorption sets in at about 111·1 A. Secondly, there is quite a strong satellite observable on the long-wave side of O $K\alpha$ at about 24·6 A. More precise determinations of these wave-lengths will be published later.

Physics Laboratories, University College, London, W.C.1. F. C. CHALKLIN.

[1] *Phil. Mag.*, **10**, 600; 1930. See also: Faust, *Phys. Rev.*, **36**, 161; 1930. Prins, *Z. Phys.*, **69**, 618; 1931. O'Bryan and Skinner, *Phys. Rev.*, **44**, 602; 1933.
[2] See Morand and Hautot, *Comptes Rendus*, **195**, 1070; 1932; **197**, 521; 1933. Prins, *Z. Phys.*, **81**, 507; 1933. F. C. and L. P. Chalklin, *Phil. Mag.* (in the press).

Dynamics and Mechanism of Aliphatic Substitution

SLATOR[1] observed that alkyl halides and symmetrical ethylene di-halides react bimolecularly with sodium thiosulphate in water, but that the velocity of reaction with iodochlorethane and bromochlorethane was independent of the concentration of thiosulphate. The phenomenon under discussion is the transition in kinetic order of a reaction due to a very slight modification in the structure of one of the reactants. The problem has been discussed by E. D. Hughes and Ingold[2], who reveal varied and more reliable instances of the same phenomenon. For example, β-phenylethyltrimethylammonium hydroxide decomposes bimolecularly, whereas halides of the corresponding *p*-nitro derivative decompose unimolecularly.

The velocity of hydrolysis of both ethyl chloride and tertiary butyl chloride depends on their concentration, but only in the former case is it influenced by the concentration of alkali. The elimination of methyl alcohol and tertiary butyl alcohol from substituted sulphonium hydroxides are processes of the second and first order respectively (E. D. Hughes and Ingold[3]). According to the theory of Ingold, relating to reactions of type *B*, high cationic stability of the rejectable group and low nucleophilic activity of the reagent-anion tend to favour a unimolecular mechanism, which in turn admittedly implies a relatively long life to the activated organic ion.

The question may now be raised whether the kinetic distinction observed between two similar but specific chemical reactions under ordinary conditions would persist at totally different concentrations. In principle it is possible for the order of reactions of B_1 and B_2 respectively to become reversed below and above a critical concentration (c) of the reagent anion; c (in gram-molecules per litre) would be related to the *average* life-time (t) of the activated organic reactant (in seconds) by the equation

$$c = \frac{A}{t}\sqrt{\frac{\mu}{T}}$$

μ is the reduced mass of the molecules concerned; and A, which is a function of the molecular diameters, is approximately 11. From Slator's data, t for iodochlorethane becomes about 5×10^{-10} second. The Lindemann mechanism thus leads to plausible results when applied to reactions in solution; but it is noteworthy that change in kinetic order due to variations in the concentration, although sought[4], has not yet been found. This fact, and the demarcation between mechanisms B_1 and B_2 may have a common origin in the limited range of dilution conventionally employed.

There is no incompatibility between the two hypotheses. On the other hand, Lindemann's theory, accepted as the explanation of a well-known effect discovered by Hinshelwood in gaseous reactions, is in a sense complementary to Ingold's theory, which derives its support from the successful prediction of the course of organic elimination reactions.

E. A. MOELWYN-HUGHES.
Physikalisch-Chemisches Institut, Frankfurt-am-Main, Germany.
Jan. 6.

[1] *Trans. Chem. Soc.*, **85**, 1286; 1904.
[2] NATURE, **132**, 933, Dec. 16, 1933.
[3] *Trans. Chem. Soc.*, 1571; 1933.
[4] Stewart and Bradley, *J. Amer. Chem. Soc.*, **54**, 4183; 1932.

Atmospheric Pressure and the Ionisation of the Kennelly-Heaviside Layer

EVIDENCE of a connexion between meteorological conditions in the troposphere, and the behaviour of radio waves reflected from the Kennelly-Heaviside layer has been noted by Colwell[1] in America and by Ranzi[2] in Italy. Again, Stagg[3] has discovered a relation between the diurnal variation of barometric pressure at Aberdeen and the general state of magnetic conditions over the earth. There appears little doubt that some relation exists between conditions in the troposphere and the ionosphere.

Evidence which appears to bear on the fundamental nature of the relationship has been obtained as a result of two series of experiments carried out in Melbourne and Sydney during 1931 and 1932.

In the first series, carried out at the University of Melbourne with the collaboration of Mr. R. O. Cherry, during November–December 1931, and March–April 1932, the average night intensity of the sky wave from the transmitter 3 AR (610 kc./sec.) was measured at a distance of 90 km. From the second series, carried out between Melbourne and Sydney on a frequency of 1415 kc./sec. during October 1932, it was possible to find directly the maximum ionisation density in the E layer from observations of the rays of known angle which penetrated that layer.

From both series a very close direct correlation is evident between the average night-time ionisation density in the E layer and the barometric pressure at ground-level measured at a time ranging from 12 to 36 hours after the ionisation observation. For example, if on any night the average ionisation density is greater than that on the preceding night, then the barometer invariably rises within the time interval mentioned. In most cases the time lag is near to twelve hours, the greater lag being associated with slower moving disturbances.

The results obtained in the first series of experiments are in complete accord with those of Colwell, though the explanation offered differs considerably from his. Thus, Colwell considers that the "E layer is concentrated in the regions of low pressure"[4], resulting in a stronger post-sunset signal. On general theoretical grounds it is much more probable that a stronger night signal on the frequency of KDKA (980 kc./sec.), upon which station Colwell's measurements were made, would result from a *decreased* intensity of ionisation in the absorbing portion of the

E layer. Such a deduction is even more probable for the frequency at which the first series of measurements described above was made, there being small possibility of electron limitation being operative so early in the night.

That this view is substantially correct appears to be shown by the remarkably close correlation found in the second series of experiments, which gave the ionisation density directly.

The relation of the results described above to those of Ranzi, which are principally concerned with the occurrence of abnormal night time increases in ionisation, is not so obvious. It seems clear, however, that in seeking an explanation of abnormal night ionisation, the possibility of horizontal movements of the ionosphere must not be overlooked. The phenomena described above strongly suggest the presence of winds at these high levels of the stratosphere.

This work is being carried out under the auspices of the Australian Radio Research Board, to which I am indebted for permission to publish this advance report.

D. F. MARTYN.

University of Sydney.
Dec. 20.

[1] NATURE, **130**, 627, Oct. 22, 1932.
[2] NATURE, **130**, 368, Sept. 3, 1932.
[3] NATURE, **127**, 402, March 14, 1931.
[4] *Phys. Rev.*, **43**, 774; 1933.

Small Sand Craters of Seismic Origin

THE small sand craters of seismic origin, described by Dr. Sheppard in NATURE of December 30 (p. 1006), as examples of unusual structures, are common results of severe earthquakes in alluvial regions. The formation of such vents and their related fissures was first explained by R. Mallet and T. Oldham in the case of the Cachar earthquake of January 10, 1869[1], and their theory was adopted later by R. D. Oldham in his description of the numerous and widely spread occurrences caused by the Great Indian earthquake of June 12, 1897[2]. Briefly, this theory postulates a certain amount of vertical movement from below, resulting in the transmission of the wave motion through layers of loose, oozy sand into the overlying, impervious and harder layers of the surface alluvium. The inertia of the latter is believed to cause a compression of the watery sub-stratum and the expulsion of part of its contents through simultaneously formed cracks above, usually as a geyser-like flow. The spurting which reliable eye-witnesses state takes place on these occasions, the return of the water when quiescence is attained and the formation of the craters with their scored sides, are all accounted for satisfactorily by this theory.

The epicentral tract beneath which the Pegu earthquake of May 5, 1930, originated, happened to form part of a vast alluvial plain in Lower Burma, and sand vents, craters and sloughs were produced over wide expanses of country as a result[3]. Similarly, after the Pyu earthquakes of December 3 and 4, 1930, in Upper Burma, many examples were noted in suitable places, for their formation demands a bed of watery sand, overlain by a thick deposit of clay[4]. In no case, so far as they were examined either by my colleagues or myself, was any evidence found to lead to a modification of the older theory, still less to adopt the belief that they originated in a subsidence of the land, followed by a restoration to its original level, as stated by Sheppard. Insufficient attention has been paid in the past to the action of gas which may be so liberated from water-bearing strata charged with decomposing organic matter in such situations, but this would in any case only intensify the known, mechanical, surface effects of the disturbances.

The suggestion that the sandstone dykes of the Tertiary formations of south-western Ecuador may have been injected during earthquakes, recalls Kendall's identical explanation of the sandstone dykes and "fossil sand blows" of various parts of the British Coal Measures[5].

J. COGGIN BROWN.
(late Superintendent,
Burma Party, Geological Survey of India).
"Dunelm", Broxbourne,
Herts.
Jan. 19.

[1] R. Mallet and T. Oldham, *Quar. J. Geol. Soc.*, **28**, 255–270; 1872. T. Oldham, *Mem. Geol. Surv. Ind.*, **19**, 46–60; 1882.
[2] R. D. Oldham, *ibid.*, **29**, 85–111; 1899.
[3] J. Coggin Brown, P. Leicester and H. L. Chhibber, *Rec. Geol. Surv. Ind.*, **65**, 253–255; 1931.
[4] J. Coggin Brown and P. Leicester, *Mem. Geol. Surv. Ind.*, **62**; 1933.
[5] P. F. Kendal, *Proc. Geol. Soc.*, Jan. 17, 1919.

The Infinite and Eternal Energy

I SHALL be obliged if any reader of NATURE can give me the reference for Herbert Spencer's statement that:

"Amid the mysteries that become more mysterious the more we examine them, we find the one certainty that we are in the presence of an infinite and eternal energy from which all things proceed."

I quote from memory of reading this statement some forty years ago. I think it was in the form of a letter on the completion of the "Synthetic Philosophy". I have failed to trace it at the British Museum or in Herbert Spencer's works, and the Herbert Spencer Trustees have been unable to find the reference for me. Prof. Wilhelm Ostwald had not heard of it, and he asked me for the reference; but I was unable to give it to him.

It was widely quoted and commented upon in the Press at the time it was published. Consequently, it is strange that there should be any difficulty in finding the reference.

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Jan. 17.

Tidal Bores

IN NATURE of February 3, p. 180, reference is made to a suggestion by Dr. Vaughan Cornish that a co-operative study of the Trent Bore should be undertaken by a group of students, equipped with tide-gauges, etc.

The late Mr. Champion devoted much time to observations in the Trent, using a special tide-gauge, at a large number of places. At his death we undertook to examine and collate all his material, which was presented to us by his sister. This work is nearly completed, and the results will shortly be published. The characteristic shape of the bore in detail, size, rates of travel, etc., have been deduced for a number of stations.

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Research Items

Nudity in English Folk-Dancing. A photograph of a carved wooden panel, about 14 in. long, formerly in Lancaster Castle, representing figures apparently engaged in a morris dance, is published in the *Journal of the English Folk Dance and Song Society*, vol. 1, pt. 2, by Miss A. G. Gilchrist. The panel is of uncertain date, but is probably contemporary with Henry VII. There are seven figures represented, of which one wearing a cloak and feathered cap carries pipe and tabor, while another, wearing a high cap and distended skirt and bearing a ladle for contributions, is evidently the 'Maid Marian'. The fool wears cap and bells and carries a bauble or bladder. The third figure in the processional is either a nude woman or a boy with artificial female characteristics personating a woman. Sir Edmund Chambers, to whom the photograph has been submitted, suggests a connexion with whatever it may be that lies at the bottom of the Lady Godiva legend and procession. There is evidence for the appearance of nude figures in English dances in the Puritan denunciation of "light, lewde and lascivious dancing" in which the "greatest abuse" of all was "dancing naked in nets", the morris dancers, it was said, coming to dance about church during divine service. It is to be noted that nude figures on misericords, dating from the fourteenth to early sixteenth centuries at Beverley St. Mary, Worcester, Norwich, and elsewhere, wear nets while riding on goats, stags or geese. It has been suggested that these nets may have served the purpose of 'fleshings'. The subjects of medieval misericords seem frequently to have been derived by the artist from what he had seen in plays and pageants.

Growth Phases of the Organism of Cattle Pleuro-pneumonia. The micro-organism of this disease in some of its stages of growth is just on the limit of visibility and is filterable at times through a Berkefeld V filter. Bordet noted that in serum-broth cultures spirillar and filamentous forms develop together with small globular and ring forms. Other authors have suggested that some of these appearances may be artefacts, and various guesses have been made as to the position of the organism, which has been given such generic names as *Asterococcus*, *Micromyces*, *Mycoplasma* and *Asteromyces*. J. C. G. Ledingham has now studied the problem, and has obtained much information by the use of impression preparations of growth on solid media (*J. Path. and Bact.*, 37, No. 3, 393; 1933). According to him, in the initial stage of growth, numerous deeply staining chromatic corpuscles are seen with ramifying filaments of varying length and containing in their substance small chromatic bodies. Detached pieces of filaments form the vibrionic forms of Bordet. The threads form complicated masses of filaments having much resemblance to actinomycotic colonies. Terminal and endomycelial chromatic nodes in the mycelial filaments swell up into large oval structures, and in the fully developed colony become surrounded with a thick sheath amidst the tangled mycelial threads. Ledingham considers that the organism, as well as that of 'agalactia' which was also studied, must be placed in the family *Actinomycetaceæ*. Filterability through filter candles, he suggests, may be due to an unusual plasticity of the protoplasmic structure.

Plum Rust Fungus on Apricot and Peach. The disease of the plum caused by a rust fungus, *Puccinia pruni-spinosæ*, has been known to occur in English gardens for many years. A recent paper by Prof. E. S. Salmon and Mr. W. M. Ware (*Gardeners' Chronicle*, Dec. 30, 1933, pp. 490–492) reports that the disease is now attacking apricots and peaches in several districts. The new hosts do not appear to be attacked very severely, and the damage caused is very slight in comparison with the heavy losses of American and New Zealand growers. Descriptions of the fungus are given in the paper referred to, and the interesting suggestion is made that the physiological variation described by Jacky as "form 2" has been introduced to Great Britain from the Continent. *Anemone coronaria*, the St. Brigid anemone, is the winter host of the fungus.

Stocks for Cherries and Pears. The fundamental work of the staff of the East Malling Research Station on the standardisation of apple stocks is now being extended to the cherry and pear crops. In the *Journal of Pomology and Horticultural Science*, 2, No. 4, December 1933, two papers are published—"Stocks for Morello Cherries" by Mr. N. H. Grubb (pp. 276–304), and "'Free' or Seedling Rootstocks in use for Pears; their Description, Selection, Vegetative Propagation and Preliminary Testing" by Mr. R. G. Hatton (pp. 305–334). Three main types of cherry stocks were tried—sweet cherry, Mahaleb and acid cherry—and each type was budded or grafted with scions of Morello. Sweet cherry carried a scion growth of moderate vigour, but selected stocks showed considerable differences. Mahaleb was considerably larger than sweet cherry in the early stages, but later became weaker and more spreading in habit. Acid cherry stocks were found to be distinctly dwarfing. Mr. Hatton has classified the free pear rootstocks of Europe, obtaining four main botanical groups (*A*, *B*, *C* and *D*). Some very striking differences in vigour of vegetative clones have been found, and tested under field conditions. The botanical groups all varied considerably, and it is interesting to note that the extremes of vigour were exhibited by members of type *C*. The stock numbered *C*7 produced a total wood-growth of 124 metres, whilst *C*4 only gave 58 metres.

Kerguelen Archipelago. Sir Douglas Mawson contributes to the *Geographical Journal* of January a paper on Kerguelen which embodies the results of his observations during the *Discovery* visit in the summer of 1929–30. The Kerguelen Archipelago, Heard and Macdonald Islands are considered to be subærial features of a vast submarine rise on the floor of the Southern Ocean. This rise, which was traced by the *Discovery* into a high southern latitude, was formerly supposed to represent the remains of a submerged continental land mass, but Sir Douglas Mawson believes that the petrological evidence points rather to the Kerguelen area being an igneous blister on a deep ocean floor. It may, however, have been of considerably greater extent during the low-level stage of the sea in the peak period of Pleistocene glaciation. Another point of interest is the evidence that the present land topography owes most of its features to the work of ice. Sheet ice has done much of the work while deeply-cut glacial grooves are

superimposed on the earlier more general erosion. It is clear that in places, particularly on the west, shelf ice did much to protect the coast from marine erosion. The paper includes a revised map of south-east Kerguelen.

Primary Standard of Light. In an article published in *World Power* of August 1933, Dr. J. W. T. Walsh gave a history of the attempts that have been made to establish a primary standard of light leading up to the work of Ives on the black-body standard. As a direct consequence of this work, the International Commission on Illumination recommended that the brightness of a black body under precisely defined conditions should be adopted as the primary standard of light. Following on these lines, the United States Bureau of Standards developed a form of black body standard which is regarded as very satisfactory. It consists of a small tube of refractory material held at the freezing point of platinum by immersion in a bath of the solidifying metal. The tube is made of thoria and the lower end is filled with powdered thoria. The apparatus is placed in an induction furnace operated by current at a million frequency. The brightness of the hole at the top of the tube is then measured photometrically. In a second article published in the January number of *World Power*, Dr. Walsh gives the results obtained with this apparatus at the national laboratories of France, Great Britain and the United States. These results are: France 58·84 international candles per square centimetre, Great Britain 59·10 and the United States 58·84. This shows that the standard developed at the Bureau of Standards represents a primary standard of light which is reproducible from specification to the precision of about a quarter of one per cent. This is a great advance on any previous proposal. The adoption of this standard will in no way affect the value of the international candle. Its only function is to ensure that there is no drift in its value.

Heats of Dilution. A study of the heats of dilution of aqueous solutions of zinc, cadmium and copper sulphates at 25° (Lange, Monheim and Robinson, *J. Amer. Chem. Soc.*, December 1933) has given results of interest in the theory of strong electrolytes. Within the limits of error, the measured (intermediate) heats of dilution were proportional to the square root of the molality below 0·001 molal. Although this is in agreement with the limiting Debye-Hückel law, the value of the factor of proportionality was not in agreement. The extension of the theory by Gronwall, La Mer and Sandved requires that the heats of dilution should fuse into the limiting law straight lines at very low concentrations. It was found, however, that the individuality of slope persists to the lowest measured concentration, 0·00005 molal, although this behaviour is not disclosed by other methods of measurement, such as electromotive forces and freezing points, a result which the authors suggest is partly due to the lower accuracy of such types of measurement. The values for the heats of dilution are also not in agreement with those found by the electrochemical method, although there is no theoretical ground for expecting the two methods to yield different results. The values for the a parameter (correction for ionic radius) in the extended theory are found to be different for zinc and cadmium sulphates, although the electrical method had given practically the same values, and the values of the initial slopes for these 2-2-valent salts were in poor agreement with the value required by the limiting law.

Cracking of Cement. A report issued by the Department of Scientific and Industrial Research (Building Research Tech. Paper No. 15, "Temperature Rise in Hydrating Concrete". London: H.M. Stationery Office, 1*s*. 3*d*. net) deals with the rise in temperature in concrete in the process of setting and hardening caused by the chemical reactions between water and cement. In large masses of concrete the rises in temperature may be considerable, and this may not only affect the properties of the material itself but also may influence the distribution and intensity of stresses throughout the mass. The fundamental cause of some of the serious cracking that has occurred in large masses of concrete, is the expansion due to the heat evolved during the hydration process followed by contraction during the subsequent cooling. Rapid-hardening cements attain a high strength during the period when the temperature is highest. During subsequent cooling the concrete may become subjected to internal strain, and this possibility has caused considerable concern among engineers. The report contains particulars of observations of temperature rises made on some fifty important concrete structures in various parts of the world. They show generally that with modern cements there is a tendency to attain higher maximum temperatures, and to attain these temperatures in a much shorter time, than was the case with cements formerly used. The report describes the laboratory methods developed at the Building Research Station for measuring the rise in temperature of a particular concrete under conditions simulating those of practice.

Design of Beam Arrays. One advantage of short-wave transmission in radio communication is that it is possible to concentrate the radiation to a certain extent in one direction, thus forming a beam of waves. In his classical experiments, Hertz showed that by using a parabolic reflector and placing the transmitter along the focal line, much more powerful effects were produced in a receiver placed on the focal line of a similar reflector when the reflectors faced one another. Hence these waves can be reflected by conductors. A series of vertical aerials with their bases on a parabola (called a beam array) will act like Hertz's reflector. In practice, great care is taken to ensure that the axis of the beam lies in a great circle path joining the transmitting and receiving stations, but hitherto little attention has been paid to the correct angle of elevation of the beam. In a paper read to the Institution of Electrical Engineers on January 3 by T. Walmsley, the results of an investigation into the factors controlling the economic design of beam arrays are given and definite conclusions are obtained. The author states that before the design of an array system is undertaken, tests should be made over several months to find the best angle of propagation in the vertical plane. If, as in the case of the Berlin-Rugby circuit, this varies appreciably with the season of the year, an array capable of having its angle of projection varied should be built. In the case of the Rugby-New York circuit, the best angle of projection—about 79° to the vertical—varies very little during the year. As the wave-length increases the cost of array systems for a given efficiency rapidly increases. In this case also the cost increases as the angle to the vertical at which the radio energy is required to be projected or received increases.

The Teaching of History and Prehistory in Germany

THE German Minister of the Interior, Dr. Frick, has issued a circular (under official reference number III 3120/22·6)* containing "guiding ideas" (*Leitgedanken*) for historical instruction in all German schools, and has transmitted them to all educational authorities in Germany. These "directive principles" (*Richtlinien*) have been issued also to the Union of School-book Publishers, and are to serve as a standard for the educational authorities in forming their opinion of historical textbooks submitted to them for adoption. Until the publication of these historical textbooks, which can scarcely be expected before Easter 1935, these "directive principles" are also to be regarded as guiding ideas for historical instruction in all German schools. We print below a translation, with German words and phrases in parentheses where there may be doubt as to the actual shade of meaning, of the full text of the document.

The directive principles are not intended, and cannot attempt, to give even by implication a survey of the whole material or the manner of its presentation. They rather direct attention to certain important points of view that hitherto have been considered inadequately, if at all, and that must accordingly be given greater prominence (*stärker zur Geltung kommen*) in future.

Prehistory should be mentioned first, since it not only locates the starting point of our continent's historical development in the Central European cradle of our nation (*Volk*), but is further, as a "pre-eminently national science" (*hervorragend nationale Wissenschaft*) (Kossinna)†, better fitted than any other discipline to counteract the traditional undervaluation of the cultural level (*Kulturhöhe*) of our Germanic (*germanischen*)‡ forefathers.

Then from prehistoric times through all subsequent millennia until the present day, the significance of race must receive due attention; for it represents the ground (*Urboden*) from which all fundamental characters both of individuals and of peoples spring.

A further point of view is the idea of nationality (*der völkische Gedanke*) as opposed to the international idea, the creeping poison of which has for the last hundred years been threatening to corrode the German soul itself; for Germans are more prone than any other people to pursue dreams that are not of this world.

With the idea of nationality (*dem völkischen*) is intimately connected that of national citizenship (*der volksbürgerliche Gedanke*). To-day a full third of all Germans live outside the frontiers of the Reich. Historical study in treating of German history must therefore not be restricted to the area comprised within Germany's frontiers, but must always keep in view the fortunes of our brethren (*Stammesbrüder*) dwelling beyond them.

In opposition to tendencies of a different trend, it is to be required that the description of conditions of life (*des Zuständlichen*)—cultural history (*Kulturgeschichte*)—however important it may be for the characterisation of great periods of development, shall not be given pre-eminence over the political history which shapes the fate of nations. This means bringing out the forces that make history, so that the pupil shall not be lost in the bewildering multitude of isolated events, but shall grasp the main lines and deeper connexions and so be assisted in the formation of his political judgment and will (*und so in seiner politischen Urteils- und Willensbildung gefördert wird*).

The heroic idea in its Germanic expression (*der heldische Gedanke in seiner germanischen Ausprägung*), associated with the idea of leadership (*Führergedanke*) of our own day, that is linked with the earliest models of the Germanic past (*der an ältesten Vorbilder deutscher Vergangenheit anknupft*), must penetrate historical instruction at all stages. The two together with their inherent heart-stirring power arouse the enthusiasm without which the study of history may easily become for the majority of pupils a tedious accumulation of facts (*Wissenstoff*). The heroic idea, however, leads on directly to the heroic outlook (*Weltanschauung*) which specifically befits us (*die uns artgemäss ist*) as a Germanic people, as no other does, and inspires us with ever-renewed vigour in the struggle for national self-assertion (*völkische Selbstbehauptung*) in the midst of a hostile world.

In detail, the following points are still to be noted. The textbooks are to begin with an account of the primeval history (*Urgeschichte*)§ of Central Europe (the Ice Age) and show how distinct races (Neanderthal, Aurignac, Cro-Magnon) were the bearers of specific (*arteigener*) cultures. It can be shown, in primeval history already, that culture is a creation of race. This fact is only obscured, but not cancelled, by the racial mixtures of later times.

From the beginnings of prehistory (*Vorgeschichte*)§ (post-glacial times) the Nordic and Faelic races spread over North and Central Europe. The principal areas of their distribution, as well as those of the remaining primary races of Europe, are to be illustrated with simple sketches. The history of Europe is the work of peoples of Nordic race (*nordrassischer Völker*); their cultural level (*Kulturhöhe*) is revealed to us not only by the relics they have left in the way of stone and bronze implements, but also by their achievements in the spiritual domain, that science can infer—not least in the highly developed Nordic (Indo-Germanic) parent tongue which has ousted (save for survivals) the languages of the remaining European races.

We take the path to Hither Asia and North Africa

* The German text is published also in the *Nachrichtenblatt für deutsche Vorzeit, herausgegeben von Martin Jahn*, (IX 6), pp. 81–84; 1933.

† Gustav Kossinna was professor of prehistory at Berlin until his death in 1932, founder of the Gesellschaft für deutsche Vorgeschichte and the periodical, *Mannus*, and author of numerous books amongst which, "Die deutsche Vorgeschichte, eine hervorragend nationale Wissenschaft", had a very wide circulation.

‡ *Germanische* is here translated "Germanic" instead of "Teutonic"; *deutsche* remains "German".

§ German archæologists divide what in England is generally called "prehistory" into *Urgeschichte*—palæolithic times—*Vorgeschichte*—the Neolithic, Bronze and pre-Roman Iron Ages—and *Frühgeschichte*—the Imperial Roman and Dark Ages.

with the first Nordic invasions which must have taken place already in the fifth millennium B.C. This is indicated by finds of Nordic skulls in the earliest Egyptian graves and by the early-attested blonde population of the coastal region of North Africa (cf. Lapouge, "L'Aryen, son rôle social", Paris, 1885). The racial origin of the Sumerians is still obscure, but their language permits of hundreds of comparisons with Indo-Germanic roots which could be most readily explained by the assumption of a former upper class of Nordic conquerors (*die Annahme einer ehemaligen nordischen Erobererschicht*). A decisive influence on the history (*Eine entscheidende Beeinflussung der Geschichte*) of Hither Asia was first exercised by the Indians, Medes, Persians and Hittites, originally of Nordic stock (*nordrassischen*). The pupils must live through, as if it were that of their own blood-relations, the fate of these peoples who eventually declined, overwhelmed by the forces of foreign blood (*unter der Übermacht fremdrassigen Blutes*) after they had created high civilisations in India and Persia.

The history of the Greeks has again to begin from Central Europe. It must once more be insisted that it deals with our nearest racial brothers (*unsere nächsten rassischen Brüder*). Hence too our intimate relation to Greek art, quite different from our relation to Chinese, Japanese or Mexican art. The Nordic Greeks, as conquerors, formed the aristocracy (*Herrenschicht*) in the land. In Attica in the time of Pausanias, Carian was still spoken in the countryside by the indigenous population. Here in the south the struggle of classes (*der Kampf der Stände*) was based upon a contrast of races. Both in Athens and in Sparta the full citizens constituted only a minority over against the indigenous population and the slaves; these, at least in Athens, were largely of Asiatic origin. Hence with the breaking down of class barriers by the democracy and with the unrestrained mixture of races that followed, hastened by the growing decline in birthrate (*Kinderarmut*) (Polybios !) the fate of the Nordic race in Greece was sealed, and the decay of Greek culture proceeded with such furious speed that in barely 200 years the Greek people sank into complete insignificance. (Information on the racial aspect of this development in Günther, "Rassengeschichte des hellenischen und römischen Volkes".)

The history of the Nordic peoples of Italy must likewise begin in Central Europe, so that here too the racial kinship may be felt. The struggle between patricians and plebeians is to be understood mainly (*vorwiegend*) as a racial struggle (*Rassenkampf*)—hence too the particularly fierce resistance to the grant of the right of intermarriage (*Ehegemeinschaft*) to the plebeians. The Nordic element in the Romans was nearly worn out in unceasing wars. By the time of Tiberius only six of the old patrician families survived ! The overwhelming majority of the total population of Italy consisted of the descendants of Oriental slaves. The hopelessness of their plight was the background for the stoic outlook (*Weltanschauung*) of the Romans. And so by the beginning of our era the denordicising (*Entnordnung*) of southern Europe was nearly complete.

The significance of the Germanic folk-migration lies fundamentally in the fact that it brought fresh (*frisches*) Nordic blood into the Roman Empire, degenerated (*entarteten*) as it was through this racial hotch-potch (*Rassenmischmasch*). Hence the new culture of the Middle Ages bloomed (*entfaltet sich die neue Kulturblüte*) only where Germanic peoples settled permanently: in North (but not South) Italy, in Spain, France, England, but not in the Balkans. The racial influence of the Nordic Varangians (*die blutmässige Einfluss der nordischen Waräger*) in Russia was too slight to permeate the enormous region with civilising force. Only the fact that the Germanic ruling class (*germanische Oberschicht*) in Central, West and South Europe was the bearer of medieval culture makes it possible to understand how medieval chivalry at its height exhibits everywhere such a uniform character.

More emphasis than heretofore is to be laid upon the greatest achievement of the German Middle Ages, the recovery of the area east of the Elbe (*die Wiedergewinnung der ostelbischen Gebiete*). In this connexion, it must again be insisted with reference to conditions before the migration period that this area east of the Elbe right away to beyond the Vistula was once Germanic national soil (*einst germanischer Volksboden*) at a time when the Slavonic peoples still dwelt as poor fishermen in the Pripet swamps.

For the rest, however, the insistence on nationality must not lead to an unfair estimate of the Middle Ages. They were a time of very great expansion of German power (*grösster deutscher Machtentfaltung*). The foundation of national States was then achieved in no European country; take, for example, France with its constituent states (*Unterstaaten*)—Provence, Burgundy, Normandy, Ile-de-France and Lorraine.

Modern history reveals for the first time evolution in the direction of the national State. Yet from the beginning of the modern period, international influences too make themselves gradually more strongly felt. They lead to a lamentable intrusion of alien elements (*zu einer beklagenswerten Überfremdung*) into German blood, German speech, German law, German constitutional theory (*Staatsauffassung*) and finally into the whole outlook on the world. In opposition to them the development of German national consciousness is to be brought out; to-day it receives new vigour from the more thorough investigation of our own history (*des heimischen Altertums*). Such contemplation of what is specifically ours (*das Arteigene*) leads to greater emphasis on the bond of blood which unites us to our kinsmen in neighbouring regions and elsewhere abroad. It allows us to hope for increasing recognition in the kindred Germanic countries (*in den stammverwandten germanischen Ländern*), that the Nordic peoples must feel themselves a community united by destiny (*eine Schicksalsgemeinschaft*) upon the maintenance of which absolutely depends the existence of all higher Nordic civilisation.

The last twenty years of our own time must form a principal object of historical study. The terrific experience of the world war with the heroic struggle of the German nation against a world of foes, the disorganisation of our powers of resistance by forces hostile to the Fatherland (*vaterlandsfeindliche Kräfte*), the degradation of our nation by the dictate of Versailles and the consequent collapse of the liberal-Marxist philosophy are to be treated as thoroughly as the incipient awakening of the nation, from the Ruhr struggle to the dawn (*Durchbruch*) of the national-socialist idea of freedom, and the restoration of the German national community on the Day of Potsdam.

Minister Dr. Frick at the Ministerial Conference of May 9, 1933.

British Industries Fair

THE twentieth British Industries Fair which opened on February 19 is the largest national trade fair in the world. It is a visible and tangible epitome of the range, variety and character of the goods manufactured or produced within the British Empire, since only such goods are permitted to be displayed and no exhibitor may show articles other than those of his own manufacture. The three principal sections of the Fair, held at Olympia and the White City in London, and Castle Bromwich, Birmingham, respectively, will remain open until March 2. To trade buyers the Fair is open from 9.30 a.m. until 7.30 p.m. daily; the public are admitted daily from 4.30 p.m. until 7.30 p.m., and on February 24 and March 2 they will be admitted throughout the day.

At Olympia the lighter industries are represented, while the furniture and textile industries have their displays at the White City. The Birmingham (Castle Bromwich) Section is devoted to the 'heavy' industries such as hardware, sanitary ware, gas plant for industrial and domestic use, building, electricity, engineering, metals, mining and railway equipment.

It would obviously be impossible in a short article to review the exhibits, so as to give anything approaching a representative picture of the character of the Fair. All that can be attempted is to direct attention to a few selected points likely to interest scientific readers.

One interesting feature to be noticed each year at the Fair is the extent to which new scientific ideas, discoveries and inventions are being applied industrially. Sir Josiah Stamp and other writers have directed attention to the 'lag' between the completion of an invention or discovery, on the laboratory scale, and its routine incorporation, in applied form, in large-scale industrial operations. The annual exhibition of the Physical Society always has some feature or features of novel scientific interest: how long is it before such a new scientific idea becomes routine practice in the workshop? One may get some indication of the lag by noticing how long it is before the same idea is embodied in some industrial product exhibited at the British Industries Fair.

In the hardware, ironmongery and brass-foundry group of exhibits at Castle Bromwich, the number of chromium-plated products shown indicates how greatly the improved technique of the electrochemical deposition of chromium is being applied industrially—repeating, it may perhaps be said, in this connexion the older story of stainless steel. At Birmingham the latest scientific improvements in equipment for general heating and cooking, and in furnaces for the metallurgical industries are exemplified in numerous exhibits. In the exhibition of electrical plant and accessories there are new and interesting features in generators, motors, transformers, rectifiers, condensers, accumulators and switchgear. Recent developments in electrification have called for high-speed rotary machines; and the comparatively new industry—that of plastic moulding—has had its repercussions on the engineering industry by giving an impetus to the production of special presses. Similarly, the demands of motor and aircraft engineering have led to the evolution of acid-resisting and rustless steels and of new light-weight alloys having great tensile strength. All these and many other developments may be seen in the exhibits at Castle Bromwich.

At Olympia an exhibit of special scientific interest is the United Scientific Instrument Exhibit. Among the cinematograph machines shown, both for taking and for projecting, there is a pocket cinematograph camera which, by the turn of a switch, can be converted into a cinematograph projector. It is shown by Camera-Projectors, Ltd. At the stand of Messrs. Chance Brothers and Co., samples and mouldings of a selection of optical glasses representing more than one hundred varieties made by the firm are shown. Messrs. Cooke, Troughton and Simms, Ltd., of York, appear in a new rôle, as manufacturers of a complete range of microscopes for biological, medical and metallurgical studies. A gas-filled hot-cathode rectifying valve is shown by Messrs. Partridge, Wilson and Co., of Leicester, for the conversion of alternating into direct current. Messrs. Ross, Ltd., exhibit, besides a wide range of their famous camera lenses, including lenses for cinematograph work, a complete portable cinematograph projector and an epidiascope.

A novel and interesting piece of apparatus—called the 'hydro-pulsator'—is shown by Mr. Lee Guinness. It provides a high-pressure jet of water pulsating at high frequency. It is claimed that the apparatus provides a mode of vibratory massage suitable for application to the gums and other parts of the body too sensitive to be touched by the hand, and that by it the teeth may be more efficiently cleaned than by a tooth brush. Messrs. Ensign, Ltd., exhibit the "Ensign Midget", said to be "the most compact camera yet constructed". Besides a complete range of their well-known microscopes, Messrs. R. and J. Beck, Ltd., show a series of workshop projectors by which operatives may see on a ground-glass screen the magnified images of engineering and other products, the profiles of screws and similar components.

The chemical industry is, of course, well represented and the exhibits form a most noteworthy feature of the Olympia Exhibition.

University and Educational Intelligence

BIRMINGHAM.—In the annual report of the Vice-Chancellor it is announced that the number of full-time students has reached 1,840 (the maximum yet attained). The increase in the number of medical students is resulting in congestion which can only be relieved by the completion of the new Medical School adjoining the new Hospital Centre near the University Buildings. A beginning has been made with the Hospital Centre and the work is progressing rapidly, but the magnitude of the scheme is such that it is not expected that the first instalment (of 500 beds) together with the complete Medical School, will be ready before the autumn of 1937. An increase in the accommodation for the Department of Chemistry is also urgently needed, but as the estimated cost is £50,000, this cannot be undertaken until the expenditure required for the Medical School can be definitely ascertained. A chair of applied mathematics is also needed.

In the report the Vice-Chancellor refers to the problem of the quality of University students in general. He considers that of all classes there is not more than about 4 or 5 per cent of the first quality, and the university that can offer the most valuable

entrance scholarships is likely to secure the greater proportion of these. On the other hand, there are about 20 per cent who, being much below the average of ability, only just manage to get degrees, and it is these who constitute the 'unemployment problem'.

The claims of the Library are again urged: "If our ideal as a University is education and not merely the maintenance of intellectual disciplines, double the sum that we now spend on it would be sound and rewarding expenditure".

Dr. H. P. Gilding, formerly reader in experimental physiology in University College, London, has been appointed professor of physiology in succession to Prof. I. de Burgh Daly, who has been appointed to the chair of physiology at Edinburgh.

LONDON.—The title of reader in the University has been conferred on the following in respect of posts held at the Colleges indicated: analytical chemistry, Dr. H. F. Harwood (Imperial College—Royal College of Science); pathology, Dr. Joan M. Ross (London (R.F.H.) School of Medicine for Women); statistics, Dr. E. S. Pearson (University College).

OXFORD.—On February 13, Congregation passed the Statute, the preamble of which was approved on January 23, for extending and improving the provisions for the study of forestry in the University. The Statute passed without a division, but considerable opposition was offered to a decree providing a site for the proposed new forestry building in the area of the Parks allotted for the extension of scientific departments, in case a suitable site should not be found elsewhere. In proposing the decree, the Master of Balliol pointed out that the moment had arrived when a definite decision must be taken; the whole future of forestry at Oxford was at stake. If the decree were thrown out, co-operation with the Government would be imperilled. The decree was opposed by Prof. R. A. Peters, who denied that the honour of the University was at stake. The Colonial Office must have known that no commitment could be entered into without the consent of Congregation. Further exploration should be undertaken of other possible sites. The Warden of New College urged that this was not a purely domestic matter; the India Office, the Colonial Office, all the Dominions and Crown Colonies were involved. Those who opposed the decree would run the risk of destroying the centre of higher forestry instruction for the whole Empire. Prof. F. A. Lindemann said that the proposed site was unsuitable and undesirable. The decree should not have been brought in until other sites had been explored. The general opinion of the heads of scientific departments, though they wished forestry well, was unfavourable to the proposed site. The danger of exceeding the alleged time limit had been exaggerated. On a division, the decree was carried by 122 to 91.

A SHORT Unity History School will be held at Bath on April 20–23, at which discussions in connexion with present risks to peace in the world, the effects of dictatorships on world peace, and the effect of science on world peace will be introduced by Prof. H. Dingle, Imperial College of Science and Technology, Prof. R. B. Mowat, University of Bristol, and Mr. F. S. Marvin. A more extended School will be held at Rome in 1935, when the subject will be "Science in the Modern World". Further information can be obtained from Mrs. K. E. Innes, 29 High Oaks Road, Welwyn Garden City, Herts.

FOUR Lady Tata research scholarships, of the value of £400 a year each, will be open for award in June 1934, to men or women of any nationality, for research work in the subject of blood diseases, with special reference to leucæmias. Each will be tenable for a year, from October 1, 1934, and renewable up to a normal maximum tenure of three years. Candidates for these scholarships must send their applications in time to be received in London on April 15, addressed to the Secretary, Dr. H. S. Patel, Lady Tata Memorial Trust, Capel House, New Broad Street, London, E.C.2, or Prof. A. Vacha, Calvinstrasse 27, Berlin, N.W.40, or The Lady Tata Memorial Trustees, Bombay House, 24, Bruce Street, Fort, Bombay, from whom forms of application may be obtained.

Science News a Century Ago

Death of Alois Senefelder

On February 26, 1834, Alois Senefelder, the inventor of the art of lithography, died at Munich at the age of sixty-two years. The son of an actor, he was born at Prague on November 6, 1771, and after leaving school studied law at the University of Ingolstadt. His father died early, leaving him to support the family, so he turned to the stage, but with little success. Something of a poet, a painter and a musician, he then began to write comedies, and it was through his efforts to produce copies of these that he was led to his invention. Etched copper plates proved too expensive, so he tried writing on a fine white limestone and removing the untouched surface with acid. By about 1797 he had adopted the method of drawing upon the stone with a greasy substance which had an affinity for printing ink. He was granted an exclusive privilege for the process in Bavaria in 1799, and he took out an English patent on June 20, 1801. The next few years were devoted to the development of the new art and in 1809 he was given the post of director of the royal lithographic office in Munich; this position he held with a good salary for the rest of his life. In 1818 he published his "Lehrbuch der Lithographie", in which he gave an account of his discovery, and this was translated in the following year into English by his fellow countryman, Rudolph Ackermann (1764–1834), who had a print-shop in the Strand, London. Some of Senefelder's original apparatus is preserved in the Deutsches Museum, Munich.

Aurora Borealis

On February 26, 1834, the *Times*, under the above title, published the following extract from the *Westmoreland Gazette*: "This beautiful phenomenon is not often seen in this part of the world during the day, but at mid-day on Thursday we had something very like it. About 1 o'clock three stripes of pale light emanated from a cluster of fleecy clouds resting a few degrees above the horizon, and about a point to the eastward of north, shooting up beyond the zenith till it came in contact with other clouds, when they melted away; one stream was about mid-heaven, the other more eastward. About half-past one there shot from the same clouds the most

beautiful stream of pale light one ever beheld—broad at the base, but extending in width as it shot upwards, not unlike a noble plume of feathers; its progress to the zenith was rapid, but as it passed this point it melted away in ether."

Faraday and Northmore

Faraday's care to give credit to others who had made scientific investigations is recalled by a letter written on February 27, 1834, by Octavian Blewitt (1810–1884), the author of a "Panorama of Torquay" to the editor of the *Philosophical Magazine*. The letter corrected a statement made to Blewitt by Thomas Northmore (1766–1851), the Devonshire man of science who had complained that Davy, Faraday and other philosophers had failed to acknowledge his work on the condensation of gases, an account of which was published in *Nicholson's Journal* of 1805–6. When Blewitt brought this to the notice of Faraday, the latter referred to the *Quarterly Journal of Science* of 1823, in which he had said: "The most remarkable and direct experiments I have yet met with in the course of my search after such as were connected with the condensation of gases into liquids are a series made by Mr. Northmore in the years 1805–6." This answer apparently satisfied Northmore, who expressed regret that he had been ignorant of this reference.

Royal Society, February 27, 1834

Capt. de Roos's paper on the operations for raising stores lost in the wreck of H.M.S. *Thetis* off Cape Frio, on the South American coast, was concluded. A paper was read by George Dollond, giving an account of the application of a concave achromatic lens to the micrometer, proposed to be called the *macro-micro* lens. The author stated that by introducing one of the fluid concave lenses recently invented by Prof. Barlow, between the object-glass and the eye-piece of a 5-ft. telescope, it became as powerful as a 10-ft. instrument. The invention had been regarded as one of the greatest improvements made in optical instruments for many years. This application of a concave achromatic lens arose out of the series of trials that were made for the purpose of correcting the aberrations of the eye-glasses applied to the telescope constructed by the author for the Royal Society.

Palestine Association

A general meeting of the Palestine Association, convened by advertisements in the public journals, was held on January 28, 1834, in the rooms of the Royal Geographical Society, Lower Regent Street, and Mr. (afterwards Sir) Bartle Frere occupied the chair. It was reported that no meeting of the Association had been held since April 24, 1805; and that no steps had been taken to continue the researches in Palestine since the year 1809. It appeared that there remained in the hands of Messrs. Coutts a sum of £135 9*s*. 8*d*. belonging to the Association.

Following discussions in February, it was resolved that steps should be taken to transfer this sum to the Royal Geographical Society to form part of its general fund and to be employed as the council of that Society might think fit for the promotion of geographical discovery. Also, that all papers, books, etc., belonging to the Palestine Association be transferred similarly (Minutes, Palestine Association).

Societies and Academies

LONDON

Royal Society, February 15. J. C. STIMSON: The electrical condition of hot surfaces (5). The rates at which the steady equilibrium potentials are built up on gold, nickel, platinum, carbon, and copper surfaces after earthing have been studied under varying experimental conditions. The rate of charging up of a surface is a linear function of its instantaneous potential, and its logarithm is directly proportional to the reciprocal of its absolute temperature. It is extremely probable that the hot surfaces emit positive electricity over the temperature range investigated (up to 850° C.). When heated in a vacuum, the emission probably consists of positively charged metal ions; while in contact with gases, the ions are positively charged atoms or molecules of the gas. With oxygen at low temperatures, however, the ions appear to be negatively charged. G. I. FINCH and B. W. BRADFORD: The electrical condition of hot surfaces (6): A series of experiments with a gold gauze surface was carried out in such a manner that the catalytic and electrical activities of the metal could be simultaneously observed and followed. The reaction selected was the heterogeneous combination of carbon monoxide and oxygen in both moist and dry systems. The electrical condition of the metallic surface was expressed in terms of the magnitude and sign of the equilibrium potential which it acquired in given conditions, and its electrical activity was measured by the specific rate at which that potential was approached on insulation at zero or other standard potential. In general, throughout the experiments, changes in the rate of electrical charging of the metal followed closely the corresponding changes in the catalytic activity, increasing with rising temperature or with the introduction of water, and undergoing similar variations to the rate of reaction when the surface was maintained at constant temperature. G. I. FINCH and A. W. IKIN: The catalytic properties and structure of metal films (2). The surface potentials and rates of charging-up of cathodically sputtered platinum films in contact with electrolytic gas at room temperature have been determined, and the film structure examined by the method of electron diffraction. It is concluded that (1) catalytic action is determined by a prior interaction between the surface and one or both constituents of the combining mixture, whereby the catalyst becomes electrically charged, (2) activity is not determined by either crystal size or orientation, (3) catalytic activity appears to be centred round isolated atoms or molecules of platinum not forming part of any ordered array or structure. S. F. BOYS: Optical rotatory power. (1) A theoretical calculation for a molecule containing only isotropic refractive centres. (2) The calculation of the rotatory power of a molecule containing four refractive radicals at the corners of an irregular tetrahedron. A theoretical formula connecting rotatory power and chemical constitution has been obtained on the basis of the electronic theory of dispersion. The rotatory power of any molecule is expressed in terms of the ordinary refractive properties and the linear dimensions by means of certain determinants. The expression for the rotatory power is applied to the special case of the molecule containing four radicals attached to one atom, when it becomes quite simple, and theoretical predictions of rotations are compared with experi-

mental data. The formula explains the variation of rotatory power with chemical substitution and also the effects of temperature and solvent. The rotatory dispersion is expressed in terms of the refractive dispersions of the radicals in the molecule. The formula also connects the sense of the rotation with the absolute configuration of the compound, and this should be of vital importance in the study of Walden inversion reactions.

EDINBURGH

Royal Society, January 8. MARY G. CALDER: Notes on the Kidston collection of fossil plant slides (3): Some points in the anatomy of *Sigillaria elegans*, Brongniart. Certain important unrecorded features of the anatomy of *Sigillaria elegans* are described, the specimens on which the description is based having been identified from external characters. (4): On the nature of the corona and its relationship to the leaf traces in the Sigillariæ and Lepidodendreæ, with special reference to certain diploxyloid specimens in the Kidston collection. In order to establish the affinities of certain diploxyloid specimens, to which the name of "Sigillaria lepidophloioides Kidston MS." had been given, the information regarding the nature of the corona and its relationship to the leaf traces in the Sigillariæ and Lepidodendreæ is reviewed. The specimens are finally referred to *Lepidodendron cf. Harcourtii*, Witham. DAVID WATERSTON: New light upon Bishop James Kennedy (1400 ?–1465) from an examination of his remains, recently disclosed during alterations to the College Chapel at the University of St. Andrews. The skull is mesocephalic, but Alpine rather than Nordic. An endocranial cast shows a large and highly developed brain. There had been a fracture of the clavicle which had been treated creditably, a cervical rib, extensive spondylitis of the spine and some occupational modifications. R. GRANT: Studies on the physiology of reproduction in the ewe: (3) Gross changes in the ovaries. Œstrus is associated with growth and rupture of one or more follicles and interœstrum with the development of endocrinologically active corpora lutea. Ovulation is spontaneous and occurs 18–24 hours after the beginning of œstrus. Ovulation and formation of corpora lutea occur also during the last month of anœstrum. Active corpora are present in pregnancy until about two weeks before parturition. In lactation and most of anœstrum, the ovaries are quiescent.

PARIS

Academy of Sciences, January 3 (*C.R.*, 198, 1–128)*. MICHEL FLANZY: A new method for the micro-estimation of methyl alcohol in the presence of considerable quantities of homologous alcohols. The method proposed, which is based on the preliminary conversion of the alcohols into their iodides, can determine with accuracy one part of methyl alcohol in the presence of 1,000 parts of a higher alcohol. Contrary to the accepted view, methyl alcohol has been found by this method in all fermented liquids. MME. RAMART-LUCAS: Colour and the structure of the aromatic oximes. HENRI WAHL: The chlorine derivatives of *p*-xylene. RAYMOND QUELET: A method for the synthetical preparation of the chlormethyl derivatives of the phenolic ether oxides. RENÉ PERRIN: Reflections on the formation of the earth. J. DUFAY: The emission spectrum of the night sky in the ultra-violet region. J. COULOMB and J. DE LAGAYE: A series of measurements with the Arago actinometer. A discussion of observations made three times daily at the Côte de Landais from 1912 to 1933. There appears to be no exact relation between the radiation and the temperature. The radiation shows two marked maxima corresponding to the two years of maximum sunspots included in the period considered. JEAN PIVETEAU: A primordial skull in a Triassic fish from Madagascar. ROBERT LAMI: A new species of *Laminaria* from the Iberico-Moroccan region: *Laminaria iberica*. P. LAVIALLE and P. JAEGER: The fertility and sterility of the androœcium. Their relations with staminal polymorphism in *Knautia arvensis*. ROBERT LEMESLE: The various effects produced by *Fusarium anthophilum* on the ovule of *Scabiosa succisa*. G. MONNOT: The action of sero-opotherapy on the production of the fatty matter of the milk in milch cows. The experiments were carried out on various strains of cattle and in different regions with uniformly successful results. The increase in fat claimed is from 25 to 40 per cent, the quantity of milk remaining the same. The animals increase in weight during the treatment and remain in good condition. J. BRANAS and J. DULAC: The mode of action of copper mixtures. Function of the deposits. The value of the treatment appears to depend on the copper dissolved in the mother liquor: the deposits on leaves appear to be incapable of furnishing rain-water with sufficient copper to afford any protection. JACQUES MONOD: The independence of the galvanotropism and the current density in the ciliated Infusoria. E. BRUMPT: Parasitic specificity and determinism of egg-laying of the fly *Lucilia bufonivora*. CH. DHÉRÉ: The fluorescence of synthetic pyocyanine.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, 19, No. 11, 939–990, Nov. 1933). CHARLES A. KRAUS and GILMAN S. HOOPER: The dielectric properties of solutions of electrolytes in a non-polar solvent. The increase of dielectric constant plotted against concentration gives curves concave to the axis of concentration; the effect is of a different order from that due to ordinary polar molecules. It is suggested that the electrolyte is present as ion-pairs which with increasing concentration form more complex aggregates. The symmetry of its ions has a marked effect on dielectric behaviour at higher concentrations. EVALD L. SKAU and WENDELL H. LANGDON: The purification and physical properties of chemical compounds. (4) A development of a theoretical basis for the behaviour of controlled time-temperature curves. W. E. CASTLE: The linkage relations of yellow fat in rabbits. Lack of a reducing enzyme in the liver permits carotene to pass into fat storage tissue, thus colouring the fat. The condition is sporadic and has been shown by Pease to be a simple recessive linked with albinism. Castle has shown that a loose linkage exists between colour and brown hair and skin pigmentation. Yellow fat is now found to be linked with the latter. The three genes are in the same chromosome; double crossing-over occurs with less than the expected frequency, indicating 'interference' for a mammalian chromosome for the first time. TH. DOBZHANSKY: Rôle of the autosomes in the *Drosophila pseudo-obscura* hybrids. There are two races of *D. pseudo-obscura* which when crossed give offspring the males of which have either rudimentary testes, or normal sized testes incapable of producing functional sperm. This characteristic seems to be due to interactions between the *X*-chromosomes of one race with the autosomes

* Continued from p. 267

of the other. CHESTER STOCK: An Eocene primate from California. Five fragments of jaws, apparently closely related to the tarsiid lemurs (*Anaptomorphidæ*) including the Eocene genera *Omomys*, *Hemiacodon* and *Euryacodon*, have been found at Sespe, north of the Simi Valley. Descriptions and photographs of the fragments are given. J. L. WALSH: Note on polynomial interpolation to analytic functions. SELIG HECHT and GEORGE WALD: The influence of intensity on the visual functions of *Drosophila*. For intensity measurement a series of plates bearing translucent bars of different densities were used; for visual acuity, plates with opaque bars of different widths. A single fly in a glass cell is observed when illuminated with varying intensities of light passing through such plates. At low illumination, two lights are discriminated when the ratio of intensities is nearly 100; this decreases with increased intensity (I) to 2·5. Visual acuity varies with log I, increasing in a sigmoid manner with increase of log I. Assuming the reciprocal of $\Delta I/I$ measures visual acuity, the ratios *Drosophila*/bee/man are 1/60/249 for maximum intensity discrimination, and 1/9·4/1110 for maximum visual acuity. The differences are related to the variation in number of elements functional in the retinal mosaic. T. D. A. COCKERELL and LOUISE M. IRELAND: The relationships of *Scrapter*, a genus of African bees. Cytological and morphological details of insects often suggest 'lateral evolution', that is, a type gives rise to new types without itself disappearing. Moreover, various genes appear to remain latent for long periods. As regards *Scrapter*, from Africa, and *Euryglossidia*, from Australia, though superficially closely alike, they seem not to have had a common ancestry with their special generic characters. OSWALD VEBLEN: Spinors in projective relativity. A formal development of the generalised Dirac equations. W. A. ZISMAN: Corrections to earlier papers (see NATURE, 132, 687, Oct. 28, 1933). All values (statistical) of Poisson's ratio are 5·5 per cent too small. The general conclusions are unaffected.

Forthcoming Events

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

Monday, February 26

ROYAL SCHOOL OF MINES, SOUTH KENSINGTON, at 5.30.—Prof. J. A. S. Ritson: "Explosives and their Use in Breaking Gound" (succeeding lectures on February 27 and 28, and March 1).*

EAST LONDON COLLEGE, at 5.30.—Prof. G. I. Finch: "High Voltage Oscillographs" (succeeding lectures on March 6, 12 and 19).*

ROYAL GEOGRAPHICAL SOCIETY, at 5.30.—G. Rayner: "Observations in the Southern Ocean" (Geographical Film).

Tuesday, February 27

ROYAL SOCIETY OF ARTS, at 4.30.—Prof. C. G. Seligman: "Anthropological Research in the Southern Sudan".

UNIVERSITY COLLEGE, LONDON, at 5.30.—Prof. L. Ruzicka: "The Many Membered Carbon Rings" (succeeding lecture on March 1).*

Thursday, March 1

ROYAL SOCIETY, at 4.30.—C. Sykes and H. Evans: "Some Peculiarities in the Physical Properties of Iron-Aluminium Alloys".

A. J. Bradley and J. W. Rodgers: "The Crystal Structure of the Heusler Alloys".

Friday, March 2

BEDSON CLUB, at 6.30.—Prof. J. Kendall: "Elements, Old and New" (Twenty-fifth Bedson Lecture).

ROYAL INSTITUTION, at 9.—Dr. H. J. Gough: "Current Research Problems in Engineering".

GEOLOGISTS' ASSOCIATION.—Annual General Meeting. A. L. Leach: "The Isle of Caldey: its Geology and Archæology" (Presidential Address).

Saturday, March 3

ROYAL INSTITUTION, at 3.—Lord Rutherford: "The Transmutation of Matter" (succeeding lectures on March 10, 17 and 24).

Official Publications Received

GREAT BRITAIN AND IRELAND

The British Electrical and Allied Industries Research Association (Incorporated). Thirteenth Annual Report, October 1, 1932, to September 30, 1933. Pp. 117. (London.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 21 (N.S.), No. 2: Some Difficulties in Current Views of the Thermal History of the Earth. By Dr. J. H. J. Poole. Pp. 9–22. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1*s.*

The University of Sheffield. Report on Research Work carried out in the Departments of Mining and Fuel Technology during the Session 1932–1933. Pp. 28. (Sheffield.)

Leeds University. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing during the Session 1932–33. Pp. 18. (Leeds.)

The Hundredth Annual Report of the Royal Cornwall Polytechnic Society. New Series, Vol. 7, Centenary Number, Part 3, 1933. Pp. xxv–xxxix+203–288+13. (Camborne: Camborne Printing and Stationery Co., Ltd.) 5*s.*

OTHER COUNTRIES

U.S. Department of Agriculture. Circular No. 301: The Cyclamen Mite and the Broad Mite and their Control. By Floyd F. Smith. Pp. 14. (Washington, D.C.: Government Printing Office.) 5 cents.

The Snellius-Expedition in the Eastern Part of the Netherlands East-Indies, 1929–1930. Vol. 5: Geological Results. Part 2: Geology of Coral Reefs. By Dr. Ph. H. Kuenen. Pp. 126+11 plates. (Utrecht: Kemink et Zonen N.V.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 85. Descriptions of New Fishes obtained 1907 to 1910, chiefly in the Philippine Islands and adjacent Seas. By Henry W. Fowler. Pp. 233–367. (Philadelphia.)

Proceedings of the American Society for Psychical Research. Vol. 22: The Margery Mediumship—The "Walter" Hands: a Study of their Dermatoglyphics. By Brackett K. Thorogood. Pp. xix+228+123 plates. (New York: American Society for Psychical Research.)

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 730: Surface Water Supply of the United States, 1932. Part 5: Hudson Bay and Upper Mississippi River Basins. Pp. vi+206. 15 cents. Water-Supply Paper 735: Surface Water Supply of the United States, 1932. Part 10: The Great Basin. Pp. v+107. 10 cents. Water-Supply Paper 736: Surface Water Supply of the United States, 1932. Part 11: Pacific Slope Basins in California. Pp. xi+416. 15 cents. (Washington, D.C.: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. 87, No. 19: An Oligocene Eagle from Wyoming. By Alexander Wetmore. (Publication 3227.) Pp. 9. (Washington, D.C.: Smithsonian Institution.)

U.S. Department of Agriculture. Circular No. 303: Soil Profile and Root Penetration as Indicators of Apple Production in the Lake Shore District of Western New York. By A. T. Sweet. Pp. 30. (Washington, D.C.: Government Printing Office.) 5 cents.

The Pasteur Institute of Southern India, Coonoor. The Annual Report of the Director for the Year ending 31st December 1932, together with the Twenty-sixth Annual Report of the Central Committee of the Association for the Year ending 31st March 1933. Pp. 74. (Madras: Madras Publishing House, Ltd.)

The Imperial Council of Agricultural Research. Scientific Monograph No. 7: Influence of Manures on the Wilt Disease of *Cajanus indicus* Spreng., and the Isolation of Types resistant to the Disease. By Dr. W. McRae and Dr. F. J. F. Shaw. Pp. iv+68+16 plates. (Delhi: Manager of Publications.) 2.4 rupees; 4*s.* 3*d.*

Memoirs of the Asiatic Society of Bengal. Vol. 12, No. 1: Three Arabic Treatises on Alchemy by Muḥammad bin Umail (10th Century A.D.) Edition of the Texts by M. Turāb Āli. Excursus on the Writings and Date of Ibn Umail, with edition of the Latin Rendering of the Mā' al-Waraqī by H. E. Stapleton and Dr. M. Hidāyat Ḥusain. Pp. iv+213+2 plates. (Calcutta: Asiatic Society of Bengal.) 9 rupees.

CATALOGUES

The *Engineer* Directory and Buyers Guide, 1934–35. Pp. 248. (London: The *Engineer*.)

Watson's Microscope Record. No. 31, January. Pp. 24. (London: W. Watson and Sons, Ltd.)

The Protexray Tube. Pp. 56. (London: Cuthbert Andrews.)

Botany and Gardening. (Catalogue No. 218.) Pp. 40. (London: Dulau and Co., Ltd.)