NATURE

SATURDAY, AUGUST 30, 1930.

CONTENTS.

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

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 3174, Vol. 126]

Eugenic Sterilisation.

SOME of the young people of Germany would have us believe that much of the time that can be spared from their more materially fruitful exploits is given over to singing a song which they call "Deutsche Jugend, heraus". Its language, borrowed from historical romanticism, permits, if it does not foster, a certain diversity of interpretation, and some lines with a frankly Christian significance may even be omitted at the discretion of the singer. Claim to popularity is thus made more catholic.

> Wollt Ihr ein neues bauen
> mit Händen stark und rein,
> in gläubigem Vertrauen
> lasst dies die Losung sein:
> Den Feind in eigner Mitte
> gefällt in ernstem Strauss. . . .

Moralists, it is easy to see, may use these lines to assist them in focusing attention upon that enemy in their midst distinguished as the *beam*, while the nationalist may recognise more immediately its particular referability to the communistic *mote*.

We are assured, however, that the resiliency of this *credo* unites rather than divides, and such demonstrations as we have enjoyed tend to reinforce the assurance audibly. But we cannot help wondering what will happen in the world when the youth of one country or another not only present accessible enemies in their patriotic songs but also define them with scientific precision.

The real enemies of mankind are made, yearly, more and more accessible to attack by science, and if it were not for the protective screens, intangible and often fantastic, thrown up by the unscientific for whom nakedness, even the enemy's, still seems to possess terrible powers, mankind might subjugate very speedily its worst foes. But if, as Sir Walter Fletcher has lately pointed out, a mere ailment, like cancer, has only been made accessible to scientific study through the lifting of foolish and superstitious taboos, how can we expect the direr social maladies to be approached courageously? A protective hedge of errors and superstitions hems them in on every side, so rank and poisonous that it seems that even science is infected and intimidated while it attacks.

How else is it possible to explain the demand just put forward* by a committee of the Eugenics Society for permissive legislation which would take a whole generation to achieve a reduction in the incidence of mental defect not of a hundred, not of fifty, not of twenty-five, but, problematically,

* Committee for Legalising Eugenic Sterilisation. Eugenics Society, London, 1930.

of seventeen per cent ? Between our people and the realisation of this slender benefit stands " an ambiguity of the law " which the Society proposes to remove. A person may, with consent, be sterilised in the interests of his *own* health. In the interest of the public health, present or future, he may not be sterilised. By a curious legal inversion, the 'willing mind' of the individual cannot take away the offence against the public even should he be prepared to save it from all possibility of contamination by his own progeny. The offence consists in a 'maim' which deprives the individual, or so it may be contended, of martial courage, and the State of a vessel, however unsuitable otherwise, for this same virtue. To contentions of this sort, surely the monosyllabic genius of Mr. H. G. Wells's latest novel has supplied the only effective answer.

To meet the practical situation, the committee proposes a Bill legalising eugenic sterilisation. This would authorise the mental deficiency authority or superintendent of an institution to sterilise a mental defective, subject to the consent of the parent or guardian and of the Board of Control, and of the spouse if the defective is married. In the case of defectives deemed capable of giving consent, sterilisation would not be performed otherwise than with this consent. It would authorise the voluntary sterilisation of a person about to be discharged from a mental hospital for the insane as recovered, again with the added consent of Board and of parent, guardian, or spouse ; and it would legalise voluntary sterilisation for the sole purpose of preventing the transmission of hereditary defect seriously impairing physical or mental health or efficiency.

Five members of the committee and another contributed to the *Lancet* for July 19 a letter defending this policy. The defence combats the assertion that if every certifiable mental defective had been sterilised twenty or thirty years ago it would have made little appreciable difference to the number of mental defectives existing to-day. It repeats a sentence of the committee's report urging that " if all the defectives in the community could be prevented from having children the effect would be even on the most unfavourable genetic assumptions with regard to defectiveness, to reduce the incidence of mental defect by as much as 17 per cent in one generation ".

Obviously a 17 per cent reduction in the incidence of mental deficiency is more desirable than a 17 per cent increase. But do the committee's proposals ensure this reduction ? Clearly, no. The words quoted promise at least that reduction if the fertility of *all* living mental defectives is prevented. The committee's proposals, with their emphasis upon the voluntary principle, by no means ensure that the 300,000 certifiable mental defectives in England and Wales would be sterilised. Who must consent ? (1) The patient, if he is capable. (2) The parent or guardian. (3) The spouse if the patient is married. (4) The Board of Control. The calculation, it is true, is based on two assumptions " highly unfavourable " to the effectiveness of the proposals—that the genetic factor responsible for defectiveness (primary amentia) would be much 'carried' and would only rarely produce manifest defectives, and that defectiveness is uniformly distributed throughout the community. (The fertility of defectives also is assumed to be that of the average of the population.)

How unfavourable, on the other hand, are the chances of permission ? Nothing is gained by attempts to write off opposing assumptions. A figure is a figure, right or wrong.

Again, is a 17 per cent reduction all that eugenic science can promise ? Disregarding altogether those so-intelligent defectives who will strive to serve the country by seeking this minor mutilation, is it the institutional class that constitutes the chief danger to society ? Prof. MacBride (NATURE, Jan. 11, 1930, p. 40) says emphatically that this but touches the fringe of the problem. " The defectives most dangerous to society are those who are never confined in institutions at all ! The high-grade defectives are just able to support themselves in the lowest paid and most unskilled occupations, and no civilised government would take the responsibility of confining them, and so they go on propagating large families as stupid as themselves." His idea of penal sterilisation, a punishment " for the economic sin of producing more children than the parents can support ", is one which becomes more and more difficult to apply as more and more ways are devised by the State for screening the individual from biological estimation.

Is there not a real danger that the advocates of such legislation as here may mistake the assent of the political machine for victory ? If assent were gained, would it not be much more accurately determined as the hall-mark of failure ? It is not the assent of the State, but the initiative and creative power of the State, that is needed to secure essential progress, and that will not exist until our legislators of all parties or of any party derive their inspiration from the cultivation of natural knowledge.

Biochemistry for Students.

(1) *The Essentials of Chemical Physiology: for the Use of Students.* By Prof. W. D. Halliburton, Dr. J. A. Hewitt, and Dr. W. Robson. Twelfth edition. Pp. xii + 383. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1929.) 9*s*.

(2) *A Text-book of Biochemistry: for Students of Medicine and Science.* By Prof. A. T. Cameron. (Churchill's Empire Series.) Second edition. Pp. xi+482+2 plates. (London: J. and A. Churchill, 1929.) 15*s*.

(3) *A Course in Practical Biochemistry: for Students of Medicine.* By Prof. A. T. Cameron and Prof. Frank D. White. (Churchill's Empire Series.) Pp. x+222+4 plates. (London: J. and A. Churchill, 1930.) 8*s*. 6*d*.

(1) AFTER more or less of a dependent career, biochemistry has at last attained what one might call 'Dominion status' among the community of the biological sciences, and the three small volumes under review are a token of this attainment. One of them, "The Essentials of Chemical Physiology", which was first published in 1893, now appears in its twelfth edition, the original author, Prof. W. D. Halliburton, the pioneer of biochemistry in Great Britain, being assisted in its production by two representatives of the modern school, Dr. J. A. Hewitt and Dr. W. Robson. For training medical students in what will be of real value to them in their professional work as physicians, the book is excellent. The guidance by the experienced teacher of a difficult subject is seen in the selection and arrangement of the experiments, and these are described in such a way as to give the student opportunity of testing for himself the broad principles of the subject, as well as of acquiring some practice in those quantitative methods which are used as aids in clinical diagnosis.

To acquire perfect accuracy in the use of quantitative methods would take much more time than the already overcrowded medical curriculum can afford. Nor, indeed, were the time available, would it be of much value to try to do so; nevertheless, it is most important that the physician should learn enough about how the methods are carried out, so that he may be in a position to know what emphasis to place upon the results submitted to him by the clinical chemist. It is through a lack of this knowledge that many physicians fail to put a proper value on the assistance they can derive from the biochemist. They are apt to look upon him merely as a technician whose work is done when he has reported the results of the often laborious, and sometimes useless, chemical analyses assigned to him. They fail to realise that intimate collaboration between physician and biochemist, not only in the diagnosis but also in the conduct of the case, would be invaluable. It is this principle that a modern course in biochemistry should teach, and the present volume furnishes an admirable stepping-stone leading to its realisation by the student.

The theoretical matter is sufficient in scope to connect the purely chemical with the physiological aspects of the subject. Occasionally, as is a common fault with all elementary texts in a growing science, dogmatic statements are made, when really the truth is not known with certainty. For example, it is stated on p. 149 that regurgitation of the duodenal contents is the *normal* method by which the acidity of those of the stomach is prevented from rising too high. Is this proved?

The printing of the experiments in bold type is an excellent idea.

(2) The other two volumes are of a somewhat different type. One of them is the second edition of a "Text-book of Biochemistry", and the other, which now appears for the first time, a practical manual to go with it. The text-book differs from Halliburton's "Essentials" in being not restricted to the needs of the medical student. It treats the subject on somewhat broader lines, and will be found most useful as an introductory text for those who may be looking forward to a career in biochemistry itself, or are studying it with the view of entering one or other of the many non-medical sciences (agriculture, bacteriology, food chemistry) in which its principles are applied.

By a judicious use of small print, much of the more advanced matter is kept by itself and may be omitted without disturbing the sequence of the text. Although the author is a chemist by training, he has succeeded admirably in incorporating with the purely chemical material the biological and the medical applications of his subject. Here and there, however, the physiological teaching is somewhat unorthodox, as, for example, on p. 143, where we are told that the intestinal juice is largely secreted by the glands of Brunner.

The book is clearly written, the subject matter very well selected and arranged, and sufficient attention is given to the discussion of unsolved problems of biochemistry to arouse the interest of the better type of student, for whom also a short bibliography at the end of each chapter affords a guide to further reading. The early appearance of a second edition is evidence of the demand for

such a book, and the author may justly be proud of his success.

(3) The "Practical Biochemistry", by the same author in association with F. D. White, contains a series of laboratory exercises requiring at least fifty-six periods of three hours each to carry out. This exceeds considerably the time available for such work in the great majority of the medical schools of Great Britain, so that, if the text were adopted, considerable pruning would be necessary by the teacher. The course is arranged in two parts; the first dealing with qualitative procedures and the second with quantitative. In the latter, only one approved method has been selected for detailed description of each substance estimated, brief references being also given to other methods. As an accurate and useful laboratory guide to the fundamental experiments of biochemistry, the book is excellent.

An Optical Miscellany.

(1) *Introduction to Physical Optics.* By Prof. John Kellock Robertson. Pp. vii + 422 + 6 plates. (London: Chapman and Hall, Ltd., 1930.) 20*s.* net.

(2) *Traité de polarimétrie.* Par Prof. Georges Bruhat. Pp. xvi + 447. (Paris: Éditions de la *Revue d'optique théorique et instrumentale*, 1930.) 65 francs.

(3) *Guide de l'ouvrier en verres d'optique de précision.* Par Col. Charles Dévé. Pp. xvii + 258. (Paris: Éditions de la *Revue d'optique théorique et instrumentale*, 1930.) 36 francs.

(4) *Zur Geschichte der Zeissischen Werkstätte bis zum Tode Ernest Abbes.* Von Moritz von Rohr. Mit Beiträgen von Max Fischer und August Köhler. Pp. viii + 120 + 10. (Jena: Carl Zeiss, 1930.)

THESE four books represent some aspects of the widespread domain of 'Optics'. (1) Prof. Robertson's "Introduction to Physical Optics" will appeal more to the theoretician than to the experimentalist. Its tendency is to present an idealised picture in which mundane difficulties disappear, as is no doubt quite necessary if some slight ideas of relativity and wave mechanics are to be introduced before the end of a not-too-long book. It is, however, a very lucid and direct treatment in which the modern developments of the subject of the interaction of radiation and matter receive their due balance of attention. The early parts comprise a clear discussion of lens and mirror optics (treated on the 'wave' basis), interference, and diffraction. The mathematics is limited to simple algebra and trigonometry.

While it is good to find that the sign conventions used in the lens and mirror problems are in agreement with those of technical practice, it is greatly to be desired that authors would not alarm students by remarks such as "in any problems dealing with refraction at a spherical surface, it is better not to work from a formula but from fundamental considerations". If the use of unsymmetrical formulæ such as

$$\frac{n}{p}-\frac{1}{q}=\frac{n-1}{r}$$

were only replaced by the symmetrical form

$$\frac{n'}{q}-\frac{n}{p}=\frac{n'-n}{r}$$

the need of injunctions about "fundamental considerations" would not dismay people whose time is limited.

We wish that it could be realised that the physical difficulties, over which books such as this glide so easily, have an educational value in themselves. Let the student realise that the slits actually used in Young's experiment may be big enough to contain thousands on thousands of atomic sources of light in their breadth (let alone their length), and what becomes in his mind of the "well defined wave fronts" which spread out (according to this book) from a single slit? These conceptions really are a little too facile, in view of the matters dealt with in the concluding chapters. Do we really understand 'interference' so well; more especially interference under large path differences?

(2) Prof. Bruhat in his "Traité de polarimétrie" writes for serious experimenters who are interested in exact measurements. To make the subject intelligible to a wider circle, he includes a discussion of the principles of the wave theory. His experience evidently allows him to assume very little exact and systematic knowledge on the part of most beginners in this field, so that all points in connexion with instruments and their functions are explained with the greatest thoroughness and care. As he admits himself, some parts of the book are "over-developed" with respect to the requirements of certain classes of reader, but, as new applications of polarimetric measurements are continually being described, the collection of cognate material in a single volume will find few to condemn it.

After dealing at length with instruments and sources of light, he discusses the chief phenomena of rotary polarisation and measurements in this connexion. Some attention is given to the theories of stereo-chemistry; then normal and anomalous

rotary dispersion and dichroism are discussed. The treatment is introductory and non-mathematical. After this preparation a special section is naturally devoted to the determination of sugar contents, and some final sections deal with the rotary effects of crystals and magnetic rotary polarisation.

This book illustrates in a most striking manner the vast developments of such special subjects which have taken place within the last half-century. The comprehensive bibliography is a very useful feature. We may envy Prof. Bruhat the catholicity of his reading and knowledge, especially when his well-known works on electricity and thermodynamics are remembered.

(3) Col. Charles Dévé's little guide for the worker in optical glass is one of the latest of the useful series published by the Institut d'Optique, to which Prof. Bruhat's "Polarimétrie" also belongs. It should be very useful to those who have to control the grinding and polishing of glass. The section on the mechanical theory of the grinding process is very original and suggestive. This subject is a matter which has received very little systematic attention (at least, if it has, the results have never been published), so that this analysis and explanation should appeal to the practical worker who can arm himself with the necessary technical dictionary and thus make shift to overcome the language difficulties, which are somewhat more formidable in connexion with workshop and commodity terms than in ordinary scientific literature.

While the chapters on practical tests for optical glass and finished prisms, etc., will offer some useful hints, they by no means exhaust the subject. We are surprised to hear that the "méthode des ombres portées" is "incomparablement plus sensible" than a suitable form of the Foucault test. The "vérifications à l'atelier" include many useful methods, but include no mention of the interferometer, which has long since ceased to be a purely laboratory instrument. The auto-collimator is important enough in practice to receive more attention. These suggestions are, however, not made to minify the value of a book on a subject in which the available literature is so scanty.

(4) Turning to an item of greater human interest, Prof. M. von Rohr writes an interesting history of the Zeiss Optical Works up to the time of the death of Abbe. It will appeal to all who have even a slight knowledge of optics, and are also interested in the development of technical industry.

Here we trace the early influences surrounding the founder of the firm, Carl Zeiss, which doubtless led to his desire for the co-operation of such a partner as he found most fortunately in Ernst Abbe.

Abbe himself was indifferent to publicity, and but little of his scientific work is published; but these pages give some glimpses of his unremitting activity and painstaking thoroughness—especially in the account of his early experiments on the mode of the formation of the image in the microscope. This firm found the secret of success in team-work by competent individuals under adequate leadership. If this was a singularly effective recipe in the latter half of last century, it is now a *sine qua non*.

L. C. MARTIN.

Law, Causation, and Reality.

Identity and Reality. By Émile Meyerson. Authorized translation by Kate Loewenberg. (Library of Philosophy.) Pp. 495. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Co., 1930.) 16*s*. net.

Identität und Wirklichkeit. Von Émile Meyerson. *Deutsch von Kurt Grelling nach der 3 Auflage des Originals.* Eingeleitet und mit Anmerkungen versehen von Prof. Leon Lichtenstein. Pp. xl + 534. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1930.) 21 gold marks.

THE publication of English and German translations of Dr. Meyerson's work (1908) is a somewhat tardy recognition of its importance. The present versions are based on the third edition of 1926, which is practically that of 1912 with notes on subsequent developments in science. Although this may seem to restrict the value of the book, the additions accord sufficiently well with the author's analytical investigation of the two cardinal principles which research has once again thrust into the forefront of debate—universal causation, and universal conformity to natural law. What constitutes the ultimate ground of their presumed universality? Is it the inductive outcome of observation and experiment, always imperilled, therefore, by the Damoclean sword of revolutionary discovery or even the negative instance? Or does its validity consist in some quite irrefutable, and in a sense *a priori*, characteristic of thought, which finds an adequate foundation in the very structure of reality?

Most scientific workers would unhesitatingly reject the second suggestion as a mere vestige of antiquated speculation, discredited equally by its anthropomorphism and by every sound principle of methodology. On the other hand, it must be clearly realised that the deductive, and again in a sense *a priori*, proofs of mathematics are acquiring

a steadily expanding applicability within almost every field of research; and this to such a degree that Prof. Whitehead, in "Process and Reality", regards his own survey of science as ample justification for appealing to rationalism and metaphysics. Similarly, Dr. Meyerson maintains that the scientific concepts of conservation, mechanism, and inertia arise not only from the two sources of 'lawfulness' and 'scientific causality', but further, as regards causation, from *a priori* factors which, though they certainly remain concealed by science, must not, therefore, remain ignored. On the contrary, it is precisely these factors which, like an 'unconscious' incessantly though invisibly directing scientific activities, have actually determined their slow historic meanderings from their Ionian origins to to-day, alike in the purely mechanical and the non-mechanical spheres. Thus all the dominant concepts "rest upon what constitutes the foundations of the human mind" (p. 409).

From this point of view Meyerson explicitly affirms that "metaphysics penetrates all science, for the simple reason that it is contained in its point of departure. We cannot even isolate it in a precise region." It follows, therefore, that "the ontological character of scientific explanation is ineffaceable" (pp. 377, 385); and although Hume's scepticism and Kant's agnosticism are outstanding anticipations of the prevailing scientific reaction to this contention, recent correspondence in these columns clearly expresses the suspicion (to say the least) that the science of to-day, and still more of the future, must criticise its own self-denying ordinances if it is to do itself justice by securing adequate self-consistency. The ultimate issues are undeniably debatable and profoundly subtle and involved; nevertheless, it is the expansion of science that is forcing them more and more irresistibly into consideration. Now, however unexpected the advances may be, they still retain an ineradicable element of continuity; and this implies that earlier developments may illuminate future problems to an important degree. Certainly the present volume is an inquiry into the nature of knowledge as such; but the author possesses an unusually wide and detailed acquaintance with past scientific theory and research, which he has incorporated in a systematic and impartial critique of current principles directly pertinent to reigning controversies.

It appears to be rapidly becoming a vital question whether experiment and induction may not tend to make science too extremely Baconian; and Meyerson cites a frank opinion of Liebig's in support of his own plea, favoured among others by Poincaré and Duhem, for pure theory with all its epistemological implications. He begins with an important distinction between the concept of natural law, postulating determined changes in properties, and the idea of causation, implying the constant equality of original properties to the final, when changed conditions are duly taken into account. Thus causality comes to involve "the principle of identity applied to the existence of objects in time"; it is, therefore, "profoundly different from that of lawfulness" (p. 43).

In its instinctive search for adequate explanation, then, science has consciously or unconsciously pursued this ideal of absolute identity, as expressed in increasingly intelligible forms of atomism, conservation, and inertia; and this raises the fundamental problem as to how far this principle must be carried. Meyerson proceeds to maintain that, despite all attempts to displace explanation by description, or to employ symbolism, science remains "profoundly impregnated with the search for causality" in the foregoing sense. It is, of course, obvious that all constants and relativistic absolutes are immutable identities; hence the further crucial issue whether these constants must be progressively reduced to a minimum. If not, how are they interrelated? And how reconciled with the patent diversities of Nature, with teleology and indeterminancy?

Here also Meyerson is insistent that "only the foundation of mechanism, the explanation of phenomena by motion, is and will be really eternal" (p. 415). Yet though science seems committed to an endless transition to more and more refined types of mechanism, no mechanism can ever be final; all mechanical hypotheses ultimately become self-contradictory and even absurd; while to carry the causal principle to its conclusion involves "the annihilation of the phenomenon"—a tendency visible in the reduction of natural process to pointer readings and equations. Equations, again, are essentially reversible, conflicting therefore with the irreversibility inseparable from Carnot's principle. Finally, "the end of the reduction can only be irrational" (p. 409), even though scientific instinct demands the minimum of an irrationality it can never evade. Yet can we agree that reason leads only to irrationality? Is not 'super-rational' a more fitting term? To conclude with a simple analogy, is the calculus irrational to the child mind, or is it not rather super-rational? And may not this best describe the aspect which reality must ever present to scientific thought?

J. E. TURNER.

Our Bookshelf.

American Civil Engineers' Handbook. Editor-in-Chief: Thaddeus Merriman; Associate Editor-in-Chief: Thos. H. Wiggin. Fifth edition, thoroughly revised and enlarged. Pp. iii + 2263. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 40*s.* net.

FOR the past twenty years or so "Merriman's Pocket Book"—to give its original title—has been familiar as a useful compendium of American practice in civil engineering, sharing the field with Trautwine and some others across the Atlantic and following in the footsteps (more or less) of Molesworth, Kempe, and other British publications. Now it has reached a fifth edition, and in consequence of the lamented death of Mansfield Merriman, the original compiler, it is issued under the names of his successors, Thaddeus Merriman and T. H. Wiggin. As in the case of previous editions, a number of associate editors have assisted in dealing with separate sections.

Naturally there are changes—partly in the material and partly in its disposition. The new edition contains 2263 pages, or 268 more than its immediate predecessor. The order of the sections has been modified somewhat to suit an alternative arrangement by which the book can be obtained, if desired, in two volumes instead of one. The present number of sections is 22, and they comprise all departments of civil engineering work and even encroach in some measure, as is inevitable, on the neighbouring domains of mechanical and electrical engineering; but, except in a few casual and fragmentary paragraphs, they do not intrude appreciably into aeronautics.

The difficulties of selecting and arranging material for inclusion in a handbook (the term pocket book is no longer applicable to "Merriman" and has been discarded since the third edition) are considerable if not almost overwhelming, and the nineteen associate editors have, not unnaturally, had different views on the matter. The critical reviewer can find here and there examples of what he may consider as superfluities and inadequacies, but he must admit that neither his own, nor perhaps any, selection would be likely to meet with universal and unqualified acceptance. It can be said, and said cordially, that "Merriman" in its fifth edition maintains the high standard of previous issues and should have the same popularity; though, as affects British engineers, in quite a number of respects its outlook is definitely coloured by American conditions and American methods of practice. B. C.

Aquatic Mammals: their Adaptations to Life in the Water. By A. Brazier Howell. Pp. xii + 338. (Springfield, Ill., and Baltimore, Md.: Charles C. Thomas; London: Baillière, Tindall and Cox, 1930.) 22*s.* 6*d.* net.

WHALES are fashionable at present, both among scientific men and the public, on account of their supposed forthcoming extinction by large steam whalers working upon the high seas away from all territorial control. A comparative anatomy of aquatic mammals based mainly on them, the sea cows, the seals, and the otters is hence opportune. Thirty-five other genera of aquatic mammals are mentioned, most being rodents or insectivores. The head with special sense organs, mouth, and skull come in for treatment, our author then passing to neck, trunk, tail, and limbs in turn. We feel that these chapters would be much more informative if the habits of aquatic animals had been reviewed at greater length, especially their food and feeding as closely affecting teeth and head. Theories are provided as to the fatty tissues, respiratory, digestive, and vascular systems, but we would have liked these studied more closely in relation to the author's Lamarckian views on evolution. Why he should state that "the porpoise has less need for intelligence than almost any other living mammal" is a mystery to us.

This book is necessary to libraries and will be useful to anatomists, for they will find in every section theories with which they disagree. They are possible explanations inserted by the author to stimulate his readers, and they are successful. He himself is only wedded to his Lamarckism as his introduction shows. We do not know how variations that can be selected by Nature arise, but we would like to know what percentage of each generation of his white mice "made to dig industriously in the ground for each and every day", with outcome a race with specialised digging feet, have died because they could not stand our author's drastic compulsion through "twenty or a hundred thousand generations". However, the functioning of all organs is the important study here, not the method of an evolution, which might just as well have been assumed.

The Passion for Life. By Rev. John Lewis. (Published on the Foundation established in Memory of James Wesley Cooper of the Class of 1865, Yale College.) Pp. x + 123. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1928.) 9*s.* net.

THESE five lectures have a certain interest as illustrating the contemporary tendency to strengthen older feelings and institutions by an infusion of science. Mr. Lewis is a student and a tutor of anthropology and also minister in a Welsh church. The last generation tended to shut the door of the laboratory when it went to the oratory: this one, including Mr. Lewis, tries rather to make passages between them. It is a wholesome change, but difficult to carry out, and liable to deform one or other of the structures thus connected. In this case the account of religion which results would not satisfy the more thoroughgoing students of religion. Mr. Lewis tells us that he is more and more convinced that the "premier motive of religion is the passion for life", but this definition, though containing a large element of truth, is both too wide and too narrow. The 'passion for life', being a general animal, or even biological, characteristic, can scarcely be taken as the differentia of the religious impulse in man, while, on

the other hand, the study of religion reveals other, perhaps equally potent, elements in its genesis—fear, for example, awe, and, above all, the social nexus, which, though cognate, cannot be identified with 'the passion for life'.

The book, however, contains a good deal of suggestive matter, rather of the hortatory than the scientific kind, and an interesting and more detailed account of the cult of the 'Great Mother', especially among the Babylonians. Mr. Lewis ranks first the Sumerian-Babylonian stage of civilisation, then the Egyptian, Indian, and Chinese, followed by Greece and Rome, the Arabian, the Mayan, and the British-American. F. S. M.

A Text Book of Dairy Chemistry, Theoretical and Practical: for Students of Agriculture and Dairying. By Edgar R. Ling. Pp. vii + 213. (London: Chapman and Hall, Ltd., 1930.) 6*s*. net.

THIS book is divided into two main parts—theoretical and practical. The theoretical part evidences very careful preparation and an appreciation of modern views in dairy science. In almost every section recent investigations are referred to, and at the end of each chapter there are references to the publications cited.

The chapter on the constituents of milk contains a short account of the vitamins and of the part they play in nutrition. Chapter ii. deals with the composition of milk, and the factors which influence composition. In the following chapter attention is directed to the physiological and legal considerations which are associated with variation in composition, and reference is made to abnormal milk and the applicability of methods used for the detection of adulteration.

Milk products, condensed milk, dried milk, and cream are discussed, and in the same chapter are sections treating of the rising of cream, mechanical separation, reconstituted cream, etc. The conditions affecting the making of butter and the methods used in the detection of adulteration are referred to in Chapter v., whilst cheese and dairy by-products are dealt with in the following chapter. Mention should be made of the chapter on the action of heat on milk and the action of milk on metals. The treatment throughout the theoretical part is uniformly good; the subject matter is quite up-to-date and is presented attractively.

The second part deals with the practical operations used in the separation and examination of milk, and the methods of analysis of milk and milk products. Naturally there is not in this part the same opportunity for the exercise of individuality, but the details are fully and clearly given.

The Quantitative Analysis of Inorganic Materials. By Norman Hackney. Pp. xv + 378. (London: Charles Griffin and Co., Ltd., 1930.) 30*s*. net.

THE aim of the book, which is largely fulfilled, is to give sound, practical, and commercially accurate methods of analysis in a form suitable for use by advanced university students and graduates. Included in the scope of the work are sections dealing with the use of apparatus, the theoretical considerations underlying the more important analytical operations, the determination of the commoner elements, volumetric analysis, the more commercially important separations of the elements referred to, and the complete analysis of ferrous and non-ferrous alloys, and of a few selected ores and other materials.

The separation and determination of the metals are given in the order in which they are met when the analysis is carried out according to the usual group method, and are fully and clearly described, volumetric methods being given due emphasis. The importance of the application of most, though not all, of the newer organic reagents in the separation and determination of the elements is rightly stressed.

The book is free from printing errors and has a satisfactory index. In view of the recommendation of the Joint Committee for the Standardisation of Scientific Glassware, that standard volumetric glassware shall be graduated in terms of the litre (l.) and millilitre (ml.), it is undesirable to perpetuate the use of the symbol 'c.c.'. On the whole, however, the book can be recommended for use by students and young chemists in commercial laboratories. A. G. F.

Einführung in die theoretische Physik: mit besonderer Berücksichtigung ihrer modernen Probleme. Von Prof. Arthur Haas. Band 1. Fünfte und sechste, abermals völlig umgearbeitete und wesentlich vermehrte Auflage. Pp. x + 396. (Berlin und Leipzig: Walter de Gruyter und Co., 1930.) 15 gold marks.

THE new edition of the first volume of Prof. Haas's summary of mechanics and physics contains so many alterations that it is almost a new book. The main change, however, is the inclusion of two chapters on classical thermodynamics, the first on general principles and the second on their applications. In these chapters, as elsewhere, exact formulation of fundamental ideas and typical results is insisted upon rather than detailed analysis of specific problems, the general standard being rather above that of most honours courses in physics. Other important changes are additions to the section on generalised equations of motion, and the insertion of a section on diffraction. As a coherent account of classical work, this book, which is in the clear and precise style characteristic of all Prof. Haas's publications, is invaluable; it is to be hoped that the appearance of a new edition of the second volume, on more recent work, will not be unduly delayed.

Birth Control: Why and How. By George Whitehead. Pp. iii + 174. (London: John Bale, Sons and Danielsson, Ltd., 1929.) 6*s*. net.

MR. G. WHITEHEAD gives us a trenchant account of the arguments in favour of limiting the size of families, and also gives us an account of the mechanisms thereof. The author rightly points out that most of the arguments against birth control are based on sheer ignorance and prejudice, or the use of the subject for political propaganda.

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.*]

Giant English Oysters (*O. edulis*).

IT is commonly believed that old individuals of *O. edulis* are incapable of spawning as females, and as the matter is of some importance economically, an interest is thereby added to the following observations.

On Sept. 20, 1929, Miss E. T. Nicol and Mr. W. Searle each collected a giant oyster (*O. edulis*) near low water mark on muddy gravelly ground in Salcombe Estuary, near the Salstone (east of the Salstone and south of Wareham Point). These oysters were kindly given to one of us (J. H. O.) for examination, and were kept in dishes in the hope that natural spawning might occur. Apart from size, these individuals were in all macroscopic respects similar to the common oyster (*O. edulis*). On Sept. 26, as spawning had not occurred, and observations could not be continued after the following day, the oysters were measured and weighed, and then placed in a strong solution of T.N.T. (trinitrotoluene) to narcotise them. On Sept. 28 the oysters were not sufficiently narcotised to permit careful opening, but Mr. Amirthalingam arrived at the laboratory and continued the observations on the living animal. The oysters were carefully extracted on Sept. 30 and both were found to be females. The larger oyster, *B*, had in fact spawned a few ripe eggs into the mantle cavity and was found to be a very fine well-fished individual with its gonad and gonoducts full of ripe eggs ready to be spawned. The eggs are of the same size, *c.* 150μ,

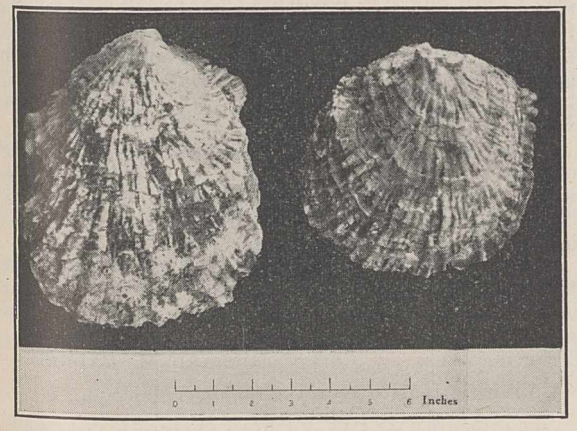


FIG. 1.—Giant oysters from Salcombe Estuary.

as those in smaller *O. edulis*. The smaller individual, *A*, was a well-fished maturing female and contained developing eggs 80-100μ in diameter. The gonoducts were empty.

The flesh of each oyster was rough dried with blotting-paper and weighed: *A* weighed 67 gm., and *B* 94 gm. As a fine oyster meat weighs only 8-8½ gm. these weights offer a good criterion of size. The entire giant oysters weighed respectively 731 gm. (= about 1⅗ lb.) and 1265 gm. (= about 2¾ lb.), and their shells were very 'deep' as well as large (see Fig. 1). A large entire eating-oyster weighs 2-2½ oz. and has a subcircular shell 8-9 cm. in diameter and depth about 3 cm. The shell *A* had the dimensions: Length and breadth, each = 15·8 cm., and depth = width = 4·3 cm.; *B* had length = 17·6 cm., breadth = 19·8 cm., and depth = 5·9 cm., as shown with other dimensions in Table I. Both individuals were therefore undoubtedly giants, and not merely large thin specimens such as are sometimes produced from a flat habit of growth—as on a flat surface of attachment.

Similar giants have occurred in other localities. On June 4, 1927, one of us (J. H. O.) examined a sample of 17 large deep oysters (4-4½ inches subcircular) originating from Poole Harbour. These observations were made at the beginning of the breeding season, when four individuals were found to be ripe or nearly ripe females, seven ripe or nearly ripe males, two others indifferent males and four individuals in a neuter condition. Similar large individuals are said to have been common at one time in the upper reaches of the Fal River, and fossil forms of apparently the same species are known to attain a length of about 10 inches.

TABLE OF DIMENSIONS OF GIANT SALCOMBE OYSTERS (*O. edulis*).

	Length in cm.	Breadth in cm.	Width in cm.		Weight entire (gm.).	Weight of Dry Shell (gm.).	Weight Oyster Meat (gm.).	Approx. Wgt. of Liquor (gm.).	Approx. Vol. of Liquor (c.c.).	Sex.
			External.	Internal.						
A	15·8	15·8	4·3	3·0	731	574	67	70	68	Maturing female
B	17·6	19·8	5·9	3·8	1265	1038	94	133	130	Ripe female

It is difficult to estimate the ages of specimens *A* and *B* owing to the possibility of two increments of shell occurring in one season, but it is certain that the age would be expressed in double figures. The observations recorded above, however, show clearly that large or giant oysters do retain the capacity to function as females. From what is now known about *O. edulis*, there is therefore every probability that individuals may change sex annually from female to male and back again to female from the age of about three to at least twelve years, if left undisturbed on good oyster beds. There is also little doubt that the oyster *B*, mentioned above, would have produced at least 10 c.c. and possibly 20 c.c. of eggs, which if developed would have yielded a minimum of about three million larvæ. Hence the value of large oysters of this kind not only for adding to the stock on good beds, but also for replenishing those beds which have apparently been fished out. It is indeed possible that the sudden repopulating of old beds may be due to a spatfall obtained under favourable conditions from relatively few giant individuals tucked away in inaccessible places. The shells of *A* and *B* are retained in the museum of the Marine Biological Laboratory at Plymouth.

J. H. ORTON.
C. AMIRTHALINGAM.

The University, Liverpool, and
University College, London.

Measurement of Space-Potential in High Frequency Discharge.

MEASUREMENTS of the space potential as well as the concentration and the average velocity of the ions and electrons in the different parts of a discharge tube have been greatly facilitated by the elegant method developed by Langmuir and Mott-Smith (*Phys. Rev.* 28, p. 727; 1926). This method has already been

successfully employed in the study of d.c. discharges, but, so far as we are aware, it has not yet been used in a.c. discharges. In the latter case, a number of difficulties have to be overcome before it can be successfully applied.

In dealing with d.c. discharge, the space-potential is generally referred to that of one of the electrodes maintaining the discharge; it cannot be so referred in the case of an a.c. discharge. Moreover, in high frequency discharges obtained with external sleeve electrodes—a subject of many recent investigations—the volt-ampere characteristic of the Langmuir 'exploring electrode' cannot be obtained when one of the external electrodes is used in the circuit.

We have been able to overcome this difficulty by using an extra bobbin-shaped internal electrode to complete the circuit through the 'exploring electrode'. This internal electrode is kept outside the region of the main discharge so as not to affect it in any way. A typical volt-ampere characteristic as obtained by us in oxygen at a pressure of 0·14 mm. of mercury is plotted in Fig. 1 with the logarithm of the current to the 'exploring electrode' as ordinate and its voltage as abscissa. It is to be observed that the nature of the curve is similar to that obtained in d.c. discharges as described and fully discussed in "Conduction of Electricity through Gases" (Methuen's Monograph Series) by K. G. Emeléus.

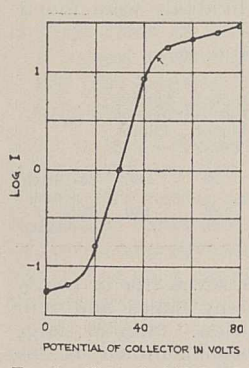


FIG. 1.—Characteristic log I, V curve.

From such characteristic curves we have measured not only the variation of the space-potential but also the concentration and the average velocity of the electrons in different parts of the discharge. A typical set of results is given below:

Oxygen under pressure 0·14 mm. of Hg.
Distance between electrodes, 15 cm.
Frequency, $1{\cdot}2 \times 10^6$.

Distance from left electrode.	Space potential.	Average electron velocity (volts per cm.).	Concentration of electrons.
4·5 cm.	24 volts	7·83	$2{\cdot}62 \times 10^8$ per c.c.

A detailed description of the method with discussion of the results is being published elsewhere.

Incidentally, it may be mentioned that C. J. Brasefield (*Phys. Rev.* 35; 1930) has carried out measurements of electron velocities in high frequency discharge by a spectroscopic method, remarking that it is extremely difficult, if not impossible, to employ Langmuir's 'exploring electrode' method for measurements in high frequency discharge. The above application of Langmuir's method, the success of which is evidenced by the agreement of some of Brasefield's results with ours, was developed by us before Brasefield's paper came to our notice and shows that his remark regarding the difficulties apprehended, but not specifically mentioned in the paper, is not warranted.

D. BANERJI.
R. GANGULI.

Wireless Laboratory,
University College of Science,
Calcutta, July 4.

The Possibility of Separating Two Forms of the Ammonia Molecule.

A FEW years ago it was observed by Baly and Duncan (*Jour. Chem. Soc.*, **121**, 1008; 1922) that ammonia gas drawn quickly from a cylinder containing liquid ammonia was less rapidly decomposed on a hot platinum wire than gas drawn slowly from the same cylinder, or obtained in certain other ways. They offered as a possible explanation that ammonia molecules may exist in two forms of different reactivity, which may be separated or perhaps converted entirely into one form under suitable conditions.

Since that time, spectroscopic evidence has indicated the existence of two, or perhaps several, kinds of ammonia gas molecule, which presumably differ in certain symmetry properties, and it has been suggested by Tronstadt (*Z. f. Phys. Ch.*, Abt. B, **5**, 355; 1929) that a separation of such forms may have been achieved by Baly and Duncan.

Although this explanation of the different decomposition rates observed by these experimenters seemed to me rather improbable, it would be a very important fact if such a separation can occur under the conditions of ordinary chemical experiments, especially if the forms separated should have appreciably different reactivities. Consequently the question has been put to a spectroscopic test by a study of three of the absorption bands of ammonia gas in the red and near infra-red, making comparisons on gas obtained under varying conditions. The bands chosen were those at 8800 A., 7920 A., and 6474 A., which have been analysed by Badger and Mecke (*Z. f. Phys. Ch.*, Abt. B, **5**, 333; 1929) and Badger (*Phys. Rev.*, **35**, 1038; 1930). Though they are perhaps not yet understood in all their finer details, it seems quite certain that all these bands give evidence for two forms of ammonia molecule.

In the case of the bands at 8800 A. and 6474 A., ammonia gas drawn rapidly from a cylinder (a 10-litre vessel was filled in 3 sec.) was compared with gas drawn slowly from the same cylinder, and with gas which had stood five days in the absorption vessel. In the case of the band at 7920 A. a similar comparison was made, and in addition a sample of liquid ammonia was fractionated and the gas obtained from the first and last fourths was compared. The gas evaporated from solid ammonia which had been kept at liquid air temperature twenty-four hours was also studied.

In every case the same absorption spectrum was obtained. Neither the intensity of the bands as a whole nor the relative intensities of the various band lines was appreciably different from the usual in the case of any of the gas samples.

Consequently it is very unlikely that the results of Baly and Duncan are to be explained by a separation of two forms of ammonia molecule, or that such a separation occurs under ordinary experimental conditions.

RICHARD M. BADGER.

California Institute of Technology,
Pasadena, California,
July 9.

Isomorphism and Chemical Homology.

THE ions of the formula AX_4 (for example, SiO_4, CrO_4, etc.) have been studied, and their fundamental vibration frequencies can be accounted for by simple molecular models: the polarisability of the oxygen ion in all these cases where it enters is of the same order as that given by the refraction of the crystalline oxides. It is admitted that in these cases the linkages are ionic.

Now, considering the ionic radii of the following as given by Goldschmidt and Pauling :

$^{++}Be=0{\cdot}34A.$	$^{+}NH_4=1{\cdot}43A.$	$^{+++}B=0{\cdot}20A.$	$^{++++}Ti=0{\cdot}64A.$
$^{++++++}S=0{\cdot}34A.$	$^{+}Tl=1{\cdot}43A.$	$^{+++++++}Cl=0{\cdot}26A.$	$^{+++++}Nb=0{\cdot}69A.$
$^{+++++}P=0{\cdot}35A.$	$^{--}O=1{\cdot}32A.$	$^{++++}Th=1{\cdot}10A.$	$^{++++++}Mo=0{\cdot}62A.$
	$^{-}F=1{\cdot}33A.$	$^{++++}U=1{\cdot}05A.$	$^{++++}V=0{\cdot}61A.$

predictions of certain cases of chemical analogy and isomorphism are possible.

For example : $\left\{\begin{matrix}BeF_4^{--} \\ SO_4^{--}\end{matrix}\right.$ $\left\{\begin{matrix}BF_4^{-} & [Ti^{IV}F_6]^{--} \\ ClO_4^{-} & [Nb^{V}OF_5] \\ SO_3F^{-} & [Mo^{VI}O_2F_4]\end{matrix}\right\}$ observed by →(Magignac).

$[Mo^{VI}O_2F_4]^{--}$, $[Mo^{V}OF_5]^{--}$ } Mauro and Scacchi (*Rend. R. Accad. Lincei*, 1888). { $[V^{V}O_2F_4]^{---}$, $[V^{IV}OF_5]^{---}$

For the realisation of these predictions, other factors such as the deformability of the constituent negative ions must be considered. The easiest way is to see whether the molecular volumes of the simple salts of the corresponding complex ions are sufficiently close (isomorphic tolerance being of the order of 10 per cent) and then whether they form mixed crystals in all proportions. Once assured of this, it is possible to extend the predictions to more complex cases. Search of the literature shows that in recent years similar examples have been observed by Wilke-Dörfurt and Günther Balz (*Z. Anorg. Chem.*, **159**, 197 ; 1927) in the cases of BF_4^-, $(SO_3F)^-$, and ClO_4^- ions. All simple and complex salts of the corresponding ions are isomorphous.

In continuation of his work on the homology of fluoroberyllates and sulphates, Dr. P. B. Sarkar has recently obtained further interesting examples of chemical analogy and isomorphism of the monofluorophosphate ion (PO_3F) with the SO_4 ion. Both SO_4 and PO_3F ions are likewise isosteric and isoelectric. Having determined the molecular volumes of K_2SO_4 and K_2PO_3F, which are very close, he found that they formed mixed crystals in all proportions.

Working on this analogy, he has been able to isolate the following compounds :

Series (i) MSO_4, $(NH_4)_2PO_3F$, $6H_2O$
where M = Ni, Cu, Co, Zn, Mn, and Mg.

Series (ii) $NiPO_3F$, $(NH_4)_2PO_3F$, $6H_2O$ } isomorphous with the double sulphates of Locke.
$CoPO_3F$, $(NH_4)_2PO_3F$, $6H_2O$ }

Series (iii) $NiPO_3F$, $7H_2O$ isomorphous with $NiSO_4$, $7H_2O$
$CuPO_3F$, $5H_2O$,, ,, $CuSO_4$, $5H_2O$
$CoPO_3F$, $6H_2O$,, ,, $CoSO_4$, $6H_2O$

Series (iv) Am_2PO_3F, $Al_3(SO_4)_3$, $24H_2O$ } isomorphous with alums.
Am_2PO_3F, $Al_2(PO_3F)_3$, $24H_2O$ }

Thus a close chemical analogy of ions composed of elements belonging to widely different groups of the Periodic Table is possible.

A detailed study of these will be published in the *Journal of the Indian Chemical Society*.

P. C. RÂY.

Department of Chemistry,
University College of Science,
Calcutta, June 24.

Spike Disease of Sandalwood.

IN NATURE of June 14 a short account is given of the work on spike disease of sandalwood in progress in the Biochemical Department of the Indian Institute of Science, Bangalore. This disease had previously been investigated in the laboratories of the Mysore Agricultural Department under the direction of Dr. Coleman, whose transmission experiments indicated the probability of a virus infection. In view of the very extensive damage caused by the disease not only in Mysore State but also in the Madras Presidency and Coorg, proposals were considered for a joint investigation by Mysore, Madras, and Coorg. For various reasons the Mysore Government preferred to continue on independent lines, but arrangements were made by the Government of Madras and the Administration of Coorg for an investigation to be carried out at the Indian Institute of Science under my general direction. Under this scheme the two authorities named have made an annual grant for the employment of a special staff which has enabled two whole-time assistants to be employed on this research, assisted by various research students in the Department. At the same time facilities were granted for extensive field experiments to be carried out in the Salem district of Madras and in Coorg with the co-operation of the forest officers concerned. In these circumstances it has been possible to arrange for an investigation of wide scope both in the laboratory and in the field.

Results of very considerable interest have already been obtained not only in the comparative study of diseased and healthy sandal but also in regard to the transmission of the disease. The view put forward by Dr. Coleman as to the infectious nature of the disease has been fully confirmed, and by an improved technique the disease can now readily be transmitted by bud or patch grafting, by the latter term being meant the simple implantation of a small patch of stem tissue from a diseased specimen in the stem of a healthy plant. The success of this method has much facilitated the inquiry by rendering available for study plants of various ages in all stages of the disease, grown under controlled laboratory conditions.

Sandal is of course a parasite, and the inquiry has already demonstrated that the nature of the host plant probably exerts a considerable influence on the susceptibility of sandal to infection. There is in evidence a marked variation in susceptibility, and it seems likely that a study of the factors responsible for such variation may open up an important line of advance in the practical amelioration of the disease.

Shortly before I left Bangalore in August last, arrangements were put in hand for a further entomological survey of sandal areas in view of the possibility of an insect vector being concerned, the circumstances in which the disease spreads lending considerable support to such a theory. It is understood that such a survey will shortly be undertaken.

ROLAND V. NORRIS.

Tea Research Institute of Ceylon,
Nuwara Eliya, Ceylon,
July 7.

Control of Mites Attacking Stocks of Insects and Fungous Cultures.

MITES have long been a great hindrance to the experimental entomologist and mycologist. Successful efforts have recently been made at the Imperial College Biological Field Station to kill mites and their eggs by fumigation, without harming to any considerable extent insects or fungi.

Pyridine and ammonia, recommended by Jewson

and Tattersfield (*Ann. Appl. Biol.*, **9**, 213; 1922), for removal of mites from fungous cultures, were found to be harmful to insects and to their food. Pure acetylene, shown to be harmless to the larvæ of *Plodia interpunctella* Hb., although toxic to the adults of *Ephestia kuhniella* Zell., unfortunately proved to be harmless to mites at any concentration. Finally it was decided to try carbon tetrachloride and trichlorethylene, since both compounds have most of the properties desirable in a fumigant but are effective against the more resistant stages of most insects only at high concentrations.

At ordinary room temperature and humidity, exposure of infested cultures of the following groups of *Aspergillus, flavus, fumigatus, tamarii, terrens* and *niger* and of a species of *Syncephalastrum*, to carbon tetrachloride at a concentration of 0·5 c.c./litre for twenty-four hours, killed the mites but left the fungi unharmed. Exposure to trichlorethylene for the same time but at half the concentration gave the same result. Fumigation of infested stocks of *Calandra granaria* L. in barley and maize, and of stocks of *Rhizopertha dominica* F. in maize, with carbon tetrachloride at a concentration of 0·5 c.c./litre for four hours killed the mites while, after thorough aeration, the bulk of the adult insects recovered.

Trichlorethylene used at a concentration of 0·225 c.c./litre for twenty-four hours for the fumigation of stocks of *Calandra granaria* and of *Sitotroga cerealella* Ol. in barley freed the stocks of mites while allowing a useful percentage of the insects to survive.

Experiments with these insects in tubes when removed from their food have shown that:

(1) Adult beetles survive the fumigation; (2) moths and eggs of *Sitotroga* are killed but the larvæ and pupæ survive; (3) adult mites are killed by exposure to carbon tetrachloride at a concentration of 0·35 c.c./litre for only four hours or to trichlorethylene at a concentration of 0·225 c.c./litre for the same time; (4) eggs of mites are killed by exposure to trichlorethylene at the concentration of 0·225 c.c./litre for twenty-four hours.

Determination of the mites used is not yet completed.

Further details together with the results of fumigation of other insects will be published shortly.

M. SHAFIK.
A. B. P. PAGE.

Imperial College,
Biological Field Station,
London Road,
Slough, Bucks., Aug. 1.

Sunspots and Pressure Distribution in Monsoon Regions.

THE excellent collection of "World Weather Records" affords an opportunity to examine the mutual relation between the sunspot period and air pressure distribution over the globe. This relation I have studied by computing the difference between mean annual air pressure (for three years) near sunspot minimum and that for the following maximum. This difference I call 'effect', as does Dr. Mecking, who introduced this expression (*Annalen der Hydrographie und maritimen Meteorologie*, 1918). I have used all pressure material published in the above-mentioned collection, computed the differences for years: 1911–13–1917–19; 1900–02–1905–07; 1888–1890–1892–94; 1877–79–1882–84; 1866–68–1870–72; 1855–57–1859–61; 1842–44–1847–49; and so far as it was possible, plotted charts showing lines of zero effect separating the areas of positive and negative effect. These charts show slight differences from one sunspot period to another; a discussion of them will be published elsewhere.

While drawing the charts, the question arose whether there is on the earth an area where the air pressure effect is related always in the same way to increasing spottedness, that is, where on the earth is increase of sun spottedness associated always with an increase or always a decrease of air pressure (annual mean for three years)? The charts have shown that such an area of positive effect actually exists and it covers roughly the following regions: The first area is Central Asia about south of latitude 55° N., east of Caspian Sea, Mesopotamia, Persia, Afghanistan, Baluchistan, east Turkestan, plains of the Indus. The second area lies north of latitude 10° and extends from the Arabian Sea across south-east India, Bay of Bengal to Burma and Siam, and the third area embraces nearly the whole of Australia, Java, and extends probably across the Indian Ocean to southern Madagascar and Natal.

These three fields cover approximately the greater part of the Indian monsoon area within the tropics. The fact that the sunspot period manifests itself always in the same way within this area suggests that sunspots affect the general circulation of the atmosphere through pressure conditions in the monsoon regions. Further discussion of the data computed for the successive months of the year will show how far this conjecture is justified. The area where the effect of the sunspot period is always negative was difficult to determine; examination of the maps seems to point to the fact that if there is any place it lies probably in a long strip across the Pacific, north of the equator and south of the latitude of Hawaii.

S. HANZLÍK.

Meteorological Institute,
Charles University, Prague.

Oviparity in a Sea-Snake (*Laticauda colubrina*).

IN view of the fact that all sea-snakes (*Hydrophiidae*) are generally regarded as viviparous,[1] the following occurrence seems worthy of note.

A few days ago six specimens of *Laticauda colubrina* were presented to the Raffles Museum, where they were put into a tank of sea-water.

On the morning of June 5 it was noticed that several eggs had been deposited overnight; the number appeared to be six, but owing to the cloudy nature of the water it was difficult to say with certainty. Two were removed for examination and the remainder left in the water. It will be interesting to observe if any of these eggs hatch out. It seems uncertain whether they would usually be laid on land or in the water. The former seems probable,[2] as oviparity is usually associated with a terrestrial habitat, and *Laticauda* is known to spend much of its time out of the water, its broad ventral shields adapting it to shore-going. It frequently climbs fishing-stakes, insinuating itself under the blanket of the tenant, the warmth of whose body it appears to appreciate. On the other hand the eggs have not the usual leathery shell of those of land reptiles, but are covered with a thick skin through which the yolk and germinal disc are visible. Possibly this skin will harden on exposure to the air.

Of the two eggs examined, one measures 80 mm. × 25 mm., the other 68 mm. × 27 mm. It was of course impossible to tell definitely which of the snakes was the parent, but it was probably the largest specimen, calculated as well over five feet in length.

Keepers from the various lighthouses in the vicinity of Singapore report that *Laticauda* becomes numerous at this time of the year. This might be interpreted as a shoreward migration for breeding purposes, but it would be curious to find such a habit in reptiles so essentially tropical in habitat, in an area which is

characterised by the absence of seasonal change; and where there are very few organisms, plant or animal, terrestrial or aquatic, with definite reproductive periods.

This evidence of oviparity seems to support the view that the Laticaudinæ are the most primitive of the sea-snakes, for although the ventral shields might be regarded as an advantageous redevelopment, the egg-laying habit can scarcely be viewed in the same light, and must therefore be regarded as a legacy from an ancestral terrestrial form.

NORMAN SMEDLEY.

Raffles Museum, Singapore,
June 5.

[1] Malcolm Smith ("Monograph of the Sea-Snakes", 1926, p. xiv) reiterates this statement of previous authors.
[2] Semper (quoted by Gadow: "Camb. Nat. Hist. Reptiles", p. 637) observed that the young of this species were born amongst the rocks on the shores of low islands, and guarded for some time by the female.

The Dissociation Theory of Solutions.

IN Dr. S. C. Bradford's letter on this subject in NATURE of Aug. 2, he says "that the vapour pressure of salt solutions is determined by the attractions, volumes and motions of the particles only". This statement is obviously what should obtain; for, given any three suitable physical properties, a fourth should, theoretically, be calculable from them. Hence hypotheses such as that of dissociation, or of association between solvent and solute, should only be introduced when other phenomena are contemplated.

Working on the assumption that three physical properties are sufficient and that the areas of solute and solvent are involved, I have found several formulæ connecting osmotic pressures (and therefore the ratio of the vapour pressures of solution and solvent) with the volumes, areas, and concentrations. Two of these, which embrace aqueous solutions of cane sugar *a* methyl glucoside and isodulcite, both at 0° C. and 30° C., give a constant, the extreme variations of which are about 5 per cent. These two (omitting, for simplicity, the temperature function which is within 10 per cent of unity) are:

$$(1)\quad P\omega s_1^2 s_2^2/N\left\{\left(\frac{s_2}{s_1}\right)^{\frac{3}{2}}+\left(\frac{s_2}{s_1}\right)^{\frac{4}{3}}+\left(\frac{s_2}{s_1}\right)^{\frac{6}{5}}+\ldots\right\}=\text{constant}.$$

$$(2)\quad P\omega^2/A(1-\tfrac{1}{2}A^{\frac{3}{2}}+\tfrac{1}{4}A^{\frac{4}{3}})=\text{constant},$$

where P is the osmotic pressure, ω the specific volume of the solution, s_1 is the change in the volume of a large quantity of solution when 1 gram of solvent is withdrawn, s_2 is the corresponding volume for the solute, N is the number of gram molecules in 1000 grams of solvent. If c_2 and c_1 are the grams of solute and solvent, respectively, in 1 gram of solution, then $A=\frac{c_2 s_2}{c_1 s_1}\times\frac{M_\omega}{M_s}$ (where M_ω and M_s are the molecular weights of solvent and solute respectively).

I hope to publish elsewhere a fuller discussion than is possible in the columns of NATURE.

BERKELEY.

Berkeley Castle, Gloucestershire.

Photo-Electric Cells.

THE merit of a theory is so easily distinguished from the merit of a book in which it is adopted that we are not debarred, as authors, from asking "F. C. T." for the grounds of his "most serious" criticism of our volume on "Photo-electric Cells" reviewed in NATURE of July 19, p. 90. He says that the theory that photo-electrons are the free electrons of the metal is "not one which is generally accepted"; and "generally" must surely refer to the weight rather than to the number of opinions. But what authority can have greater weight than that of Sommerfeld, Fowler, Nordheim, and all who are developing with such success a theory of the metallic state? They take it for granted that the photo-electric effect is one of the interconnected properties characteristic of the metallic state, and that this state represents the presence of electrons free in Drude's original sense, because their kinetic energy is determined by the temperature and much greater than any potential energy they may derive from atomic fields. There are doubtless a few antiquarians still fumbling with ideas of the era before quantum mechanics; but it seems to us that the theory to which "F. C. T." objects is by now one of the commonplaces of modern physics.

NORMAN R. CAMPBELL.
DOROTHY RITCHIE.

Wembley, July 21.

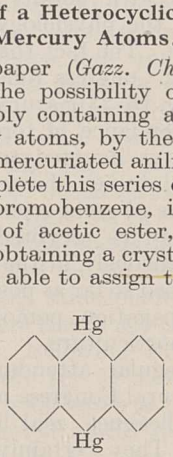
THE wording I adopted was perhaps a little unfortunate, as it might imply that I regarded my criticism as a most serious one, whereas on the contrary I felt that of the few small criticisms that occurred to me, the only one worth mentioning was the point about the photo-electrons being only free electrons.

What I meant by the sentence to which the authors object, and what I still feel, is that, despite the success which has met the modern attempt to correlate thermionic and photo-electric emission, the authors were unjustifiably definite in taking it for granted that only the free electrons of a metal are emitted photo-electrically. It is true that an explanation of the very serious difficulty that the critical wave-length is independent of temperature has recently been given, but is that really satisfying enough to establish the theory so surely that it becomes "one of the commonplaces of modern physics"? F. C. T.

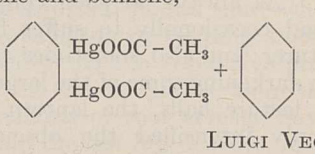
The Formation of a Heterocyclic Ring containing Mercury Atoms.

IN an earlier paper (*Gazz. Chim. It.*, **58**, 712; 1928) I showed the possibility of obtaining some compounds probably containing a heterocyclic ring closed on mercury atoms, by the action of sodium thiosulphate on bimercuriated anilines.

In order to complete this series of investigations, I have treated *o*-dibromobenzene, in petroleum solution, in presence of acetic ester, with 2 per cent sodium amalgam, obtaining a crystalline substance to which I have been able to assign the following structural formula:



On boiling the substance with glacial acetic acid, it gives, by decomposition of the molecule, *o*. diacetylmercuribenzene and benzene,



LUIGI VECCHIOTTI.

Institute of General Chemistry of the
R. University of Bologna.

The Ninth International Horticultural Congress.

THE long history and proud record of the Royal Horticultural Society is sufficient evidence that horticulture has long been highly regarded in Great Britain, and that British horticulturists have known how to organise themselves in the promotion of their common interests. Nevertheless, until the meeting of the International Horticultural Congress in London, on Aug. 7–15 last, as the result of an invitation delivered at the previous congress in Vienna in 1927, no international horticultural congress has previously met in Great Britain. Whilst the congress provides opportunity for the mutual discussion of problems which are often of great scientific interest and are presented at the formal sessions of the congress, these meetings, and the excursions with which they are interspersed, are perhaps still more valuable as providing opportunities for personal contact between workers, from many countries, interested in various phases of horticulture; at the same time the various committees set up and maintained by successive congresses give permanence to efforts to deal with such horticultural problems as the nomenclature of horticultural varieties and of the colours employed in their description, fruit culture, botanical gardens, the international exchange of young gardeners, etc.

At the dinner to the official delegates given by the Royal Horticultural Society in its Greycoat Street Hall on Monday, Aug. 11, very general expression was given to the opinion that this Ninth International Congress had been very successful and fully justified the hopes of the original promoters of this international horticultural effort. On its scientific side, horticulture is obviously very closely bound up with botany, and particularly with the study of the physiology and structure of the growing plant. The fact that the Fifth International Botanical Congress followed immediately at Cambridge (Aug. 16–23) naturally ensured a very representative attendance of foreign botanists, so that the three days devoted to communications upon horticultural topics showed a quite exceptional list of papers of great scientific interest. As a result, three sessions, devoted to papers, were conducted simultaneously in the Caxton Hall, the papers being grouped so far as possible around three main topics—propagation, pomology, and tropical and sub-tropical horticulture.

Some of the regular attendants at the International Horticultural Congress may have felt that their scientific colleagues' zeal had rather outrun their discretion. They certainly have a right to expect that, on these horticultural occasions, the botanist should make an effort to make himself intelligible. As always, at such conferences, the audience had occasionally to suffer from the inaudible lecturer; and also, sometimes, in view of the difficulty in darkening some of the large windows in one of the lecture halls, the lantern illustrations provided only intensified the obscurity of the lecturer's utterances. Communications might be made in one of three languages—English, French, or German—and this also added to the difficulty, as either speaker or audience might be struggling with an unfamiliar medium. International congresses, like our own British Association meetings, also suffer from the speaker who reads a paper which will be more suitably studied in print. In these days, when science has multiplied the facilities for intercommunication of ideas, there seems little excuse for this procedure. A halting speaker, or a speaker using an unfamiliar language, may well read from a manuscript, but at least that manuscript should be the condensed and vivid précis of the full account, intended for print, which an audience assembled at such pains has the right to expect. If the speaker on these occasions will not learn this lesson, then time will see all the business of these international meetings carried on in informal conversations in the corridors and anterooms around large empty lecture theatres.

Such a result would be unfortunate, because the papers presented are always, as in the present case, of very great interest. In the space available it is not possible to comment upon all communications. The main topic indicated in advance for discussion at the Ninth Congress, was propagation, vegetative and seminal. Many of the papers presented dealt with vegetative propagation, and in the following paragraphs an effort is made to indicate the general nature of some of the very interesting communications made under this head.

Vegetative Propagation.

The practice of vegetative propagation has always been of great interest, because by this means alone can most of the remarkable horticultural achievements obtained by hybridisation be perpetuated in the garden. It also appeals to the genuine gardener, because every new plant presents a new problem in practical propagation and new peculiarities of plant behaviour are always coming under notice in the propagating frames. Modern commercial methods now demand standardised horticultural produce, and this again sends the horticulturist to renewed study of vegetative propagation. A Cox's Orange apple can represent a definite standard of quality and flavour, because all Cox's Orange apples really come from one plant; the next generation is obviously going to see standardised types of cacao, rubber, coffee, tea, etc., driving others off the market, because they similarly will be the result of the successful development of vegetative propagation. Thus, in the present congress, Mr. W. G. Freeman discussed the vegetative propagation of cacao, Dr. P. J. S. Cramer and Lieut.-Col. F. Summers the propagation of rubber, whilst Prof. H. S. Reed communicated a paper by Prof. H. J. Webber, the Director of the Citrus Experiment Station at Riverside, California, upon propagation problems with citrus.

Some of the general considerations as to the development of vegetative propagation were raised

by Prof. J. H. Priestley and Dr. A. B. Stout. Vegetative propagation is a possible method of propagating the higher plant, because of its method of growth. The new parts of the plant are laid down at the apices of shoot and root respectively; therefore, when a plant is cut into pieces, provided it still contains such growing points or regenerates new ones, it will continue to grow. Many stems when cut from a bush thus grow on freely: a black-currant stem roots freely at its base, whilst the stem continues to grow and branch, so from one stem a new bush develops; from it again a stem can be taken and grown into a bush, and so many bushes can be obtained from one single bush—and thus in time one black-currant plant may occupy square miles of space and yield tons of crop, all the currants being as like to one another as the currants gathered from the original bush. There is still much discussion, which Dr. Stout ably summarised, as to whether such a bush can thus be multiplied not only indefinitely in space but also in time. The original bush would grow old and die, but there is no clear answer yet to the question whether the young bush, still being propagated from branches separated from bushes within this 'clone'—as the colony of vegetatively propagated plants from the same parent is termed—should necessarily fail in vigour with the increased age of the clone.

At one time 'degeneration' of such vegetatively propagated clones of potatoes was much under discussion; now it has been shown that such variation is often the result of the accumulation of disease within the stock, especially virus disease. When a true seed is grown from such a stock, the fertilised egg is separated from the parent plant by a barrier wall which usually prevents transmission of the virus disease. Thus the new seedling starts unhampered by the virus, which is now found in new members of the clone from the beginning; the result is that the new seedling seems more vigorous than the 'degenerate' descendant of the clone. It is sometimes possible, however, to select bits of the clone to which the virus has not yet spread, and then, by multiplying the new pieces of the clone from the virus-free stock, it seems possible to get it back in all its pristine vigour. At least, such work, as also the cases of vegetatively propagated seedless bananas and breadfruit trees, etc., show how dangerous it would be to attempt to set a limit, at present, to the potentialities in vegetative methods of propagation.

At the same time it has its very striking limitations; Dr. Auchter, of the Department of Plant Industry, Washington, U.S.A., illustrated this very vividly in his account of recent American work on rooting cuttings of fruit trees, especially apple. Very few varieties of valuable scion apples can be propagated upon their own roots, because it is so difficult to get branches from these trees to root when removed and put in the soil. Dr. Auchter described some very interesting experiments of Dr. Gardner at Maryland, in which 100 per cent success had been obtained instead of the usual 1 per cent or 0 per cent, the branches having been previously bound with black tape near the base since growth commenced, and whilst still on the tree—curiously enough, in this experiment, the buds on these rooting shoots failed to grow out! Dr. Auchter also brought to light the very interesting fact that propagation of seedling apple trees by either stem or root cuttings can often be successfully accomplished, although the same methods are quite unsuccessful when tried with the same tree when it is several years old. Dr. Niels Esbjerg also described attempts to root scion apples in which some success had been met with; whilst Dr. H. A. A. van der Lek directed attention to the significance of the presence or pre-existence of root initials in favouring rooting. External conditions in rooting cuttings were especially considered in communications (by Miss Mary E. Reid and Dr. P. W. Zimmerman, from the Boyce Thompson Institute for Plant Research, Yonkers, U.S.A.); whilst the very considerable practical success obtained in cutting propagation at the Edinburgh Botanic Gardens was described and illustrated by Mr. L. B. Stewart.

In spite of the advance that is slowly being made in this difficult field, the difficulty in propagating many desirable woody plants as cuttings results in their appearance as 'scions', raised into the air upon the root systems of another plant with which they are in union through the process of budding or grafting.

Around the Mediterranean, these practices are still utilised in various forms with the olive and the vine, and were discussed very fully by Dr. Mameli Calvino (Italy), Prof. Dr. H. Faes (Switzerland), whilst Prof. Ravaz (Montpelier) argued again the much-discussed problem as to the relative influence of stock and scion upon one another. Prof. Ravaz concludes that there is no reciprocal influence of stock and scion upon one another in vines, the colour, shape, size, and flavour, etc., of the grapes varying as much in a clone upon its own roots as when carried on various stocks. The general question at issue here is of great complexity and magnitude, and it is well worth while multiplying efforts to obtain scion varieties upon their own roots, as urged by Dr. Esbjerg, so that the performance of such plants may be compared with the performance of the varieties upon different stocks in the critical atmosphere of the experiment station. Where this is not possible, then the experiment station, following the lead of East Malling, will certainly try to study the performance of a clone of scion upon a uniform clone of vegetatively propagated stock, rather than upon different seedlings with, of course, varying growth vigour.

It is another question, however, and one keenly debated in horticultural circles now, whether the commercial propagation of seedling stocks should be replaced entirely by the vegetative propagation of stocks. In the United States, as in the British Dominions, orchards of root acreage have sprung into being within the last few decades, in which the scions have been budded or grafted upon seedling stocks because of the relative simplicity of this

method. On one hand, it is argued that it is not sufficient for horticultural standardisation, which has to meet stringent modern commercial requirements, that the scion should be a clone, so that the produce of one variety, whilst plucked from the branches of one and the same plant, may be nourished on those branches through the roots of countless different varieties. On the other hand, it is argued by the practical man, in the light of horticultural experience, that a Cox's Orange scion gives a Cox's Orange apple whatever the root system may be, and Prof. Ravaz's experience with vines seems to endorse this conclusion.

Whilst it is agreed that certain stocks, 'dwarfing' stock, modify the habit of the tree in that they cause dwarfed growth and early bearing, there is no evidence that the quality of the scion fruit is modified; and provided that ordinary care to select vigorous seedlings is shown, there seems little doubt that uniform orchards of the scions are obtained—uniform because the stock is not limiting appreciably the natural vigorous full growth of the scion.

Much work still remains to be done upon this interesting problem; the interchange of comment and criticism at the congress is a good augury for the report of progress at a later congress, whilst some of the contributions show the interesting range of the problems. Thus, Prof. N. F. Hansen (Dakota, U.S.A.), Dr. L. Filewicz (Poland), and Dr. J. Smolak (Czechoslovakia) joined in a symposium upon fruit culture problems in regions where frost damage is frequent and severe. In the course of this discussion, Dr. Filewicz pointed out that certain apple trees which are susceptible to frost in central Poland resist the winter after top-grafting with a more hardy variety. Dr. Filewicz described some very remarkable experiments in keeping frost-injured trees alive and bearing by making new unions between shoots thrown up from the roots and buds on higher branches still capable of growth.

An Elizabethan Colony of Craftsmen.

By Dr. E. F. ARMSTRONG, F.R.S.

THOSE who walk the fells of the Lake District will not have failed to notice the abandoned copper workings which scar the hillsides in many places, notably at Manesty and elsewhere in Borrowdale, near Stair and at Goldscope in the adjacent Newlands Valley, at Grasmere, in the Vale of St. John, and in other localities. Whilst it is common knowledge that these represent ancient mines dating from the time of Elizabeth, only the few are aware how unique and interesting a historical story is attached to these visible relics of bygone days. It has relation to the formidable enterprise of bringing from Germany to the Keswick dales a little colony of workmen and experts in the mining and smelting of copper. It needs very little imagination and knowledge of the existing conditions in England at that time to picture the dales as then, surely very remote from medieval civilisation, particularly when it is remembered that the Lord Warden was watching the fords to hold back the Armstrongs and the Grahams but a few miles north of where the craftsmen in Borrowdale were to be engaged in their peaceful activities.

Though the enterprise was in the end a business failure, it left its impress on the district in numerous ways, as witnessed by many mixed marriages with the dalesfolk, by German words absorbed into the local dialect, by place names: the details of all these afford a fascinating study in local history. Far more important, however, in its ultimate effect on the prosperity and future of the district, must have been the spending there during the life of the venture of upwards of £100,000, and that at a time when money was worth several times what it is to-day. Although many of the fortunes made locally were lost for King Charles, this undoubtedly led to a development of the Lake country, both then and afterwards, quite out of proportion to its inaccessible and wild character, as well as to the provision and maintenance of routes and roads to Newcastle via Barnard Castle and to the south in advance of the times. Leland, whose "Itinerary" was written about the year 1545, calls Keswick a poor little market town. Elsewhere we read of the Lake country being almost *terra incognita* until the publication of the letters of Gray, the poet. It is a satisfaction to those who are fighting for the preservation of the natural beauty of the district to-day to remember that Gray's later letters, especially those from the Lakes in 1769, show before those of most others the rising sense of the picturesque in literature.

The known facts relating to the settlement compiled from local sources have been supplemented in an altogether unexpected manner by the discovery at Augsburg of the original account books of the German firm, Haug, Langnauer and Co., including twelve volumes of manuscript which are the actual journals written at Keswick and sent first to Hans Loner, the agent in London, and by him, after some added pages of balancing, to Germany. These have been rendered available by W. G. Collingwood in 1912 in a publication of the Cumberland and Westmorland Antiquarian and Archæological Society.

The value and interest of this find is very great when it is remembered that the earliest known English diaries come from the late sixteenth century and that some of them grew out of a punctilious habit of keeping accounts. More than the usual bald facts of the financial operations began to be added, and the entries became amplified, so that one finds in them as here the ancient day spread out before us in considerable detail.

The Company or Society of Mines Royal was founded in 1564, when an indenture was made between the Queen on one part and Thomas Thurland and Daniel Hechstetter on the other, to search, dig, try, roast, and melt all manner of mines and 'ures' of gold, silver, copper, and quicksilver in a number

of counties. The Queen was to have one-tenth of the precious metals and one-twentieth or 2*s.* per cwt. on the copper.

Hechstetter proceeded to form a company with a number of prominent shareholders, including Lords Burghley, Pembroke, Leicester, and Mountjoy. In 1566–67 parties of German workmen were brought from Schwatz to Keswick. A rich mine was very soon found at Newlands, on the manor of the Earl of Northumberland, in 1566—the Germans called this "Gottesgab", a name which locally became Goldscope. The Earl stopped the working after a time, claiming the sole right to the minerals. His suit against the Queen went before all the judges and barons of the Exchequer in 1568, when it was decided by a majority that as there was more gold and silver than copper and lead in these mines, the Queen was within her rights in claiming them. A strange miscarriage of justice this, and an early example of faulty analysis (!), particularly as it remained the leading case regarding Royal rights in mines until the time of William III.

Hechstetter's accounts were made up seven times a year; they enable us to picture almost every happening in the life of the colony. For example, in 1569 we find complete accounts, amounting in all to £21 9*s.*, for building the men's bathroom. Whereas the company bore the expenses and outlay, the men agreed to repay this afterwards out of club money and fines. At that time, apparently, the use of baths was frequent in Germany, both in private houses and in public baths: it is stated that the hot bath was used as an antidote to immoderate drinking. Wine for the colony was bought by the tun or cask and resold to the men at a price which made no profit; there are entries of its purchase at Newcastle, at Kendal, and at Cockermouth, in the last instance from Henry Fletcher, the well-known merchant who had entertained Mary Queen of Scots on her landing at Workington a few months earlier (May 15, 1568), when she fled to England after the defeat of her army at Glasgow.

The smelt houses were begun in the summer of 1566 at Brigham, on the Grete, half a mile from Keswick. Within a year, Thurland confessed that they were "more chargable than he had imagined", an experience which has been repeated by most inventors of new processes down to this day. Hechstetter persevered, however, and did well to create, in a country so barren of facilities, a cluster of workshops and machinery so famous as to make Camden at the end of the century write "not without admiration to those that behold it". Alas! The progress of actual smelting was accompanied by the devastation of the woods far and wide, local labour being used for this purpose, though skilled charcoal burners were imported from the Midlands. An attempt was made to form charcoal-burning stations in Ireland at a time when the opposition of the Earl of Northumberland made local supplies difficult.

There are items in the accounts of 1569 for the carriage of sea or stone coal from Cockermouth and from Workington, and a payment of 1*s.* 4*d.* for a man to watch for several nights over the coal at the smelting house for fear of it burning; this seems to have been their first practical introduction to mineral coal. One Anthony Dediman was promised £20 if he found coal mines near Keswick; there is an entry of £4 in hand and 3*s.* 4*d.* earnest money. No coal was found, but he spent a good deal in this fruitless search.

Although the first royal charter to dig coal in the Castle Fields was granted in 1239 by Henry III. to the freemen of Newcastle, and the coal trade became an important branch of commerce within fifty years, apparently it was not in general use in provincial towns until the reign of Charles I. These journals must be the first records of coal being worked in Cumberland, for it was not until a hundred years later that Whitehaven became a busy export centre, chiefly to Ireland and Scotland.

The mines, workshops, and houses were lit with tallow candles, but in November 1570 there is mention of a sample of train oil which soon afterwards was used in the mines. Although, according to Hakluyt, whale fishing began somewhat later than this date, it is known that a number of English ships were fishing off Iceland about this time. This is probably one of the first uses of the oil in England.

The original business of Haug and Co. was drapery, and at first they tried to sell silk and satin and other costly stuffs at Keswick, disposing of more than £400 worth.

The mines were worked to some extent by what is called 'tributing'; the miner chose his own place, hewed at his own pleasure, and was paid a percentage on the value of the ore he got. He paid for his own candles and tools. Apparently the earnings by this method were very uneven. The system survived to the end of the period of copper-mining at Coniston.

The details of one of Hechstetter's journeys with three others from Augsburg to London show how he travelled by cart from Speir to Mainz, hired a boat to Cologne, then a covered carriage to Antwerp, thence to Calais, how is not stated; across the water to Dover, which cost £2 6*s.*, horses to Gravesend, and from thence to London by boat. The customs at Dover extracted 16*s.* duty! The same paragraph contains the item "a poor German in charity 3*s.*".

In spite of the energy of Hechstetter and his associates, the enterprise did not prosper financially; we are told that, notwithstanding very considerable quantities of copper had been won, the difficulty of finding a market was accentuated in 1571 owing to the depression of trade in England during that year. There is a long and somewhat despairing letter from Langnauer in Augsburg to Loner in London, who in consequence approached the Queen, probably through Leicester, begging her very materially to increase the amount of copper ordered from the company.

A little later fresh impulse was given to the business by the addition of coppersmith's work, that is, the making of kettles, pots, and pans, for which skilled men were again imported from Germany. An artistic craft was thus very early introduced

into the dales, which to-day the school of industrial art is perpetuating.

In 1576, Loner left the business, but Hechstetter struggled on for a few years : the company was reconstructed by Thomas Smyth in 1580. His enterprise prospered for some years, mines being opened also in Cornwall and South Wales, but by 1597 the Keswick works were in difficulties again. A little later, in 1600, an inquiry into the condition of the northern mines showed that in thirty-six years, after paying £4500 to the Queen, £68,103 had been made by the sale of metal, and the expenses had been £104,700 plus a capital outlay of £27,000. Nearly all the money, found and lost by Augsburg and London merchants, had been lavished in the dales.

The smelt houses were destroyed at the Civil Wars, probably in 1648, and many of the miners slain.

Certain points in this very slight sketch of the colony in the dales are outstanding ; one, the effect of the intermarriage of the Germans with the dalesfolk in promoting some of the energy and intelligence for which the ' old stocks ' were remarkable, which together with the then large sums of money spent locally by the enterprise have had a far-reaching effect on its subsequent prosperity and development ; the other, the close parallelism between the trials and tribulations, both technical and financial, in starting a new industry three hundred and fifty years ago and to-day. Very little profit in this respect seems to have been gained by experience ; indeed, it appears axiomatic that the first venturers will not reap material rewards. Then, as now, we cannot withhold admiration from the German craftsmen for their willingness to try new ideas, new methods, with scientific thoroughness and exactitude.

Obituary.

PROF. H. H. TURNER, F.R.S.

THE death of Prof. H. H. Turner occurred at Stockholm, where he was attending the meetings of the International Union of Geodesy and Geophysics. Just before the afternoon meeting on Saturday, Aug. 16, he fell forward on the table. His colleagues at first thought he had merely fainted, but the doctor who was called found that he had a severe attack of cerebral hæmorrhage and had him removed to the hospital. His wife was informed and she and her daughter went at once to Stockholm by aeroplane. He died on Wednesday, Aug. 20, without recovering consciousness.

Herbert Hall Turner was born at Leeds in 1861, and went to the Leeds Modern School and then to Clifton College. He obtained a Major Scholarship at Trinity College, Cambridge, was Second Wrangler in 1882 and second Smith's Prizeman in the following year. He became Chief Assistant at the Royal Observatory, Greenwich, in 1884, shortly before his election to a fellowship at Trinity. He soon became interested in the problems of fundamental astronomy and made researches on the $R - D$ discordance of the Greenwich transit circle. He elucidated but did not find a complete explanation of this still unsolved problem of the persistent difference between the zenith distances of stars from observations taken by reflection from mercury or directly. It is still in doubt to what extent this is due to flexure of the instrument, the differences of temperature in the observing room from that outside, and other instrumental causes. Turner made series of observations of the temperature in different parts of the room, and varied the conditions in which the observations were taken, taking the direct observation before that made by reflection.

A leading part was taken by Turner in a determination of the longitude of Montreal. This was determined in three links : Greenwich-Waterville, Waterville-Canso, Canso-Montreal. The difference of longitude Montreal-Washington being already known, the longitude of Washington was thus determined. The result obtained by this complicated series of connexions agreed closely with the direct determination found in recent years with the assistance of wireless signals. The difference of longitude Paris-Greenwich was twice determined conjointly with French astronomers. Here the results were not accordant, as in both series the French obtained a larger value than the English observers. Accordant results were not obtained until 1902.

Turner took part in a number of eclipse observations, and, like other astronomers, suffered from the vicissitudes of weather. At one of these expeditions, a brother-astronomer was seriously ill with fever. With characteristic kindness, Turner deliberately read the thermometer wrongly to the patient, and so cheered him that his temperature fell before the end of the visit. For the eclipse of 1896, in Japan, Turner introduced the use of the cœlostat. M. Lippmann had pointed out that a mirror turning on an axis in its own plane at half the speed of the earth's rotation and pointing to the pole gave a stationary image of the entire field. Turner realised the great convenience of this for photography of the sun at eclipses, and, with his friend Dr. Common, designed instruments which have served English observers in many subsequent eclipses. The weather was unfavourable in Japan in 1896, but Christie and Turner had good fortune in India in 1898, Newall and Turner in Algiers in 1900, and Turner and Bellamy in Egypt in 1905. He went to Paris for the eclipse of 1912 as a spectator, as the duration of totality was too short for serious observation ; and at the eclipse which passed over England in 1927 he and Dr. Knox Shaw had only partially favourable weather at Southport.

Turner entered heartily into the scheme for the International Photographic Map of the sky inaugurated at Paris in the late 'eighties. Christie obtained one of the standard astrographic telescopes made by Sir Howard Grubb for Greenwich, Gill one for the Cape, Pritchard for the University

of Oxford, and others were obtained by the Australian observatories at Perth, Melbourne, and Sydney. In November 1893, Turner contributed to the Royal Astronomical Society a short and important paper on the method to be employed in the determination of the positions of the stars from the micrometric measures of the photographs, a method which has been generally adopted by astronomers. After the death of Pritchard in 1893, Turner was appointed to succeed him as Savilian professor of astronomy at Oxford, and carried out the part of the work allotted to Oxford with great energy. He took the line that the short exposure photographs, which would give the positions of some two million stars, should be measured and the rectangular co-ordinates of the star-images published promptly with such additional data as were necessary for the determination of the accurate positions of the stars. He urged this very strongly, and on the formation of the International Astronomical Union was, on the nomination of the first president, M. Baillaud, appointed chairman of the Committee dealing with the International Photographic Map of the Heavens. His efforts have brought the scheme much nearer completion than it would otherwise have been. After finishing the Oxford section, he measured photographs belonging to other observatories, and was largely instrumental in getting the observatory of the Nizam of Hyderabad to take up the photography and measurement of a zone allotted to an observatory which had later been unable to carry out the work. Among other interesting by-products of the work, Turner found that owing to curvature of the field, the photographs which were in critical focus at a distance of 30′ or 40′ showed far fewer stars at the centre of the field than at this distance.

Turner was a delightful popular exponent of astronomy, with a natural facility for speaking. He also wrote several popular works on astronomical subjects. His short and lively contributions to the *Observatory* magazine, "From an Oxford Notebook," were widely read and appreciated. Some of these consisted of amusing incidents or historical reminiscences interesting to astronomers. Others contained references to the current work and publications of other atronomers, with friendly criticism and appreciation.

On the death of his friend Prof. Milne, Turner took charge and largely extended the organisation which Milne had formed for the collection of seismographic records from all parts of the world. Milne-Shaw seismographs, comparatively inexpensive instruments devised by Milne, but improved greatly by Mr. Shaw of West Bromwich and manufactured by him, have been installed all over the world and the times of different phases of the shocks were reported to Turner at Oxford. As in the Astrographic Catalogue, he attached great importance to the prompt collection and publication of these data, which have thrown great light on the internal constitution of the earth. Turner made frequent harmonic analyses of earthquake records with the view of finding correlation between them and other astronomical and meteorological phenomena.

His disposition made Turner like work in co-operation with other people. He always enjoyed the international meetings of astronomers and other men of science. He invited the International Solar Union to Oxford in 1907, and attended the meetings at Meudon in 1904, at Mt. Wilson in 1910, and at Bonn in 1913. He was also a Royal Society representative at the meetings of the International Association of Academies. At the meetings of the International Astronomical Union he has been president of the Committee for the Photographic Map of the Heavens, and at the International Union of Geodesy and Geophysics, president of the Section of Seismology. He was secretary of the British Association from 1913 to 1922.

Turner will be greatly missed at the meetings of the Royal Astronomical Society, which he attended with the greatest regularity. He has served on the council for forty-three years, and has been secretary, president, and foreign secretary of the Society. At the council meetings he invariably took a charitable view of a doubtful paper, and at the meetings never failed to compliment a young author on his research. At the dining club after the meetings he was secretary and Glaisher president, to the great satisfaction of the members, for many years. On Glaisher's resignation owing to failing health, Turner became president, and continued to delight and enliven the gathering by speech and occasionally by song. He took a great interest in other people's work, including modern developments, and was a very kindly and genial colleague, whose death will be mourned by astronomers all over the world.

Prof. Turner was elected a fellow of the Royal Society in 1896. He was a corresponding member of the Paris Academy of Sciences, and he received the Bruce medal of the Astronomical Society of the Pacific in 1927. He was given honorary doctorates by the Universities of Leeds, Sydney, Wales, Strasbourg, Durham, and California. F. W. D.

PROF. J. F. POMPECKJ.

DR. JOSEF FELIX POMPECKJ, professor of geology and palæontology in the University of Berlin, and Geheimer Bergrat, died on July 8, while still in the midst of his activities. He was born in East Prussia on May 10, 1867, and graduated as Ph.D. at Königsberg in 1890, with a thesis on Trilobites. He had a varied official career, beginning in 1891 as assistant in the geological institute at Tübingen, and removing two years later to Munich, where he was both a curator in the Palæontological Museum and *privat-docent* in the University. In 1904 he became professor in the Agricultural Academy at Hohenheim, and in 1907 he was promoted to the professorship of geology first in the University of Königsberg and then in the University of Göttingen, where he followed A. von Koenen. He remained at Göttingen for six years, and in 1913 returned to Tübingen as professor in succession to E. Koken. In 1917, on the retirement of his old teacher, W. Branca, he was appointed professor in the University of Berlin, and in 1925–26 he served his term as rector of the University.

Prof. Pompeckj was especially insistent on the necessity of studying sedimentary rocks and fossils together, and all his researches were guided by this idea. In continuation of his doctoral thesis, he began by studying the Trilobites and other early Palæozoic fossils and their distribution in the various rocks in which they were found. He published papers on Trilobites and on the Cambrian formations of Bohemia, Sardinia, and other regions. In his latest years he returned to the same subject when examining the boulders on the north German plain. His most important work, however, was on the stratigraphy of the Jurassic formation, especially of Württemberg, but also of the Arctic regions, from which he examined several collections of rocks and fossils. In this connexion he became an authority on certain groups of Ammonites and other Mollusca. He was ever in search of general principles, and his addresses on the former extension of seas (1909), on race-persistence among Ammonites (1910), on the origin of the copper-slate (1920), and on environment, adaptation, and struggle in the light of geological research (1925), are full of interesting and valuable suggestions.

Outside the University, Prof. Pompeckj also took his full share in promoting geological and palæontological science. For many years he was one of the editors of the *Palaeontographica*, *Geologische und Paläontologische Abhandlungen*, and *Neues Jahrbuch für Mineralogie, etc.*, and he was an active member of the German Geological Society, of which he was several times president. The Geological Society of London expressed its appreciation of Prof. Pompeckj's contributions to science by electing him a foreign correspondent in 1925.

We regret to announce the following deaths:

Dr. Henry Fraser, formerly director of the Institute for Medical Research, Federated Malay States, when he made valuable contributions to our knowledge of beri-beri, bacillary dysentery, and leprosy, on July 17, aged fifty-seven years.

Mrs. Albert Howard, Second Imperial Economic Botanist to the Government of India, who was associated with her husband in the work of the Institute of Plant Industry, Indore, on Aug. 18, aged fifty-three years.

His Grace the Duke of Northumberland, K.G., president of the Royal Institution and Chancellor of the University of Durham, on Aug. 23, aged fifty years.

Dr. George W. Patterson, associate dean of the College of Engineering of the University of Michigan, known for work on standards of electrical current, on May 22, aged sixty-six years.

Prof. Conrad von Seelhorst, professor of agriculture in the University of Göttingen, author of "Handbuch der Moorkultur", on July 6, aged seventy-seven years.

News and Views.

The anniversary address of Mr. C. R. Peers, president of the Society of Antiquaries, which is printed in full in *The Antiquaries Journal* for July, ranged over a wide variety of topics in archæological research, not the least interesting section being his review of current activities in the field. A matter of special interest to the readers of Nature, in view of recent correspondence in our columns, was the reference to the researches of Mr. Reid Moir and Mr. Burchell on the boulder clay of Norfolk and Yorkshire. Touching upon the archæological aspect of their work, he pointed out that in common with other recent research, it tended to contract still further the distinction which has been drawn between the culture of palæolithic and neolithic man. For these glacial deposits have been found to contain an appreciable number of flints which were surface deposits before the clay was laid down, and are, therefore, indubitably of palæolithic date, yet of a type which would generally be regarded without question as being neolithic. Such a classification, he said, can no longer be accepted, and palæolithic man would appear to have "made a most impressive invasion of what, till late, was neolithic territory".

In dealing with research in the field, Mr. Peers referred in some detail to the conditions in which excavations are being carried out under the auspices of the Society of Antiquaries at Colchester and St. Albans. A preliminary account dealing with the first fortnight's work at St. Albans appeared in the *Manchester Guardian* of Aug. 14. The prospects are indeed promising. There are already indications that it may be possible to fix with some certainty the date of the great defensive Roman wall, assigned by some to the first, by others to the third century A.D. If further investigations confirm that it is of first century date, as the evidence at present suggests, it will also fix the date of the London wall, which is identical in construction with that at St. Albans, and in both cases will demonstrate the correctness of the view which holds that these cities were walled after the suppression of Boudicca's rebellion. The entrance gates of the town have been unearthed and the foundations of one of the two flanking towers usually found with such gates have been laid bare. Verulamium has a history stretching from prehistoric times to the fifth century A.D. This is unique in Britain, and with the view of throwing light on its Celtic culture and on the later phases in its history, Mrs. Wheeler is excavating houses fronting on Watling Street within the town. Three have now been unearthed. They show that after the Roman occupation the Roman art of building was lost, but a remarkable pot, unearthed from the beaten clay floor which had been laid down over the tesselated pavement, suggests that the Roman-taught art of pottery was still practised in degenerate form.

We have received an interesting communication, unfortunately too long to print in full, from a correspondent, W. W. L., commenting upon the views expressed in our article "Education, Environment, and the Criminal" (Nature, July 12, p. 45). The writer directs attention to the arguments and assumptions typified in that article, and urges that the attitude of science to-day countenances a self-expression demanded for unregulated and uncontrolled impulses

and selfish desires, while neglecting the means whereby the true individuality of man can evolve and find self-expression. Finally, our correspondent asks whether if human beings have no conscience, no psycho-spiritual nature, no evolutionary objective, does it matter what they do? W. W. L.'s letter raises a question which is becoming increasingly important in modern life, namely, the relation of science and ethics; but the form in which the criticism is made suggests an application of a moral standard as a test of the validity of scientific reasoning which would stultify research. The research worker as such, whatever his duty towards humanity and his fellow-citizens as an individual, in dealing with scientific data is concerned only with the truth—the facts, and the inferences from those facts. It is in the application of scientific conclusions to the problems of life that the ethical standard comes into operation. It is not for the psychologist or the sociologist to speak of the 'higher' and 'lower' impulses in the sense used by our correspondent. These are distinctions for the social reformer who applies the conclusions of the psychologist and the sociologist relating to these phenomena in dealing with his own special problems of social reform.

AN article by Prof. Raymond Dart, in the *Times* of Aug. 22, gives an account of some results obtained in excavating the Mumbwa Caves during the last three months by the Italian scientific expedition operating in Portuguese East Africa, South Africa, and Southern Rhodesia under Capt. Attilia Gatti and Prof. Lidio Cipriani. Mumbwa is approximately 130 miles south-west of Broken Hill, where Rhodesian man was discovered. The excavations revealed strata with implements ranging from the most recent types of stone age implements to Mousterian; but the most interesting find was that of a peculiar type of iron smelting furnace at a depth of six feet below the surface above it and eight feet below the surface at the middle of the cave. This is the first occasion on which a smelting furnace has been discovered in South Africa in conditions which permitted of an archæological dating. On one side of the furnace was a great accumulation, 2 ft.–3 ft. thick, of ashes, burnt rock, incinerated bones, clay, slag, and of quartz and metal showing the action of fire. On the other side, between the furnace and the cavern wall, were human burials. Two of these which were carefully excavated showed that the bodies were buried in sepulchres of stones piled beehive fashion and supported by earth. The skeletons were all of Bushmen. The furnace stratum and overlying earth were filled with quartz flakes and implements of middle and late stone age type, and one foot below the furnace was the Mousterian level with implements of ironstone similar to that which attracted the iron smelters. In the superficial deposits were found occasional iron arrow-heads and pottery, these probably of Bantu origin.

IT is obvious, in view of the peculiar archæological conditions in South Africa, that the material discovered by Capt. Gatti and Prof. Cipriani is susceptible of very diverse interpretation. Prof. Dart himself regards the furnace culture as coeval with the later phase of the palæolithic and as the introduction of a superior race into an Africa "still in the throes of the stone age". The continuation of the stone age culture relatively unaltered, he holds, shows that the local inhabitants were not initiated into the mysteries of the smelters. It is further suggested that this evidence points to an antiquity for a knowledge of iron smelting in Rhodesia of 3000–4000 years, the superficial supposedly Bantu finds being perhaps 2000 years later. Prof. Dart goes on to point out that whereas the Zimbabwe culture, usually associated with mining and metal working, has been attributed recently to a Bantu people of about 400 to 500 years ago, we now have in the Mumbwa cave evidence that metallurgy was being actively prosecuted in the Zambezi watershed thousands of years ago. Prof. Dart's conclusions may be soundly based, but in default of a more precise nomenclature for the implements in accordance with the generally accepted classification of South African stone age cultures, they are difficult to appraise. Implements of "late stone age type" in South Africa might be of any date. Nor is it possible to say that the smelters' culture is of Bushman origin on the evidence of burials which might be intrusive or explicable in other ways, unless the proof of their contemporaneity is more convincing than has been shown at present. More precise information as to the type of the furnace, which differs from that of the Bantu, may furnish some clue. If further examination of the data supports Prof. Dart's dating, this is a discovery of first-rate importance; in any event it is extremely interesting.

AUGUST ANDRÉE started from Danes Island, Spitsbergen, on July 11, 1897, with two companions, Drs. Strindberg and Fraenkel, to drift across the north pole by balloon. Ample supplies of food and ammunition were taken, the capacity of the balloon was increased by 300 cubic metres to 4800 cubic metres and the fabric strengthened by additional coats of varnish, but the risks were clearly great. Andrée sent messages by pigeons up to July 13, when their position was lat. 82°, long. 15° E. After that, nothing was heard of the party. Now, after an interval of thirty-three years, comes the report that the bodies of Andrée and one of his companions have been found on White Island, Franz Josef Land. It seems that a party from the Norwegian expedition carrying out investigations in Spitsbergen and the Arctic Ocean under Dr. Horn landed on the south-west of White Island on Aug. 6 and found traces of a camp near the coast. Further search led to the discovery of a boat and sledge, with notebooks, instruments, and other equipment marked "Andrée's Polar Expedition, 1897", and near by was Andrée's body. Another body was found some distance away and between some great stones in a cleft in the rocks. Both bodies have been well preserved by the intense cold, and their discovery is thought to be due to the unusual warmth of the present season. The remains of the expedition have been put on board the *Bratvaag*, the ship carrying the Norwegian expedition, which is due to return to Tromsö early in September.

THE preservation of memorials to famous men of science should be regarded as a duty. We are glad, therefore, to record that the tomb of Sir Humphry Davy in the old cemetery of Plainpalais in Geneva, which had fallen into disrepair, has not only been renovated but also that arrangements have been made for it to be suitably cared for in the future. Davy died in Geneva on May 29, 1829, while on his way home from Rome, and the funeral, arranged by de Candolle, the eminent botanist, was attended by a large number of the citizens of Geneva. Last year on the centenary of Davy's death the Faculty of Science of the University of Geneva visited his tomb and laid a wreath upon it. Through Dr. R. Fleming, of the Physiological Laboratory, Geneva, the attention of the Royal Institution was then directed to the state of the monument, and, thanks to the action of that body and the collaboration of Sir Humphry Davy Rolleston, it has been possible for a complete restoration of it to be carried out.

ACCORDING to a recent *Daily Science News Bulletin* issued by Science Service, Washington, D.C., a curious phenomenon was recently observed by the General Electric Company engineers who operate the broadcasting station WGY (Schenectady, U.S.A.). Having solved the problem of broadcasting waves in the broadcast band with 200 kilowatts, they attempted to broadcast waves of short wave-length using similar large power. With a power of 35 kilowatts brilliant brush discharges flashed and wavered round the antenna when the carrier wave was modulated with the current from the microphone in the studio. The carrier wave alone had no effect on the air near the antenna. It was only when it was modulated that violent corona effects were observed. These discharges caused the air to vibrate and produced noises like thunder which roughly reproduced the music. The antenna apparently acted like a gigantic loud speaker. If allowed to continue it would doubtless have arced across the insulators, fused the copper wires, and broken the antenna. To prevent this effect the wires were replaced by much thicker ones. Large hemispheres were also placed at each end of the antenna. This diminished the electric stress on the air near the conducting surfaces and 35 kilowatts of power are now successfully modulated by WGY on short waves without the formation of corona flashes.

THE overhead line from Luton to Bedford which was put into operation on May 29 last gives a good idea of the British 'grid' scheme which is rapidly being erected in many parts of the country. It consists of six steel cored aluminium line conductors and one overrunning steel cored aluminium earth conductor for lightning protection. Each line conductor consists of thirty aluminium strands surrounding seven steel strands. The insulators have nine discs, each ten inches in diameter, in series, which are suspended from the cross arm ends on straight line galvanised steel lattice towers. The towers vary in height from 72 ft. to 98 ft., and their bases vary between 14 ft. and 25 ft. square. The normal span is 900 ft. and the sag of the conductors is about 22 ft. From the æsthetic point of view little can be said for or against them, but as the transmission voltage is 132,000 they add to the risks of air navigation. In London itself it now seems quite certain that the cables will be put underground. The Italian Pirelli Co. has laid oil filled cables underground and found experimentally that they were satisfactory at pressures of 220 kilovolts. The Central Electricity Board began installing double circuit oil filled cable lines between Eltham and Deptford to work at the standard pressure of 132 kilovolts. It looks therefore as if all the main difficulties in the way of the grid transmission scheme are being overcome.

IT is highly probable that railway electrification would make much more rapid progress if it were not for the high capital outlay required. It is owing to this heavy outlay that many railway engineers are considering the possibility of using Diesel electric trains on British lines. In a brochure issued by Sir W. G. Armstrong Whitworth and Co., information is given of the advantages and growing popularity of this kind of traction. Armstrong-Sulzer Diesel electric motor coaches have been in service for more than five years without needing any overhaul. These motor coaches can be used for twenty hours out of the twenty-four and can run twice as many miles per annum as a steam locomotive. No time is required for lighting up and steam raising, and fuel for twenty-four hours' service can be pumped into the fuel tank in a few minutes. Economies can be effected when coasting down a long incline by stopping the engine. It is stated that a saving of several million pounds per annum on fuel alone could be effected by adopting this system on British railways. For the Russian State railways Diesel electric locomotives of this type have been made, having a working weight of 135 tons and of 1500 brake horse power. They are also used on one of the Tunisian railways, the Buenos Ayres Great Southern Railway, and the Swiss Federal Railways. We learn from *A.E.G.* (Allgemeine-Elektricitäts-Gesellschaft) *Progress* for August that this firm has had two petrol 150 horse power engine cars running on the Brazilian Central Railways since 1925, and that since then others of larger size have been supplied to the same railway. The Diesel electric locomotives have excellent running 'characteristics', there is practically no vibration, and the engines run noiselessly.

MR. G. STEVENSON TAYLOR gave the Gustave Canet Memorial Lecture before the Junior Institution of Engineers on the subject of industrial accidents, their cause and prevention. Mr. Taylor estimates that the total amount of compensation paid to workmen for accidents alone, apart from compensation for industrial disease, was nearly 6½ million pounds in 1928: to this must be added the cost of administrative expenses as well as medical and legal costs. He thinks that this burden on industry could be materially reduced if the problem were attacked in the right spirit and on right lines. From information obtained by inspectors and others under the Factory Acts, he pointed out that more than 50 per cent of the accidents and more than 70 per cent of the fatalities were due to causes not

connected in any way with the use of machinery. A large number of accidents occur through persons falling over objects on the floors, and he urged the importance of clearly marked alleyways. It is also found that the percentage of accidents is greater during the winter months when the daylight hours are short. He considers that the personal factor in accidents is evidenced in carelessness, inattention, and want of thought. More recent studies than those reported by Mr. Taylor show that the personal factor involves much more than is suggested above. The work of Prof. M. Greenwood and his colleagues has shown statistically that the genesis of multiple accidents under uniform external conditions is an affair of personality and not determined by any obvious extrinsic factor. Later, Farmer and Chambers have produced evidence in favour of the view that there are people who have a definite measurable tendency to have accidents. This tendency may not necessarily be related to states of consciousness over which the person has control and cannot be adequately described by the moral judgment implied in such terms as carelessness or want of thought.

SOME years ago the idea was current that stone age man was a typical savage of a low grade of intelligence and the merest rudimentary forms of culture. We are now perhaps only just beginning to appreciate the significance of the stage of development of his brain, and to discern the skill and ingenuity that went to the fashioning of a stone implement and its adaptation to the needs of daily life. An interesting point bearing upon this aspect of relics of the stone age is discussed by Mr. Reid Moir in a communication entitled "Stone Implements from a New Angle", which appears in the *Journal of the Ipswich and District Natural History Society*, vol. 1, p. 2. With sound common sense, Mr. Reid Moir argues against the views of archæologists who hold that because the number of objects of material other than stone diminishes as the time series ascends until they disappear, therefore the earlier races of man employed no material except stone. He maintains that this takes too low a view of the intelligence of early man, and goes on to argue that both the nature of the material, that is, wood, bone, and ivory, and the conditions of deposit of the implements are such as to make it improbable that anything but the most durable material would survive except in such favourable conditions as are afforded by the French palæolithic caves. Yet even so, as he points out, we have the bone implement associated with Piltdown man, as well as other specimens for which a high antiquity is claimed. Mr. Reid Moir gives a useful hint to archæologists when he points out that the great majority of stone implements are implements with which other implements, now vanished, would be fashioned, As to the deeper significance of this dictum, we recommend consideration of Mr. Reid Moir's experiments in the practical use of stone implements, which the student might emulate if he can acquire the necessary dexterity and patient persistence.

FURTHER details of the International Zoological Congress have just been received, rather late in the day, as the Congress opens at Padua on Sept. 4. There will be an informal gathering at the Hotel Storione at 9.30 P.M. on Wednesday, Sept. 3. The opening ceremony will be at 10.30 A.M. on Thursday, at the University, when Dr. M. Caullery will give an address on genetics and evolution. The sections will meet in the afternoon and during such further afternoons or mornings as are not otherwise occupied. General meetings will be on the afternoon of Friday, Sept. 5, and the mornings of the following Saturday, Monday, Wednesday, and Thursday. Sunday, Sept. 7, will be filled with an excursion to the Lagoon of Venice. Shorter excursions during the meeting will be to the Royal Villa at Strà, to Rovigo, including a visit either to Count Arrigoni's ornithological collection or to Petrarch's house at Arquà, and to Abano. From Friday to Sunday, Sept. 12–14, there will be an excursion to the Lagoon of Comacchio, Badia di Pomposa, Bonifica di Codigoro, Ferrara, Bologna, and Ravenna. Favourable terms have been arranged at the hotels of Padua, and the Italian State Railway will issue return tickets from any frontier station or port to Padua at a reduction of 30 per cent. An exhibition of optical and other scientific instruments by Italian and foreign firms has been arranged. The address of the Congress is Via Loredan 6, Padova.

IN a pamphlet entitled "How Unemployment Might be Prevented", Capt. J. W. Petavel, formerly lecturer on "The Poverty Problem" at the University of Calcutta, advocates the formation of labour colonies or guilds as a solution of the unemployment problem. The basis of the proposal is that members of the guilds would undertake the direct production of most of their requirements, and the scheme is worked out to suit both Indian and European conditions. The author holds that the scheme would greatly increase the well-being of the Indian peasants, whose agricultural output is low, but whose needs are simple. In Europe it is suggested that the labour colonies might if necessary be modified so as to allow the workers to put in part of their time in ordinary factories and part in work at the colonies. In support of the scheme the success of a Swiss colony is cited. This has been organised on a self-supporting basis for 'unemployables', who can earn their keep at the colony together with a small surplus which is paid them on leaving. Educational colonies are also advocated for young persons up to eighteen years of age, who would spend half their time at school and the other half in productive employment at the colony, bringing back produce to their homes in lieu of wages.

AN important Congress of representatives of Czechoslovakia and Rumania was held at Krakow last December, for the purpose of discussing common interests in the protection of Nature. The *compte rendu* of the Congress, which has just been published, illustrates the necessity and the value of co-operation in such matters. The chief objective of the meetings was the attainment of agreement especially in regard to the national parks lying on the borders of the countries concerned, for the creation of a great boundary reserve in the mountain range of Czywczyn, and for the protection of the valley of the Dniester.

No less than fifty-three resolutions were agreed upon, perhaps the most important being those concerned with the setting-up of a permanent Commission representing Rumania, Czechoslovakia, and Poland, to deal with common problems and to endeavour to obtain general laws applicable to the three States, but allowing possibilities of modifications in detail to meet special needs in any particular territory. Other resolutions signified areas suitable for reserves, and pleaded for the protection of the forests, which are gradually disappearing, of rare animals and plants, for the reasonable regulation of fisheries in the boundary reserves, and of sport.

WE have received the annual report for 1928–29 of the National Institute for Research in Dairying, University of Reading. The Institute's home is four miles from Reading at the Shinfield Manor House; this was acquired in 1923 and adapted at a cost of £30,000, and a considerable balance of this sum still remains to be raised by public appeal. The report reviews the work of the Institute during the year, giving summaries of papers published by the staff during the period, and forecasts some of the investigations to be carried out in the future.

THE Ministry of Health has issued to councils of counties and county boroughs in Great Britain a "Memorandum on Cancer as a subject for the attention of Local Authorities" (Cancer—vii., *Circular* 1136). Its object is to suggest the desirability of local authorities acquiring more complete knowledge of the reactions between cancer and the local community, with the view of devising such local ameliorative measures as may be necessary and practicable. A scheme of methods of investigation, appropriate action, and co-operation with other authorities is suggested.

THE summer issue of *Sunlight*, the journal of the Sunlight League (Vol. 2, No. 2), contains articles urging that greater use should be made of the healing virtues of the sun's rays, particularly in England. Sir Bruce Bruce-Porter and Dr. Eidinow write on ultra-violet and other rays in health and disease, the Marchioness of Aberdeen and Temair on open-air village settlements, and Dr. Saleeby on the children's home at Chailey Heath, Sussex, which locality he maintains need not fear comparison with Leysin, and is far superior to Berck, the most celebrated sun-cure place in France.

THE *Journal of the Cancer Research Committee of the University of Sydney* for May (Vol. 2, No. 1) contains articles of considerable interest. Prof. Welsh writes on the classification and characters of the endothelial new growths, Mr. Mankin discusses micro-methods of chemical analysis, describing methods for the estimation of molybdenum, potassium, sodium, calcium, and chlorides, and Mr. Gower Stephens deals with the radiation treatment of brain tumours. From a small number of cases of brain tumour treated with X-radiation, experience shows improvement which is usually prompt and definite.

The Carnegie Institution of Washington has published a new edition (April 1930) of its "Classified List of Publications." This useful volume of 207 pages contains a chronological list of the Institution's publications, a subject index, with brief summaries of the most important works, and an authors' index. It is impossible to indicate here the variety or importance of the contributions to knowledge so listed, but an indication of the extent of the catalogue is given by the fact that the subject index is arranged under twenty-seven branches of science. Such books as are not out of print are available to correspondents at prices approximating to the cost of publication, and price-lists or classified lists as issued will be sent to scientific workers on the receipt of the requisite address.

THE Liverpool Electric Cable Company, Ltd., of Bootle, Liverpool, has sent us a catalogue of low tension paper insulated cables. All the cables described in this catalogue are manufactured in accordance with the regulations of the British Engineering Standards Association and the components of the cables are in accordance with the B.E.S.A. specifications.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in chemistry at the Brighton Technical College—F. W. Toyne, Secretary, 54 Old Steine, Brighton (Sept. 2). A lecturer in mechanical engineering at the Norwich Technical College—The Principal, Norwich Technical College (Sept. 3). An assistant organiser of agricultural education under the Wilts County Council—The Clerk of the Wilts County Council, County Offices, Trowbridge (Sept. 6). An instructor in the department of navigation of the Sir John Cass Nautical School—The Principal, Sir John Cass Nautical School, Jewry Street, E.C.3 (Sept. 9). An assistant in the Barnato Joel Laboratories, Middlesex Hospital, for radiological research bearing upon the treatment of malignant disease—The Dean, Middlesex Hospital Medical School, London, W.1 (Sept. 13). An inspector under the Ministry of Agriculture and Fisheries, for the purposes of the Diseases of Animals Act, 1894–1925—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1. (Sept. 15). A demonstrator of biology at Guy's Hospital Medical School—The Dean, Guy's Hospital Medical School, London Bridge, S.E.1 (Sept. 20). An expert hydrobiologist for fisheries investigations in Turkey—Mr. E. C. Weberman, Beyoğlu, Sira Servi 4, Istanbul, Turkey (Oct. 15). A Pilkington fellow in cancer research in the University of Manchester—The Registrar, The University, Manchester (Nov. 15). A lecturer in physics at University College, London—The Secretary, University College, Gower Street, W.C.1. A lecturer on surveying and geodesy at the Regent Street Polytechnic—The Director of Education, The Polytechnic, Regent Street, W.1. Teachers of engineering drawing, heat, electricity and magnetism, mechanics and hydrostatics at the Croydon Polytechnic—The Principal, Central Polytechnic, Croydon. A laboratory steward and lecture assistant in the chemistry department of Goldsmiths' College—The Warden, Goldsmiths' College, New Cross, S.E.14.

Research Items.

Cancer of Lip and Skin.—Cancer of the lip, tongue, and skin is the subject of a report by Dr. Janet Lane-Claypon for the Ministry of Health (*Reps. on Pub. Health and Med. Subjects*, No. 59. London: H.M. Stationery Office, 2*s*. net). Cancer of the skin and of the lip is a readily curable disease if promptly diagnosed and treated. The results secured by radio-therapy appear equal if not superior to those obtained by operation, reaching 80 per cent or more of cures in the case of skin cancer. Cancer of the tongue, on the other hand, is far less amenable to treatment, either by operation or by radium. As regards causation, evidence is accumulating that the actual cancer is preceded by some apparently simple and harmless condition, such as a pimple, wart, mole, etc. A proportion of skin cancers is known to be associated with certain occupations involving contact with soot, tar, mineral oils, arsenic, and similar substances. As regards cancer of the tongue and lip, this is known to be frequently causably connected with syphilis and with smoking, but there is no evidence that the simple inhalation and exhalation of tobacco smoke are causative.

Comparison of Left and Right Ovaries.—In the whole animal economy, no organs lend themselves more readily than the ovaries to the study of quantitative and qualitative functional comparison, that is, to a comparison between the activity of one organ situated on one side, with another situated on the other side, of the body. In a preliminary note published in the *Rendiconti della Reale Accademia delle Scienze dell' Istituto di Bologna* (1929), Prof. Pasquale Sfameni shows that, as regards the ovigenic function, with cows, rabbits and women, the right-hand ovary predominates over the left. In the case of women, this predominance weakens as age increases up to thirty-five years, after which it becomes reversed. As regards the fœtus, this has the greater weight if generated by the right-hand ovules. Multiple corpi lutei are more frequent as the period of genital life advances, the superiority in this direction being shown by the left-hand ovary.

Effect of Cold on Sea Life.—The second and third parts of the recent Report of the Danish Biological Station to the Ministry of Shipping and Fisheries (**35**; 1929), by H. Blevgad and A. C. Johansen, give accounts of the effect of cold on certain animals, the first dealing with the littoral invertebrates, the second with porpoises, fish, and crustacea. The winter of 1928–29 was specially severe and its effects were felt by many animals. It is shown that this prolonged frost had a pronounced effect on the littoral fauna, but some forms were much more resistant than others. The bottom animals are particularly exposed to the dangers of being killed in ice winters in the coastal belt between 0 m. to *c*. 1 metre's depth, especially in places which are liable to be left dry at low tide. The mussel *Mytilus edulis* suffered badly, also the cockle *Cardium edule* and the oyster (*Ostrea edulis*). Dr. Johansen notes the large numbers of porpoises dead in the Bornholm Deep, having probably fled from the ice in the Belt Sea. Only in areas of slight extent was there any wholesale destruction of fish such as cod, haddock, plaice, and flounder, and this probably chiefly owing to lack of oxygen near the bottom. The eel was the fish which suffered most, although in no locality was the stock wholly eliminated. Many smaller fishes besides crabs, lobsters, and shrimps also died.

Californian Commercial Fish Catches.—*Fish Bulletin* No. 20, "The Commercial Fish Catch of California for the Year 1928" by the staff of the Bureau of Commercial Fisheries of California (Division of Fish and Game of California, 1930) contains a large amount of information concerning a variety of commercial fishes and crustaceans. This is the second of the special bulletins dealing principally with monthly tables, and it is hoped to continue this annually, including in addition summaries of other classes of fisheries statistics collected by the Bureau. The chief features of 1928 were a continued increase in the amount of fish used for canning as opposed to utilisation in fish markets, the sudden development of a mackerel canning industry on a large scale, continued indications of the failure of the local fishing banks on the narrow continental shelf to supply the increasing demands for fish, and in consequence an increasing dependence on distant and foreign areas, extension of the tuna fishing area to far below Cape San Lucas, importation of albacore from Japan and Hawaii and, finally, the commercial utilisation of sword-fish. The bulletin begins with a useful list of the common and scientific names of the fishes, crustaceans, and mollusks, after which come short chapters on the most important species. The sardine is easily the first, the total catch being 2½ times that of the rest of the fish combined. Mackerel comes next, having risen from the tenth place in 1927 to second in 1928, due to canning. The rest are much the same as in former years.

Japanese Fresh-Water Rhabdocœlids.—Dr. K. Okugawa gives an interesting list of these flatworms in his paper "A List of the Fresh-Water Rhabdocœlids found in Middle Japan, with Preliminary Descriptions of New Species" (*Memoirs of the College of Science*, Kyôto Imperial University, Series B, vol. 5, No. 1, Article 4, 1930). No details were hitherto on record relating to the fresh-water species of this group, although certain cosmopolitan forms were known to be abundant in the rivers, ponds, and lakes of Japan. The author finds that the rice-fields of Middle Japan are specially favourable situations for these worms, the area containing warm and fertile water from May to October. Thirty-one species belonging to nine families are recorded, with notes on their structure and distribution. Six new species and two new varieties are described. Many of these Rhabdocœlids are very abundant in ditches and ponds as well as in the rice-fields. The research, extending over two years, was carried out chiefly at the Otsu Hydrobiological Station on Lake Biwa under the supervision of the Director, T. Kawamura.

The Mid-Atlantic Ridge.—The origin of the Mid-Atlantic Ridge, one of the most remarkable features of the globe, is a much-disputed problem. Haug regards the Ridge as a median anticline formed by the beginning of crumpling in the great 'geosyncline' of the Atlantic. For Taylor, Wegener, and others, it is a strip of the original crust from which the continents on opposite sides have drifted away. Thus, as in the case of the African Rift Valleys, there are two diametrically opposed hypotheses in the field: one involving compression, the other tension. Dr. H. S. Washington now enters the field via the petrology of St. Paul's Rocks, a group of four rocky islets lying on that part of the Ridge which runs nearly east and west just north of the equator (*Jour. Maryland Acad. Sci.*, vol. 1, No. 1, Jan. 1930). Unlike most of the Atlantic islands, St. Paul's Rocks are not volcanic, but are composed of a plutonic ultrabasic rock—a wehrlitic dunite—that has been metamorphosed by pressure. Washington therefore regards

"lateral pressure as the sole competent cause of the uplift of this part of the Ridge, which is quite in accord with the known condition of instability and present-day seismic and submarine volcanic activity of the region". To account for the peculiar shape of the Ridge, Washington is tempted to apply the torsional hypothesis of Prinz, suggesting an eastward movement on the south and a westward movement on the north.

Remarkable Series of Earthquakes at Ito (Japan).—Ito is a watering-place on the west coast of Sagami Bay. For two months since the middle of last February the town has been shaken by almost incessant earthquakes, none of them of destructive intensity, though a few were strong enough to overturn grave-stones and crack plaster-walls. The earthquakes have been studied by Prof. Imamura and three of his colleagues in the Seismological Institute (*Proc. Imp. Acad., Tokyo.*, vol. 6, pp. 190-193; 1930). A network of five seismograph stations was formed round the epicentral area. The total number of shocks recorded from Feb. 13 to April 11 was 3684, the maximum daily frequency (of 209) being reached on Mar. 9. Comparing the hourly frequency of the shocks with the tidal phases at Misaki (on the north coast of the bay), it was seen that the shocks occurred in groups coinciding with periods of low water. The most interesting result is one due to Mr. Nasu that, with a few exceptions, the foci of the earthquakes were confined to a conical region of the crust, the apex of the cone being at a depth of 6 km., while the base is a circle of about 2 km. radius on the sea-bed in the inlet of Ito. The nearer the earth's surface, the denser is the clustering of the foci. This distribution seems to suggest the presence of a hidden extinct volcano with the above-mentioned cone as its crater.

Distribution of Earthquakes in the East Indies.—Dr. S. W. Visser has recently published a useful discussion of the distribution of earthquakes in the Dutch East Indies during the years 1920–26 (*Verhand. Konin. Magn. en Meteor. Obs. te Batavia*, No. 22; 1930). In this interval 3310 earthquakes were recorded, the great majority very slight, though 35 were registered all over the world. Of the total number, only 244 had an inland origin. A large district, including Sumatra east of the Barisan Mountains and the whole of Borneo, with the exception of the east coast, is practically aseismic. On the other hand, earthquakes are frequent all along the coasts of the Indian Ocean from Atjeh to Timor, in the north of Celebes, in a small central area of the Moluccas, including Boeroe, Ceram, and Banda, and the northern portion of New Guinea. As a general rule, the epicentres of submarine earthquakes lie on the steep slopes of the oceans and deep seas, while those of land earthquakes are closely connected with existing fractures.

Magnetic Tables for the United States.—In the *United States Magnetic Tables and Magnetic Charts for 1925*, issued by the U.S. Department of Commerce, Coast and Geodetic Survey (Serial No. 453, 1929, price 60 cents, pp. 136, 4 maps), complete revised data are given concerning the distribution of magnetic force over the United States, for the epoch 1925; the publication supersedes the Tables and Charts for 1915 given in *Special Publication*, No. 44, now out of print. It contains the observed values of declination, dip, and horizontal intensity for all places in the United States at which reliable observations have been made, together with the reduced values for Jan. 1, 1925; tables giving repeat observations at stations occupied between January 1917 and December 1928; tables giving the secular variation; and isomagnetic charts for declination, dip, and the horizontal and vertical intensities. The charts measure $20\frac{1}{2}$ in. by $26\frac{1}{2}$ in.; the lines of equal declination and dip are given for each degree, and of equal annual change for each minute of arc; the lines of equal intensity are given for each 1000γ, and of equal annual change for each 10γ. The maps extend northwards to about latitude 50°; Alaska is not included. The tables occupy 124 pages, 98 of which are reproduced from typewritten sheets by photo-lithography.

Stark Effect.—An investigation of the electric fields needed before lines of a spectrum appear which are normally forbidden by the selection rule for azimuthal quantum numbers, is described by Y. Ishida and T. Tamura in a *Scientific Paper* (No. 241) of the Tokyo Institute of Physical and Chemical Research. This effect, which is distinct from the splitting of lines already present in the absence of a field, has been studied for helium in a tube of the Lo Surdo type. The field strength below which these 'forbidden' lines are still absent is greatest when they involve no change in azimuthal quantum number (k), falls to zero for the normal change of unity, and increases again, although not to the same extent as for $\Delta k = 0$, for the lines for which Δk is 2, 3, and 4. For a transition to a definite final state from an initial state in which only the initial total quantum number (n) is variable, the field required falls off rapidly with increase in n; for example, 87 kilovolts per cm. are needed to bring out the line $2S$-$3S$, but only 3·2 kv./cm. for the line $2S$-$6S$. A disappearance of lines in very strong fields, of the order of a million volts per cm., has also been recorded recently by Traubenberg, Gebauer, and Lewin, with the Stark effect of the Balmer lines of hydrogen (*Die Naturwissenschaften*, vol. 18, p. 417; 1930).

Electrical Heating in Laboratories.—In the April number of *Helios*, an export electrical trade journal published in Leipzig, there is an illustrated article showing many heating devices for use in laboratories. Laboratories for general analytical work are sometimes built at a distance from public gas mains. If there is no great demand for gas for smelting and muffle furnaces, the cost of laying down gas mains over long distances may be unduly heavy. To obviate this expense all kinds of makeshifts have been tried, such as acetylene Bunsen burners and spirit or petroleum Bunsen burners. The cost of service for the acetylene burners is low although their initial cost is high. On the other hand, spirit or petroleum burners cost little but the charge for the fuel is high. The latter system therefore is only used in very small laboratories. The question of using electric heating in laboratory equipments has been little considered in Great Britain, although it possesses many advantages. The heat can be applied exactly where it is wanted and there is much less risk of explosions. The high radiation and convection losses from flames are avoided and despite the high cost of electricity the running cost in service may be actually less than when gas is used. Up-to-date water baths and drying cabinets heated electrically are shown, in which the consumption of energy is a minimum. In the drying cabinets the heating member is built inside the heat protection jacket, so it is easy to maintain a constant temperature. For laboratories in which much high class work has to be done, small test tube furnaces are specially suitable. Only the lower parts of the test tubes are heated and there is no useless waste of electric energy. There is no risk in heating explosive or highly inflammable material. A small crucible

furnace is shown suitable for the incineration of analytical precipitations. Permanent temperatures up to 1200° C. can be obtained without any trouble. The furnaces are furnished with an external nickel protective jacket.

Chemistry of Immunology.—*Science Progress* for July contains an article by Dr. W. O. Kermack on some recent advances in the chemistry of immunology in which the part played by non-protein compounds is more especially dealt with. These carbohydrates, called haptenes, resemble proteins in reacting with homologous antisera even in very great dilution, but they are not antigens since they cannot produce antibodies. It appears that Ehrlich's general idea of haptophores may have a real significance, and that the molecular groupings to which he gave that name may, in certain instances at least, be given a definite chemical configuration.

Iron Carbonyl.—With reference to the note on the formation of iron pentacarbonyl in a cylinder of compressed coal gas, which appeared in NATURE of June 7, p. 873, Mr. J. E. Mason informs us that the possibility of the formation of iron carbonyl in these circumstances was recognised by Dr. Bedford in 1912. On the experimental plant at Sleaford (Lincoln) for the hydrogenation of oils by the Bedford-Williams process, it was made a rule not to store hydrogen in the large laboratory cylinders for more than a day or two if the carbon monoxide content of the gas exceeded a few per cent. It is not stated that the actual production of iron carbonyl was experimentally demonstrated, as in Friend and Vallance's communication.

Atomic Weight of Tantalum.—The accepted value for the atomic weight of tantalum, 181·3 or 181·5 (the values adopted in different countries vary since the machinery of the International Committee on Atomic Weights broke down), is based on results which are not in satisfactory agreement. In the June number of the *Journal of the Chemical Society*, Kolar Ramakrishnaiyer Krishnaswami describes experiments on the determination of the ratios $TaBr_5$: 5Ag : 5AgBr and $TaCl_5$: 5Ag : 5AgCl, in which twenty-four closely agreeing results pointed to the value 181·36 for the atomic weight of tantalum. Modern methods were used and great care was taken in the purification of the materials.

Vitamin-D.—It is now known that vitamin-D is produced by the irradiation of ergosterol and that the latter is the only sterol which gives rise to it. Previously it was thought that cholesterol was the provitamin, but experiments seem to have proved that its activity is due to a content of about 0·05 per cent of ergosterol in the cholesterol. Several investigations have been made on the effect of monochromatic light on cholesterol. In the June number of the *Journal of the American Chemical Society*, Marshall and Knudson describe some experiments made with ergosterol. They conclude that the rate of production of vitamin-D is proportional to the first power of the light intensity, that it is directly proportional to the number of light quanta absorbed by ergosterol and independent of the wave-length, and that the quantum efficiency is 0·3 molecules of vitamin-D per quantum absorbed. Vitamin-D absorbs in the same wave-length region as ergosterol and is destroyed by light of the same wave-length as that which forms it. The highest concentration of vitamin-D which can be produced by direct irradiation of ergosterol is 35 per cent. This is an absolute maximum and the probable value is lower.

Yeast Research.—To summarise in a critical fashion the salient features of existing knowledge in a particular sphere of activity is no easy matter, but, once successfully accomplished, cannot be other than useful. A recent paper by Dr. L. H. Lampitt (*Jour. Inst. of Brewing*, **36**, p. 250; 1930) may be said to fall in this category, and should provide food for thought for scientific workers whether they are interested in yeast from the practical or academic point of view. After a brief sketch of the classical work of Pasteur, Büchner, Harden, and others, the problem of the acceleration of fermentation by substances which can act as acceptors for hydrogen is discussed. The anomalous behaviour in this respect of sodium arsenate is noteworthy in view of recent work on the possibility of replacing phosphates by arsenates in the cycle of changes accompanying fermentation. Reference is also made to the effects on yeast activity of antiseptics, and in this connexion attention is directed to the fact that the study of maltase, which is readily crippled by phenol, has been comparatively neglected in recent years. Fernbach's selective fermentation of dextrose and lævulose and the theoretical deductions arising therefrom are also discussed. Other starting-points for investigations include the effects of radiations on the growth of yeast, the nitrogen question (NATURE, **125**, p. 105; 1930), yeast-enzymes and the existence of bios, and the nature of the yeast-substance. It is pointed out that the confusion arising from many of the existing results is due chiefly to lack of standardisation of the experiments, and it is suggested that such results should always be confirmed by direct experiment before an investigation is started. It is interesting to note that Dr. Lampitt regards the production of carbon dioxide as the only true criterion of fermentation.

Researches on Globin.—The *Comptes Rendus du Laboratoire Carlsberg*, vol. 18, No. 4 (1930), contains a communication by Roche on the above subject. The author has confirmed the experiments of Hill and Holden, published in 1926, on the decomposition of hæmoglobin by dilute acids; the product is called paraglobin, and is regarded as different from denaturated globin. The *p*H value of natural globin is 7·5-7·6, as determined by cataphoresis. Natural globin and hæmatin form alkaline methæmoglobin, which was prepared in several other ways. The combination of a natural globin from various animals takes place with any hæmatin. The isoelectric point of paraglobin is 7·6-7·8, by cataphoresis. It shows a minimum solubility in a pure solution over the range of *p*H 6·6 to 8·4. The variations found by other authors are due to degradation of the protein in their experiments. Paraglobin forms with hæmatin cathæmoglobin, but this reaction is specific for the globin, since it does not occur with other proteins. Boiling with acid (*p*H 2-4) for a short time does not alter the isoelectric point or solubility of paraglobin, but with *p*H 7·0 it is coagulated, and is then insoluble in strong acid or alkaline media. This form is called denaturated globin. Pepsin has an optimum action on paraglobin at *p*H 2·2, trypsin at *p*H 8·2, in opposition to the results of Northrop. Trypsin does not act unless kinase is present. Pepsin liberates COOH and NH_2 in the ratio of unity. The first action of pepsin or trypsin causes modifications indicated by a movement of the isoelectric point towards more acid values of *p*H. Since this is also found in the action of the hydroxide ion, it is suggested that both changes, at the commencement, have the same mechanism.

Denaturation of Proteins by Urea and Related Substances.

By Sir F. GOWLAND HOPKINS, F.R.S.

'DENATURATION', though a phenomenon familiar objectively to all who handle proteins, involves a change of state of which the precise nature is yet obscure. The term itself is scarcely capable of adequate definition. It is only certain that native proteins dispersed in water as lyophil colloids suffer, as the result of diverse alterations in their environment, a change which is accompanied by complete loss of solubility in pure water or dilute salt solutions. If under any influence (such as that of dilute acids or alkalis) a protein denatured in this sense is retained in solution, or redispersed after separation, it is then found no longer in the lyophil but in the lyophobe condition. Denaturation thus understood is always antecedent to coagulation or flocculation, these being secondary processes dependent upon conditions which make for instability in suspensoid systems. We are quite ignorant of the nature of any molecular change which may be responsible for, or accompany, this change in the type of dispersion. Evidence suggesting that some intramolecular readjustment does, as a matter of fact, occur will be mentioned immediately.

A special interest is attached to the change of state involved in denaturation because its occurrence appears to be characteristic of the protein molecule when it is intact. It is apparently not undergone by even the most complex of its degradation products; this circumstance tends to justify the view, based also on other evidence, that the molecular structure of an intact protein has features differing from, or added to, those of a complex polypeptide.

It is well known that in albumins, globulins, and a number of other native proteins in solution, denaturation is induced by heat, by certain forms of radiation, by the action of relatively strong acids and alkalis, by adsorption at surfaces or in films and mechanically by shaking. Such proteins are also denatured when under defined conditions they are precipitated from solution by such agents as alcohol or acetone.

It has recently become known that these diverse methods of denaturation all produce, in addition to the colloidal change, a shift in the relations of sulphur within the protein molecule, such that the denatured product yields, in some cases directly, and in others after treatment with a reducing agent, a reaction characteristic of the thiol group. This is not given by the native proteins. This characteristic happening was first observed by Heffter in 1909, though he did not specially relate it with the events of denaturation. The relation has since been more fully established.[1]

An influence, seemingly quite different from those already mentioned but resulting in typical denaturation, is exerted by urea (and, as will be immediately indicated, by other related substances) when added in high concentration to native protein solutions.

This phenomenon has received but little attention until recently. So far back, indeed, as 1900, K. Spiro [2] directed attention to it. His experiments, however, were in the main concerned only with the effect of urea and certain other amides and organic bases in preventing the heat coagulation of proteins or in raising their coagulation temperatures.

Anson and Mirsky [3] have recently pointed out that urea in concentrated solution can denaturate hæmoglobin, egg albumin, and serum albumin, and that it also dissolves the denatured protein. Hsien Wu has devoted several recent papers to a study of denaturation and has observed that some denatured proteins are soluble in urea solutions, while with Huang he has taken advantage of this circumstance to determine their molecular weight, finding that "denaturation *per se* does not necessarily involve a change in molecular weight". Dill and Allsburg employed urea solutions as solvents for a protein insoluble in water. Burk and Greenberg [4] have used them in order to determine the molecular weights of proteins at their isoelectric point, and to decide whether they are capable of undergoing changes in their state of aggregation with changes of solvent. They found that hæmoglobin and egg albumin are denatured by urea, and that the former has, in urea solutions, only half the molecular weight indicated in aqueous solution. These authors refer incidentally to the circumstance that formamide, urethane, and thiourea act in solution similarly to urea though not so effectively. Owing to their particular aims, the work of the authors quoted has involved the use of urea solutions as denaturants and solvents rather than a study of the conditions and rate of the changes induced by such agencies.

The following preliminary and descriptive account of certain observations of my own (some were made so far back as 1899, though now extended) will suggest, I think, that the mechanism of this form of denaturation is worthy of close study.

The experiments have dealt with ovalbumin and with serum proteins. It will be convenient to deal first with the former, which has been more fully studied.

EGG ALBUMIN.

Pure egg albumin, twice recrystallised by the method of Hopkins and Pinkus and its solution afterwards dialysed until wholly free from ammonium sulphate, was the material usually employed. At the end of dialysis, the *p*H of such a solution is invariably within the range of 4·8-4·9.

If in a few cubic centimetres of such a solution urea be dissolved (say 0·1 gm. per c.c.; though the amount is unimportant) and the solution evaporated to dryness in a vacuum desiccator at room temperature, the urea may then be extracted from the residue with water, while the protein will be found to be wholly insoluble, forming a cast of the urea crystals which separate on evaporation. The *p*H of the mixture may be adjusted from, say, 4·0 to 7·0 without any difference in the result. If the washed protein residue be now ground up with a few small crystals of sodium nitroprusside and a drop or two of weak ammonia added, a deep red-purple colour characteristic of a sulphydryl reaction immediately develops. If ordinary egg-white be diluted, filtered, and similarly treated, it behaves as described whether at its original *p*H (7·5 to 8·0) or when brought to *p*H 4·8.

The above simple method is a convenient means for deciding whether or not a given substance exerts a denaturing influence upon proteins. Using the pure albumin a number of substances were thus tested. Positive results were given by methyl-, ethyl-, and butyl-urea; by unsymmetrical dimethyl- and diethyl-urea; by thiourea; by acetamide, formamide, and by urethane. Wholly negative were the effects of symmetrical diethyl-urea, of acetyl-, and methyl-acetyl-urea; of biuret, allantoin, and semicarbazide; of alanine, phenyl alanine, valine, leucine, and cystein; of benzamide; of creatine, caffeine, and asparagine. Also negative was found to be the effect of a number of other nitrogenous compounds more remote from the active amides.

Results so obtained are with ovalbumin quite unequivocal. The residue obtained on evaporation is either completely resoluble or the protein is manifestly denatured. When washed free from the denaturant the denatured protein yields a nitroprusside reaction in all cases, while none is given by the solution when the protein residue remains soluble.

Most of the above denaturants are but slightly dissociated in solution, and in other cases adjustment of the *p*H to near neutrality has no effect on their behaviour. It is clear that denaturation on these lines does not depend primarily upon the influence of hydrogen or hydroxyl ions.

To some degree at least, relations between constitution and denaturating power would seem to hold. An amide structure is apparently necessary, but in certain relations its activity is lost. Among the ureas, mono-alkyl substitution, or unsymmetrical di-alkyl substitution, leaves the activity qualitatively intact. Symmetrical di-alkyl ureas, on the other hand, are inactive; one amino group must apparently remain unsubstituted. To judge from the case of acetyl urea, however, mono-acyl substitution removes the activity. In biuret, allantoin, and semicarbazide activity is also lost. Acid amides (acetamide and formamide) are active, but all amino acids tried were without effect, and likewise asparagin. Noteworthy is the activity of urethane. Bases of the type of creatin or caffeine are inactive.

More detailed aspects of the events involved in denaturation on these lines are to be observed in solution. If a solution of the pure protein is fully saturated with urea (1 gm. per c.c.) at room temperature, it will be found to give a well-marked nitroprusside reaction immediately. Even before the solution has recovered from the depression of temperature due to the solution of the urea the colour reaction is marked. By the time that room temperature is reached it becomes, in the case of moderately high concentrations of protein (4-5 per cent) intense. It can be observed to increase during the following half-hour or so.* The establishment of a reactive thiol group in the protein molecule is thus a rapid process, and quantitative evidence of the simultaneous occurrence of a colloidal change will be given later.

If the urea-protein solution is exposed to the air, the thiol group is slowly oxidised. It is restored, however, by reducing agents and the colour reaction immediately reappears if the solution be first treated with cyanides (see later). Its behaviour in the denatured protein is the same, therefore, as in cysteine, glutathione, etc.

Since urea exerts not only a denaturating action, but also a dispersive action upon the denaturated protein, the behaviour of an albumin solution, when urea is added to it, will vary in detail not only with the absolute but also with the relative concentrations of the two constituents. The data in the following table will be sufficient to illustrate the observed effects as modified by concentration variations. The strongest protein solution had a *p*H of 4·9, which shifted to 5·8 on saturation with urea. The small variations at other concentrations were insufficient to affect the results.†

It will be seen that though denaturation itself is more rapid with the higher concentrations of urea (see below), the dispersive action may prevent or delay the separation of a precipitate or gel which occurs at lower concentrations. Whether gel or precipitate shall result seems to depend essentially on the rate of separation. It may be said that an identical experiment was simultaneously carried out at 37° C. with little difference in the results save that the gel formation was somewhat faster. Needless to say, any considerable modifications in the concentrations will affect the time relations as given in the above table.

Concentration of Original Protein Solutions (per cent).	Amount of Urea added. (per cent Saturation).	Condition after standing for the intervals given. Temp. 22° C.					
		Immediately.	½ Hour.	1 Hour.	2 Hours.	5 Hours.	20 Hours.
7	100	No visible change	→	Increasing	Viscosity	→	Fragile gel.*
	60	Ditto	Viscous	Gel	Firm gel	..	..
	30	Heavy cloud	Precipitate	..	Heavy ppt.	..	Protein 50 per cent pptd.
	15	No visible change	..	..	..	Cloud	Heavy ppt.
5	100	No visible change	..	..	..	Viscous	Marked viscosity
	60	Ditto	..	..	..	..	Slightly viscous.*
	30	Precipitate	→	Increasing	precipitation	→	70 per cent of protein pptd.
2	100	No visible change	..	..	..	..	Viscous.
	60	Ditto	..	..	..	..	..
	30	Ditto	..	..	Cloud	..	Definite precipitate.

* On longer standing firm gels.

Rapid gel formation can be observed in the case of still stronger albumin solutions and an easy demonstration of the potency of urea as a denaturant is so obtained. If 5 c.c. of undiluted egg-white, which has been first whipped to destroy the membranes and squeezed through muslin, be placed in a test tube and 5 gm. or a little less of urea, finely powdered to facilitate solution in the viscous material, be added, the mixture will begin to gelatinise almost as soon as the urea has dissolved. In fifteen minutes or less at room temperature a firm gel is obtained of which a

* To observe the full colour, relatively high concentrations of the nitroprusside should be used. Twenty to thirty milligrams of the solid, for example, dissolved in 5 c.c. of the solution. It is then made alkaline with ammonia.

† Throughout this notice the concentrations of urea, because they are generally so high, are for convenience reported not in terms of molarity but as percentages of complete saturation at 17° C. (1 gm. per c.c.). The results can thus be reproduced without reference to volume changes consequent upon adding varying amounts of urea to the protein solutions. The concentrations of albumin referred to are those of the original solution; those actually present in the urea-protein mixtures vary therefore with the amount of urea added. It will be found that all essential conclusions are unaffected by this circumstance; the observations upon which they are based being comparative. The actual concentration of protein in a solution saturated with urea is given approximately by multiplying that of the original solution by 0·55, and in a solution 60 per cent saturated by 0·70.

portion, if soaked in a solution of sodium nitroprusside, will develop on its surface a strong purple colour.

The gels, which result from the denaturation of the pure albumin, display many characters of interest. Though containing so high a concentration of urea, they are optically completely homogeneous and transparent, resembling in appearance pure silica gels. When treated with successive quantities of water until the urea has wholly diffused out of their structure they become slightly opaque, but they display great resistance to sol formation. When they are heated with excess of water the amount of protein found in the sol phase is, no matter what the temperature, negligibly small. Remarkable is the behaviour of an original gel, still containing the urea, when alternately cooled and warmed. If the flask or test-tube containing such a gel be placed on ice, its mass becomes pervaded with silky crystals of urea. If it now be allowed to return to room temperature or even if it be rapidly warmed to higher temperatures, it completely regains its homogeneous transparent appearance, and in the case of a well-formed gel without displaying at any moment the least sign of increased fluidity. The vessel containing it can be placed in a boiling water bath without producing any effect upon its visible characters. Gels formed originally within certain ranges of protein or urea concentration may require to be cooled to a degree or two below 0° C. before the urea separates as described and should be placed for a few moments in an ice-salt freezing mixture.

With regard to the effect of such internal crystal formation upon the ultimate structure of gels, Moran and Hardy have studied what is clearly a somewhat different case, namely, the formation and disappearance of ice crystals in aqueous gelatin gels when respectively frozen and thawed. These authors discuss the effect of the crystal formation upon the ultimate gel structure. Hardy found, though only in the case of gels much more concentrated than those dealt with here (20 per cent gelatin and upwards), that the capacity of the gel for re-adsorbing water is so great that after thawing, the spaces occupied by the ice crystals vanish "almost entirely" though the collapsed walls of such spaces do not join together. With lower concentrations of gelatin the final result is an open sponge. Hardy also found that the gel, while originally singly refractive, became doubly refractive after freezing and thawing. Evidence for such effects upon the gel structure has proved difficult to obtain in the case of the urea-protein gels by ordinary microscopic study, with or without polarised light. Doubtless a more highly developed technique may be necessary for the purpose. No ice crystals are associated with the urea crystals: separation of the latter within the gel will commonly occur at temperatures somewhat above 0° C. A study of these urea-protein systems may, I think, prove important with respect to gel structure.

When in any circumstances the denatured protein separates not as a gel but as a precipitate, it is found to be insoluble in hydrochloric acid of any strength, and is only very slowly dispersed in alkalis. On the other hand, in a saturated solution of urea it is dispersed to a clear sol.

If an albumin solution, after admixture with urea in effective quantities, be diluted or dialysed at any stage before a precipitate or gel has formed spontaneously, the denatured product is precipitated. A precipitate is obtained almost immediately after the urea has been added, but the amount becomes, of course, greater with the progress of denaturation. Precipitation does not occur, however, if the *p*H of the mixed solution is appreciably greater than 6·0. When thoroughly dialysed solutions of the crystallised albumin are employed as in most of the experiments under discussion, one effect of adding pure urea in the amounts employed is to shift the *p*H from 4·8 to ± 5·8.‡ In these circumstances the precipitation of the denaturated albumin on ten-fold dilution of the solution or on dialysis is nearly complete. If, however, before or after the addition of urea the *p*H is brought to 6·5 or higher by the addition of minute quantities of alkali, no precipitation occurs. If, on the other hand, such a solution be dialysed until all urea is removed (the *p*H being thereby somewhat reduced) the denatured protein present is found to be in typical suspensoid or lyophobe solution. The urea-free solution is precipitated by salts in minute concentration and the negatively charged particles obey the rule of Hardy. Needless to say, the charge may be reversed by shifting the *p*H to the acid side of the isoelectric point. It may be mentioned that when weak solutions of albumin containing high concentrations of urea are allowed to stand for three or four days some form of stabilisation may be observed. Clear suspensoid solutions may then be obtained on dialysis when the *p*H of the original mixture was less than 6·0. The particles then carry a positive charge.

‡ Such a change in *p*H seems in the circumstances to be unduly great. All estimations were made with the quinhydrone electrode. My colleague, Dr. M. Dixon, has since suggested to me that a chemical action of urea upon the quinhydrone might lead to error. With the hydrogen elctrode, however, a shift of the same order is observed. The values obtained with the quinhydrone are perhaps 0·2 of a *p*H unit too high.

[1] L. J. Harris, *Proc. Roy. Soc.*, B **94**, 425, 1923; F. G. Hopkins, *Bioch. Jour.*, **19**, 807, 1925.
[2] *Zeit. f. Physiol. Chem.*, **30**, 182.
[3] *Jour. Gen. Physiol.*, **13**, 123; 1929.
[4] *Jour. Biol. Chem.*, **87**, 197; 1930.

(*To be continued.*)

Norwegian Contributions to the Geology of Spitsbergen.*

DURING every year between 1906 and 1926, Norwegian State-aided expeditions have been at work in western and central Spitsbergen. Of nineteen out of the twenty-one expeditions the geologist, Adolf Hoel, was the leader or joint-leader, and he has prepared, as the first of the long series of *Skrifter* on Spitsbergen or Svalbard, an account of the whole series with summaries of the routes and the work undertaken, maps showing the journeys and the areas surveyed, and appendices on the topographic and hydrographic work.

This memoir will be a great aid to those using the special reports, of which six new contributions are issued along with it. They make an important addition to the geology of Spitsbergen. Hans Trebold has written two memoirs on the Mesozoic rocks, and shows that the Jurassic is represented by the Upper Lias and all the stages from the Lower Callovian to the Upper Volga Beds, which are equivalent to the Purbeck and Lower Wealden of England and the Tithonian of Central Europe. The sequence is then continued through the Lower Cretaceous up to the Aptian. This long succession is nearly all marine, though there are two local developments of estuarine or fluviatile beds with land plants. The author carefully discusses the geographical relations of these beds and the nature of their faunas. He discusses the

* Det Kongelige Departement for Handel, Sjøfart Industri, Handverk og Fiskeri. Norges Svalbard- og Ishavs-Undersøkelser. Skrifter om Svalbard, og Ishavet. Nr. 1, 19-24. (Oslo: Jacob Dybwad.) 10, 3, 2.50, 4, 15, 3, and 3.50 Kr.

two explanations that have been advanced, that of Neumayr, who considered the special features due to climatic influences, and that of Pompeckj and Salfeld, who explained them as the result of life in an isolated sea with unusual physical peculiarities. The author considers that the fauna was mainly controlled by growth in a special sea in which there was great continuity of evolution. He says that the isolation which he accepts is quite different from that contemplated by Pompeckj and Salfeld.

That complete separation from the other seas would affect its inhabitants is undoubted; but in view of the parallel development of the faunas in the Spitsbergen sea with those that lived farther south, some frequent connexions appear to have taken place. The peculiar features of the Spitsbergen fauna, when compared with those of England, the Mediterranean and the Himalaya, appear to indicate the influence of a colder climate than that enjoyed by the Jurassic areas farther south.

Hans Trebold has also written *Memoir*, No. 21, a description of the Valanginian Ammonites of Spitsbergen, a fauna which is similar to that of the Petchora basin in north-eastern Russia and has some of the species found in the Speeton Clay of Yorkshire.

The most remarkable addition to palæontology in this series of memoirs is the rich fauna of fossil Acanthaspid fish described by Anatol Heintz from the Downtonian. He includes that formation in the Lower Devonian, but it has been usually regarded as uppermost Silurian. The fauna described in the first *Memoir*, No. 22, is from Ice Fiord, and it includes three new families and seven new genera. The type of the new genus, *Jækelaspis*, is a species described by Ray Lankester as a *Cephalaspis* and by Sir Arthur Smith Woodward as an *Acanthaspis*. The affinities of these fish have been uncertain. Lankester and Sir Arthur Smith Woodward regarded them as belonging to the primitive class of Agnatha; but Traquair referred them to the fish as Dipnoi and members of the Arthrodira. That view is adopted by Herr Heintz. The second *Memoir*, No. 23, describes some additional new species of Acanthaspids, including a remarkable new form, *Huginaspis broggeri*, from the Downtonian of Wijde Fiord in north-western Spitsbergen. These two memoirs form a material addition to knowledge of this group.

The other Palæozoic fossil described in this new series is a simple coral, *Caninia* (*C. callophylloides*, Holtedahl sp.), from the Carboniferous of Ice Fiord. The coral is described in detail by F. Heritsch, and he clearly states the relations of the genus to *Zaphrentis*. The largest radius in the biggest specimen is 27 mm. There is nothing in this coral to call for any special climatic conditions in the Arctic Sea at the time of its existence.

Experiments in the Sea on Antifouling Paints.

PROF. J. H. ORTON (*Jour. Mar. Biol. Assoc.*, N.S., vol. 16, No. 2, 1930) describes the results of a series of experiments, extending over a period of three and a half years, to test the power of a number of paints and other substances (fifteen in all) to inhibit the growth of marine organisms, their preservation value, and their durability in sea water. The experimental material included proprietary antifouling and anticorrosive paints and was tested in seven different habitats in three different localities on wood and on shells. Observations were also made on the growths on ships' bottoms, piers, buoys, and rafts.

It was found that the fundamental factors determining the capacity of a paint to prevent growths include (*a*) capacity to adhere to a surface, which in practice may be slightly damp; (*b*) capacity to resist erosion; and (*c*) the possession of a toxicity depending upon slow but efficient ionisation of toxic substances. It is proved by critical chemical analyses that gradual loss of toxicity of the more efficient poisonous paints was accompanied by gradual diminution of the toxic elements, arsenic, copper, and zinc, in the paints. Antifouling paints exposed to strong light permit the growths much sooner than in subdued light, but, in the former case, the growth is marine algæ. It is not clear whether this phenomenon is due to the loss of toxicity in the paint due to the direct action of light, or to a greater resistance of the spores of marine algæ to toxic agents.

The preserving value of antifouling substances was also investigated, and it is shown that, for wood at least, coal-tar and black varnish have superior preservative properties to red oxide of iron, the commonest and most widely used anticorrosive paint for the bottoms of iron ships. Coal-tar and black varnish will preserve wood against *Chelura* and *Limnoria*, but not against *Teredo*, to an extent at least equal to that ensured by red oxide, but, on the other hand, they give innocuous surfaces on which marine growths establish themselves more readily than on untreated wood.

The composition of an ideal antifouling paint is discussed and the conclusion reached that if the bottoms of ships are to be maintained free from growths for a period stated in years, some other method must necessarily be used than the application of paints, owing to the comparatively rapid disintegration of the matrix of the paint due to the action of bacteria.

Ceylon Pearl Fisheries.

A MOST interesting memoir entitled "The Pearl Fishery of 1925" by Dr. Joseph Pearson, assisted by Mr. A. H. Malpas and Mr. J. C. Kerkham, is given in the *Ceylon Journal of Science* (Section C, Fisheries, Bulletin of the Ceylon Fisheries, vol. 3, December 1929). It includes a review of the scientific investigations since 1902 and is directly concerned with the industrial problems and those of economic importance.

The outstanding features of the Ceylon pearl fisheries are their irregularity and uncertainty. After the fishery of 1891, there was a barren interval of eleven years followed by five splendid fisheries in 1903–7, and after 1907 there was an interval of seventeen bad years before the fishery of 1925; making only six fisheries since 1891—a period of thirty-four years.

The establishment of a Department of Fisheries, with the appointment of a marine biologist, provision of a modern steam trawler, and the regular inspection of the pearl banks, have made possible a survey of the littoral waters of Ceylon, and much is now known of the biology of the coastal waters in general and of the pearl-banks in particular. The investigations carried on since the War have been restricted to the inspections, supplemented by trawling and dredging operations and to periodic hydrographical cruises in the Gulf of Mannar.

The situation of the pearl-banks area, with its hundreds of square miles of deep water, its lack of protection from the violence of the south-west monsoon, and a complete lack of a suitable situation in which to establish a 'nursery', makes cultural work

a matter of extreme difficulty if not impossibility. Mortality of the oysters is enormous, both young and old. At no stage in its life history is the oyster immune from attacks of predaceous fishes, especially rays, and from the effects of silting sand or other vicissitudes, including accumulating growths of *Sargassum* weed. Any system of cultivation and protection must deal with half-grown and full-grown oysters. Such a programme of oyster culture is apparently not practicable in Ceylon because local conditions are unfavourable and because the cost of such a scheme, even if feasible, would be prohibitive.

The question as to how the banks became repopulated after a term of blank years is still a matter of uncertainty. At one time it was thought that the spat from the Tuticorin banks was wafted, under favourable conditions, to the Ceylon side and vice versa, there being two breeding seasons in the year, one at the height of each monsoon, July–August and December–January, and this is probably one cause of repopulation. Other causes, however, may be important, such as repopulation from a few scattered oysters or from adjacent beds in the same local area. As to the complete disappearance of oysters after they have established themselves in large numbers, the main reason seems to lie in the geographical peculiarities of the Ceylon pearl banks. Both the Ceylon and Tuticorin banks lie on a submerged shelf limited in extent and varying from 5 fathoms to 12 fathoms in depth, which drops suddenly into one hundred fathoms. The pearl banks never lie more than five miles from the 'overfalls' to the west and the same distance from the shallows to the east. The floating larvæ are at the mercy of the elements. They might easily be carried out into deep water or shoreward into too shallow water. Then the irregular currents would cause the irregularity of the oysters, and although there are two spawning seasons and oysters are sexually mature at twelve months, there is no guarantee that a bed of oysters, once established, will produce a spat-fall on the banks.

The memoir includes chapters on the methods of pearl fishing, the history of the oysters fished in 1925, the age and growth of the oysters, and nautical notes.

University and Educational Intelligence.

ABERDEEN.—The King has been pleased, on the recommendation of the Secretary of State for Scotland, to approve the following appointments: Dr. James Ritchie, presently Keeper of the Natural History Department of the Royal Scottish Museum, Edinburgh, to be Regius professor of natural history in succession to Prof. J. Arthur Thomson, on whom a knighthood was conferred in the King's birthday honours list; Dr. David Campbell, Pollok lecturer in pharmacology and therapeutics in the University of Glasgow, to be Regius professor of materia medica in succession to Prof. C. R. Marshall.

CARDIFF.—Dr. R. T. Dunbar, lecturer in physics, has been appointed to the chair of physics at the University College of South Wales and Monmouthshire, in succession to Prof. H. R. Robinson, who has been appointed professor of physics at East London College (University of London).

GLASGOW.—The King, on the recommendation of the Secretary of State for Scotland, has approved the appointment of Dr. John Walton, lecturer in botany in the University of Manchester, to be Regius professor of botany in the University of Glasgow in succession to Prof. J. M. F. Drummond, whose resignation takes effect on Sept. 30.

THE issue of the *British Medical Journal* for Aug. 23 contains an account of medical teaching in Burma and of the new medical college opened at Rangoon last October. Until the beginning of the present century, Rangoon was very backward as regards public buildings and particularly hospitals and schools, which were out-of-date. Since then, however, as the result of a government grant and the generosity of numerous private donors, a remarkably rapid improvement has taken place. Rangoon, which has a population of nearly 400,000 inhabitants, now possesses a general hospital of 650 beds, a hospital for women, and a mental hospital, all of the most modern type and equipped with up-to-date clinical and post-mortem theatres. The new college of medicine building, for the equipment and design of which Lieut.-Col. T. F. Owens, the dean of medical studies, and Mr. S. P. Bush, the consulting architect, are responsible, is described as being unsurpassed by any teaching institute in Asia. It contains departments for physiology (including histology and biochemistry), anatomy, forensic medicine, operation surgery, pharmacology and materia medica, and pathology and bacteriology, with amply stocked and well arranged museums attached to the departments of pathology and forensic medicine, a library, and a large lecture theatre. Instruction in hygiene is given at the recently opened Institute of Hygiene, of which the director is the University lecturer in hygiene. Seven University medical chairs have been established—for anatomy, physiology, pathology, forensic medicine, surgery, medicine, and obstetrics respectively. All the heads of these departments are Europeans, as is also the case in the departments of arts, science, engineering, and law.

A CO-OPERATIVE large-scale study of the relations of secondary and higher education in the State of Pennsylvania is now in progress under the direction of the Carnegie Foundation for the Advancement of Teaching and the Educational Commission of the State. It represents an attack on the problem how to transform mass education into particular education, aiming at the maximum development and integration of each individual pupil's capacities for achievement and self-direction. Begun a year ago and planned to be completed in six years, the inquiry is being conducted, not by an outside staff but by the institutions (some fifty in number) themselves. An interim account of it appears in this year's annual report of the Foundation. At present attention is focused on the 'wastage' involved in the entry upon a four-years' college course in the institutions under observation of more than a thousand students annually who drop out during or at the conclusion of the first semester, and the still larger number who drop out during the remainder of their first year. To what extent is this wastage attributable to the high school's misjudgment of the fitness of its pupils for a university course, and to the college's failure to guide, inspire, and confirm its freshmen? To answer this question, procedures have been devised for placing at the disposal of the high school sufficient data covering a considerable period of school life for truly estimating the pupil's equipment of genuinely assimilated knowledge and state of mind before recommending entry into college, and for enabling the college to discharge its "first duty with the new student": "to assure itself of an intelligent, sincere, and feasible purpose within him and to make certain that he is so situated that this purpose can be fulfilled".

Historic Natural Events.

Aug. 31, 1886. Charleston Earthquake.—This visited a district in which earthquakes were previously almost unknown. Though not destructive in the ordinary sense, its disturbed area (of 2¾ million square miles) has seldom been exceeded. The earthquake originated in two foci about 13 miles apart and situated at depths of about 12 and 8 miles. The velocity of the earth-waves was 5·2 km. per sec.

Sept. 1, 1667. Hurricane at St. Kitts.—M. Laurent, the Governor of St. Kitts (then French), wrote in a letter: "There has blown here the most violent hurricane ever known, and I hold myself obliged to inform you that this island is in the most deplorable state that can be imagined and that the inhabitants could not have suffered a greater loss, or been more unfortunate, except they had been taken by the English."

Sept. 1, 1859. Solar Disturbance and Magnetic Storms.—During the period Aug. 28–Sept. 7, magnetic disturbances, accompanied by remarkable auroral displays, took place throughout the world. There were two major storms, the first commencing on Aug. 28 and the second on Sept. 2; it was found that each began suddenly, at (or nearly so) the same absolute time throughout the globe, and each corresponded in time with a great auroral display. Superimposed upon the disturbed conditions between these major storms, there was a moderate but marked disturbance with a sudden commencement at $11^h\ 20^m$ G.M.T. on Sept. 1. At the same time, two solar observers, Carrington and Hodgson, observed independently a brilliant patch of light that lasted about 5 min. ($11^h\ 18^m$–$11^h\ 23^m$) and moved some 35,000 miles across an unusually large and complex sunspot then nearly in line with the earth. The coincidence between the occurrence of this solar outburst (unique in observations made with direct telescopic means without the discerning power of the spectroscope applied more recently) and the minor magnetic storm was thought, at that time, to be significant. (A time interval of about 24 hours between some form of solar disturbance and the commencement of an associated terrestrial magnetic storm is now recognised.)

Sept. 1-3, 1883. Great Storm.—This storm was traced from the tropical Atlantic, where it appeared as a violent hurricane on Aug. 25, along the coast of North America and across the Atlantic to the British Isles. In mid-Atlantic the barometer fell below 957 mb. (28·25 in.). The storm reached England on the afternoon of Sept. 1, and the centre crossed England in a north-easterly direction from Pembroke to Berwick. There was a violent gale over western and southern England, as well as France and Germany, accompanied by very heavy rain. In the Thames one of the lowest tides on record occurred on Sept. 2.

Sept. 1, 1923. Disastrous Earthquake in Japan.—The Kwanto earthquake of 1923, though not the strongest, was the most destructive of all Japanese earthquakes, owing to the great fires that followed the shock. The burned-out districts in Tokyo and Yokohama covered about 6·9 and 3·1 square miles, or nearly half the area of each city; 99,331 persons were killed, 103,733 wounded, and 43,476 missing, while the number of houses completely ruined exceeded half a million, and the value of property destroyed was about 550 million pounds. The epicentre lay in Sagami Bay, to the north of the island of Oshima. The earthquake was accompanied or followed by remarkable distortions of the crust. Though the greatest known elevation on land was 7 ft. 8 in. and the greatest subsidence 5 ft. 4 in., the changes in the bed of Sagami Bay were on a scale hitherto unknown. The total areas elevated and depressed were 90 and 270 square miles, and the total volumes 5 and 12 cubic miles, the greatest uplift being 755 ft. and the greatest subsidence 1312 ft. The earthquake seems to have been caused by block movements of the crust, especially along the continuation of the rift-valley of the Sakawa River.

Sept. 1-3, 1923. Cumulus Clouds over Tokyo.—Following the destructive earthquake in Tokyo on Sept. 1, great fires broke out and continued for about 40 hours. Yokohama and other towns were also burnt. The heat of the fires caused rapid ascent of air and a strong indraught, the wind velocity reaching gale force. Gigantic cumulus clouds developed above the fires in consequence of this uprush of air, the tops of the clouds being five miles above the ground. Whirlwinds were formed over the fiercest fires, and it was observed that when these fires decayed the whirls moved on to other fires.

Sept. 2-3, 1588. Armada Gales.—It has frequently been stated that the defeat of the Spanish Armada in 1588 was largely due to storms. Careful historical investigation has shown, however, that the weather was not especially bad until the remnant of the fleet was in the open Atlantic west of Scotland and Ireland, when a severe gale occurred on Sept. 2-3, which drove some of the ships on to the coast of Ireland. Bad weather was also reported by the English fleet in the Downs.

Sept. 2, 1666. Drought before Great Fire of London.—On this date Pepys recorded: "The wind mighty high and driving it [the fire] into the City; and everything, after so long a drought, proving combustible . . . the wind carries it into the city. [The fire] still increasing, and the wind great, it being brave dry, and moonshine, and warm weather." The general wind direction during the fire was easterly, for an entry on Feb. 3, 1667, records that pieces of burnt paper were carried by the wind so far as Cranborne, near Windsor. The drought continued until Sept. 9.

Sept. 3, 1919. Detonating Meteor.—At 10.25 P.M. a meteor appeared over north-west Germany at a height which was afterwards calculated as 76 miles. It traversed a path of 194 miles from south-south-east to north-north-west in less than six seconds, and disappeared at a height of about 17 miles over Schleswig-Holstein. Its brightness was such that it was visible at a distance of more than 300 miles. Nearer the path its apparent diameter was given as up to twice that of the full moon and it made the night as light as day. From the reports received, the diameter of the glowing sphere was calculated by A. Köppen as about 270 metres (890 feet).

Sept. 3, 1925. *Shenandoah* **Squall.**—The United States airship *Shenandoah*, while flying over south-eastern Ohio, was struck by a violent squall with powerful vertical air-currents. The airship broke in two, and out of 43 officers and men 14, including the commander, were killed.

Sept. 6, 1926. Detonating Meteor.—About 9.50 P.M. a brilliant meteor travelled from the North Sea near Bridlington over Sheffield at a speed of 19 miles a second. It gave a brilliant greenish light, and was followed by a reddish trail, and the illumination was seen over almost the whole of the British Isles, as well as in Belgium and France. Just beyond Sheffield it burst with a rumbling like thunder or heavy explosions, which at Sheffield lasted for 43 seconds. An interesting feature was that while the explosion was distinctly heard at distances of 70-140 miles, and at one place 100 miles distant houses were shaken, at intervening places no noise was heard, thus providing a good example of an outer zone of audibility.

Societies and Academies.

PARIS.

Academy of Sciences. July 7.—The president announced the death of Georges Neumann, *correspondant* for the Section of Rural Economy.—**H. Deslandres**: The properties of the lines and abnormal series in atomic spectra.—**Charles Richet**: A paradox on (visual) accommodation. Looking down an avenue, after fixing the eyes on the nearest trees, there is an obvious effort of accommodation when bringing a more distant tree into focus. In a picture showing the same view in perspective, there is still a distinct effort of accommodation in changing from the nearer to the more distant trees. This is a paradox, since all the objects are in the same plane.—**Louis Roy**: The dynamical adiabatic law relating to elastic surfaces.—**N. St. Georgesco**: A problem of the calculus of probabilities with application to the search for unknown periods of a cyclic phenomenon.—**Henri Poncin**: The flow in a canal.—**J. Baurand**: The formation of waves at the surfaces of liquids.—**G. W. Ritchey**: First results in celestial photography obtained with the Ritchey-Chrétien telescope.—**Alex. Véronnet**: The trans-Neptunian planet. The determination of an orbit by three observations.—**Al. Proca**: Dirac's equation. The sixteen ψ_k components.—**E. Sevin**: The origins of a synthesis of the laws of the physical world.—**E. Kogbetliantz**: The velocity of propagation of gravitation.—**André Marcelin** and **Mlle. Simone Boudin**: Coloured stratifications by sublimation. **Mlle. Suzanne Husson**: The mechanical action exerted in a conductor by electromagnetic waves. An expression for the force due to the electromagnetic radiation on a single element oscillating in resonance has been calculated, and an apparatus has been designed and constructed capable of detecting this force.—**S. Holgersson** and **Mlle. A. Serres**: The properties and crystalline network of the ferrites. The magnetic properties of zinc ferrite differ entirely from those of the ferrites of magnesium, lead, copper and nickel. Since X-ray study proves that all these compounds have the same crystalline structure, one possible explanation of this anomaly fails. It is concluded that the magnetic properties of Fe‴ depend on the nature of the other atoms placed at the nodes of the network near those which are occupied by Fe‴.—**G. Bruhat** and **J. Terrien**: The ultra-violet absorption of solutions of tartaric acid: the influence of concentration. The absorption of tartaric acid solutions for concentrations between 0·16 and 3·3 gm.-mols per litre obeys Beer's law exactly. This confirms the conclusion drawn from the study of the rotatory dispersion, that there is nothing pointing to the existence of two forms of the tartaric acid molecule possessing different absorptions.—**Marcel Dufour**: The orthogonal trajectories of the generators of a ruled surface.—**Ch. Guilbert** and **Livet**: An improved method for taking stereoradiographs.—**Chapas**: The form of the solubility curve of benzoic acid in toluene. Taking as co-ordinates the reciprocal of the absolute temperature and the logarithm of the concentration, the curve found by experiment is a straight line which passes through the melting point of benzoic acid, ($t = 121·9$, $c = 100$ per cent).—**O. Liévin** and **J. Declerck**: The kinetics of alkaline solutions of iodine. The case of alkaline borates.—**Léon Thiéry**: The influence of nickel and chromium on the properties of malleable cast iron. Nickel can replace silicon from the point of view of the graphitisation effect: it allows the temperature of graphite formation to be lowered and gives a finer grained and better disseminated graphite. Chromium has the opposite effect; it hinders graphitisation, increases the hardness, and reduces elongation and resilience.—**Claude Fromageot**: The action of ultra-violet light on dimethylpyruvic acid. Dimethylpyruvic acid, in neutral or alkaline aqueous solution, under the influence of ultra-violet light, forms a compound capable of setting free iodine from potassium iodide. This property is connected with an ethylene linkage.—**Mlle. J. Foret**: Calcium nitroaluminate. A description and the preparation and properties of the double salt $3CaO . Al_2O_3 . Ca(NO_3)_2 . 16\ H_2O$.—**Pierre Poulenc**: Complex compounds of rhodium bromide and pyridine.—**Charles Boulanger**: The reduction of metallic salts in solution by aluminium.—**P. Delauney**: The biochemical synthesis of β.5-iodosalicylglucoside.—**Pereira de Sousa**: The eruptive rocks of the western part of Algarve, Portugal.—**Jean Lugeon**: The radioelectric determination of the position of sand storms in the Sahara from a great distance.—**R. Bureau**: The study of the propagation of electric waves with the aid of atmospherics.—**A. Gruvel**: Some submarine springs observed on the Libano-Syrian coasts.—**René Girard** and **Robert Lemesle**: Polystely in *Ramondia pyrenaica*.—**Antonin Němec**, **Joseph Lanik**, and **Mme. Anna Koppovà**: A colorimetric method for rapidly determining the citric acid soluble phosphoric acid of the soil.—**D. Bennati**, **J. Gautrelet**, and **E. Herzfeld**: Adrenaline, the alkaline reserve and apnœa.—**Georges Bourguignon** and **Mlle. Marie Louise Verrier**: The mechanism of (visual) accommodation in the Teleosteans.—**Paul Mathias**: The evolutive cycle of a trematod of the family of the Notocotylidæ (*Notocotylus attenuatus*).—**Marcel Avel**: The rôle of the nervous system in the regeneration of the head in *Lumbricus*.—**M. Lemoigne** and **P. Monguillon**: The presence of acetylmethylcarbinol and of 2·3 butylene glycol in the blood of the higher animals.—**G. Guittonneau**, **H. Delaval**, and **Mlle. M. Bejambes**: A lactic fermentation of certain sugars at a temperature of 70° C.

Diary of Societies.

CONGRESSES.

SEPTEMBER 1 TO 6.

INTERNATIONAL AIR CONGRESS (at the Hague).—Sections: Aerial Traffic, Science and Technics, Legal Questions, Medical Questions, and Aerial Tourism.

SEPTEMBER 3 TO 10.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Bristol).

Wednesday, Sept. 3, at 8.30 P.M. (in Colston Hall).—Prof. F. O. Bower: Size and Form in Plants (Presidential Address).

Thursday, Sept. 4, at 10 A.M.—(A) Discussion on The Meteorological Relations of Atmospherics.
(A) E. H. Linfoot: A Problem in the Analytic Theory of Numbers.
(B) Prof. G. T. Morgan: A State Experiment in Chemical Research (Presidential Address).
(C) Prof. S. H. Reynolds, J. W. Tutcher, and Prof. L. S. Palmer: The Geology of the Bristol Area.
(D) Dr. W. T. Calman: The Taxonomic Outlook in Zoology (Presidential Address).
(E) W. W. Jervis: General Introductory Survey of the Bristol Region.
(F) G. Ponsonby: The Incidence of the Cost of Road Maintenance and Construction.
(G) T. F. Hurley and R. Cook: The Influence of Turbulence upon Highest Useful Compression Ratio in Petrol Engines.
(H) Dr. H. S. Harrison: Evolution in Material Culture (Presidential Address).
(I) Prof. H. S. Raper: The Synthetic Activities of the Cell (Presidential Address).
(J) Discussion on The Psychology of Adolescence.
(K) Dr. A. W. Hill: Recent Developments and Present-day Problems in Taxonomic and Economic Botany (Presidential Address).
(L) Miss Margaret Drummond, Dr. J. A. Hadfield, and Dr. W. E. Blatz: The Pre-School Child.
(M) Discussion on The Influence of Fertilisers on the Yield and Composition of Plants.
At 10.15 A.M.—(K) D. W. Young: Cultivation of Hardwoods.
At 10.20 A.M.—(A) Dr. L. S. Bosanquet: The Summability of Fourier Series.

At 10.40 A.M.—(G) C. F. Abell: Some Recent Progress in Air-cooled Aero-Engine Development.
(A) Prof. E. C. Titchmarsh: Functions which are their own Fourier Transforms.
At 10.45 A.M.—(E) Mrs. D. Portway Dobson: The Bristol District in the Prehistoric Period.
At 11 A.M.—(D) Miss S. M. Manton: *Anaspides* and *Paranaspides*.
(F) Discussion on The Value and Limitation of Costing in Industry and Agriculture.
(K) A. Howard: Our British-Grown Hardwood Trees and Timbers.
At 11.10 A.M.—(K) Dr. W. B. Turrill and E. M. Marsden-Jones: Species Studies in Plants.
At 11.15 A.M.—(C) E. H. Davison: The Granite of Western Cornwall, its Alteration and Contact Metamorphism.
(H) Discussion on A Proposed National Folk Museum.
At 11.20 A.M.—(G) Dr. S. J. Davies and E. Giffen: The Present Position of the High-Speed Heavy-Oil Engine.
At 11.30 A.M.—(A) Prof. M. Siegbahn: The Highly Ionised Spectra in the Extreme Ultra-Violet.
(A) T. W. Chaundy: A Note on the Hypergeometric Equation.
(D) Prof. H. G. Cannon: (*a*) On the Internal Anatomy of a Marine Ostracod, *Cypridina* (*Doloria*) *levis Skogsberg*. (*b*) An Undamaged Specimen of *Nebaliopsis typica* G.O. Sars.
(E) S. J. Jones: The Historical Geography of Bristol.
(I) Prof. A. F. S. Kent: Some Unpublished Work on the Heart.
At 11.40 A.M.—(C) Dr. G. Slater: The Glaciated Rock-surfaces of Nooitgedacht, and the Upper Dwyka Boulder-shales of Griqualand West.
At 11.45 A.M.—(K) W. H. Guillebaud: Experimental Studies on the Artificial Regeneration of Oak.
At 11.50 A.M.—(A) Dr. D. M. Wrinch: Recurrence Relations and some Definite Integrals involving Legendre Polynomials.
(B) Prof. F. E. Francis, Dr. T. Malkin, and S. H. Piper: Natural Fatty Acids.
(K) Prof. F. A. F. C. Went: Wegener's Theory and the Distribution of the Podostemaceæ.
At 12 noon.—(A) W. Sucksmith: The Gyromagnetic Effect in Paramagnetic Substances.
(K) Prof. R. S. Adamson: Annual Rings in a Monocotyledon.
(L) Rt. Hon. Lord Eustace Percy: A Policy of Higher Education (Presidential Address).
At 12.10.—(A) Miss R. C. Young: The Algebra of Infinities.
(B) Dr. M. Nierenstein: Pyryllium Series.
(C) Prof. J. W. Gregory: The Recent Cable Fractures in the Western Atlantic.
At 12.15.—(D) Prof. F. A. E. Crew: The Effects of Density on a Mouse Population.
(I) Dr. F. W. Edridge-Green: Pseudo-Isochromatism and the Detection of Colour-Blindness.
At 12.30.—(A) Prof. W. E. H. Berwick: The Complex Multiplication of Elliptic Functions.
(B) Dr. H. T. S. Britton, Dr. R. A. Robinson, and W. L. German: Complex Acids of the Rarer Elements.
(C) S. H. Straw: On the Fauna of the Palæozoic Rocks of the Little Missenden Boring.
At 2.—Conference of Delegates of Corresponding Societies.
Prof. P. Abercrombie: National Parks (Presidential Address).
(I) R. J. Bartlett: Some Effects of Low Frequency Vibration on Body and Mind.
At 2.15.—(D) The Work of the Great Barrier Reef Expedition:—A. P. Orr: Conditions in the Sea-water bathing Coral Reefs.
At 2.30.—(H) Mrs. D. P. Dobson: General Survey of pre-Roman Sites in the Bristol District.
Prof. D. H. Campbell: The Preservation of the Red Wood Forests in the Western States.
(K) J. Macdonald: The Measurement of Standing Trees.
(M) T. Wallace: Soil Surveys.
At 2.40.—(J) E. Farmer: A Consideration of the Frequency Distribution of Certain Tests.
At 2.45.—(D) F. S. Russell and Miss S. M. Marshall: The Plankton of the Seas round the Great Barrier Reef.
At 2.50.—(M) T. Swarbrick: Stock and Scion Relationship.
At 3.—Miss G. V. Barnard, Dr. Cyril Fox, and Dr. M. Wheeler: Folk Museums and Local Societies.
At 3.10.—(M) F. Tutin: Investigations on Tar Distillate Washes.
At 3.15.—(D) Dr. C. M. Yonge: The Food, Feeding, and Digestive Processes of Corals.
At 3.20.—(J) H. E. O. James: Interference.
At 3.30.—(H) Dr. R. E. M. Wheeler: A Prehistoric, Roman, and Post-Roman Site in Gloucestershire; the Excavations at Lydney.
(K) Dr. R. N. Chrystal and E. R. Skinner: (*a*) Notes on the Biology of *Xylonomus brachylabris*. (*b*) Notes on the Biology of *Xyphidria prolongata* . . .
(M) A. W. Ling: Sugar Beet Investigations.
At 3.45.—Sir Leonard Hill: The Registration of Ultra-Violet Light in Towns and Country.
(D) Dr. T. A. Stephenson: The Growth, Breeding, and Life Conditions of Corals.
At 3.50.—(M) C. V. Dawe: The Work in Agricultural Economics at Bristol University.
At 4.—(H) R. W. M. Wright: Celtic and Saxon Bath.
(J) Mr. Sahai: Outstanding Features of the Circular Type of Character.
At 4.10.—(M) F. Hirst: Problems in connexion with the Establishment of the Canning Industry.
At 4.30.—(H) Mrs. E. Clifford: Report on the Barnwood Discoveries.
At 5.15 (at Merchant Venturers' Technical College).—Sir Daniel Hall: Apples: the Bearing of Research on Improved Production (Public Lecture).

Friday, Sept. 5, at 10 A.M.—(A) Papers dealing with Aspects of the Solid State by Prof. J. E. Lennard-Jones, Prof. W. L. Bragg, and Dr. E. Bloch.
(B) Discussion on The Present Position of the British Dyestuff Industry.
(C) Discussion on The Validity of the Permian as a System.
(D) Dr. D. de Lange: The Phylogeny of the Placenta.
(E) Prof. P. M. Roxby: The Scope and Aims of Human Geography (Presidential Address).
(F) Sir John Mann: Some Neglected Aspects of the Housing Problem.
Sir Josiah Stamp: The Inheritance Enquiry.
(G) Sir Ernest W. Moir, Bart.: The Interdependence of Science and Engineering, with some Examples (Presidential Address).
(H) Miss D. A. E. Garrod: Excavations in the Caves of the Wady el-Mughara.
(J) Mrs. S. Isaacs: The Relation between Thought and Fantasy in Young Children.
(K and M) Discussion on Mineral Elements in Plant Nutrition.
(L) The Curricula of Central Modern and Senior Schools.
At 10.30 A.M.—(D) Dr. C. Tate Regan: The Evolution of the Primates.
(I) Prof. R. R. Gates: The Blood Groups and their Inheritance.
At 10.35 A.M.—(A) Dr. R. A. Fisher: Inverse Probability.
(A) Dr. J. Henderson: The Methods of Construction of the Earliest Tables of Logarithms.
At 10.45 A.M.—(H) G. Horsfield: First Excavations at Petra.
At 11 A.M.—(E) Town Planning.
(G, I) Discussion on Air Pressure Variations encountered in Engineering Works and their Physiological Effects.
(I) Miss M. Grace Eggleton and Prof. C. Lovatt Evans: The Removal of Lactic Acid after Exercise in the Mammal.
(J) Prof. C. W. Valentine: The Foundations of Child Psychology (Presidental Address).
At 11.15 A.M.—(H) Sir Flinders Petrie and E. Macdonald: Neolithic and Palæolithic in the Beersheba Basin.
At 11.30 A.M.—(A) Dr. J. Wishart: Combinatorial Methods in Problem of Sampling.
(D) Prof. F. H. Edgeworth: On the Musculature for opening and closing the Mouth in Vertebrates.
At 12 noon.—(A) J. O. Irwin: The Approximate Evaluation of Single and Double Integrals.
(D) Miss D. M. Sladden: (*a*) The Adaptation of *Alytes* to Warmth. (*b*) The Production of Defects in the Frog.
(H) R. F. Parry: Cheddar Excavations.
(K) A. Malins Smith: The Composition of Upland Bog Water and its Relation to Algal Vegetation.
(M) Dr. J. F. Tocher: The Adulteration of Milk with Water.
At 12.30.—(A) Dr. L. J. Comrie: Modern Babbage Machines.
(D) Prof. J. Graham Kerr: John Samuel Budgett, a Bristol Naturalist.
(H) Dr. H. Taylor: Recent Work of the Spelæological Society.
At 2.15.—(D) H. W. Miles: On the Diversity of Habit of three Sawflies (*Tenthredineæ*) infesting Gooseberry.
At 2.30.—(E) Col. E. W. Lennard: Some Intimate Bristol Connexions with the Overseas Empire.
(H) Sir Flinders Petrie: Excavations at Bethpelet, Palestine.
(M) Sir Frederick Keeble: Agricultural Problems in South Africa.
At 2.40.—(J) Miss C. A. Simmins: The Mental Processes involved in learning a Foreign Language.
At 2.45.—(D) Miss M. J. Norris: The Factors affecting Fertility in certain Moths.
At 3.—(M) Commissioner D. C. Lamb: The "Human Aspect" in relation to Agriculture.
At 3.15.—(D) Prof. J. W. Munro: The Feeding Habits of Bark Beetles.
(E) Major R. W. G. Hingston: British Guiana.
(H) H. St. George Gray: Explorations of Somerset Earthworks.
At 3.20.—(J) H. Binns: Some Experiments with Wool-textile Trade Advertisements.
At 3.30.—(M) H. W. Miles: Recent Research in the Potato Root Eelworm and its Relation to Potato Sickness.
At 3.45.—(D) J. V. Pearman: The Natural History of the *Psocoptera*.
At 4.—(H) C. W. Phillips: The Circle, Avenue, and other Earthworks on Walton Down, near Clevedon.
(J) Dr. C. S. Myers: The Place of Industrial Psychology in a University City.
At 5.15.—Sir Arthur Keith: What Dr. John Beddoe did for Modern Anthropology (Public Memorial Lecture).
At 8 (in Victoria Rooms).—Prof. E. V. Appleton: Wireless Echoes (Evening Discourse).

Monday, Sept. 8, at 10 A.M.—(A) Dr. F. E. Smith: The Theories of Terrestrial Magnetism (Presidential Address).
(B) Discussion on Chemotherapy.
(C) Prof. O. T. Jones: Some Episodes in the Geological History of the Bristol Channel Region (Presidential Address).
(D) C. B. Williams: Migration among the Lepidoptera.
(F) Prof. P. S. Florence: The Theory of Women's Wages.
(G) The Trend of Airship Construction:—Lt.-Col. V. C. Richmond: The Development of Rigid Airship Construction.—B. N. Wallis: The Design and Construction of H.M.A. *R100*.—W. E. Doerr: The Airship *Graf Zeppelin*.
(H) L. S. B. Leakey: The Kikuyu.
(I, J) Discussion on In what Sense can we speak of Primary Colours?
(K) Prof. W. Goodspeed: Cytogenetic Evidence as to Species Origins and Relationships in the Genus *Nicotiana*.
(K) Capt. C. R. Robbins: Air Surveys in Relation to Forestry.
(M) Dr. P. J. du Toit: Veterinary Science and Agriculture (Presidential Address).
At 10.15 A.M.—(E) S. K. J. Baker: The Population Map of Uganda: A Geographical Interpretation.
At 10.30 A.M.—(L) Disciplinary Values in Education.
At 10.40 A.M.—(K) M. Thomas: Fermentations in the Cells of Higher Plants in the Presence of Oxygen.
At 10.45 A.M.—(D) N. N. Murti: The Physiology of the Heart of Larval Starfish and Sea-Urchins.
(H) A. L. Armstrong: The Antiquity of Man in South Africa, as demonstrated at the Victoria Falls, Rhodesia.

At 11 A.M.—(A) Dr. P. A. M. Dirac: The Proton.
(C) Prof. A. H. Cox and D. A. B. Davies: On a 100-feet Base-level in the Cardiff Area.
(E) M. Amer: The Social Geography of the Egyptian Oases.
(K) W. L. Taylor: The Afforestable Lands of Great Britain.
At 11.10 A.M.—(K) Prof. D. Thoday and N. Woodhead: The Growth and Metabolism of *Kleinia articulata*.
At 11.15 A.M.—(C) Prof. G. Delépine: The Dinantian Zones of Goniatites in the North of France and Belgium.
(D) W. E. Swinton: The Plesiosaurs of the Bristol Museum.
At 11.30 A.M.—(A) Prof. A. C. Dixon: Integral Equations.
(F) Prof. T. E. Gregory: Rationalisation and Technological Unemployment (Presidential Address).
(H) Miss M. A. Murray: Excavations in Minorca.
(I) A. D. Macdonald and J. Schlapp: Quantitative Aspects of the Action of Drugs.
(J) Dr. R. H. Thouless: (*a*) The Influence of the Physical Object on Perception, and its Bearing on the Laws of Perspective. (*b*) Dr. Houston's Substitute for Weber's Law.
At 11.40 A.M.—(K) H. Evans: Buffering and Acidity in *Kleinia articulata*.
At 11.45 A.M.—(G) Dr. A. E. Trueman: The Classification of the Upper Carboniferous.
(D) M. A. C. Hinton: Extinct Cave Fauna of the Bristol District.
(E) W. Fogg: Morocco: Some Aspects of the Sebou Basin.
At 12 noon.—(C) Dr. D. A. Wray and Dr. A. E. Trueman: The Sequence of Non-Marine Lamellibranchs in the Upper Carboniferous of Yorkshire.
(C) Dr. D. A. Wray: The Succession of Marine Bands in the Coal-Measures of Yorkshire.
(L) Miss L. E. Hawker: A Quantitative Study of the Geotropism of certain Seedlings, with Special Reference to the Nature and Development of their Statolith Apparatus.
(K) Dr. J. Burtt Davy: A Preliminary Report on a Recent Investigation of the Forest Floras of Northern Rhodesia, Nyasaland, Pemba, and Zanzibar.
At 12.10.—(A) R. Stoneley: The Identification of the Phases of Earthquake Shocks.
At 12.15.—(E) V. S. Swaminathan: The Villages and Village Life in the Tamil Country.
(H) Sir Richard A. S. Paget, Bart.: Influence of Mouth Gesture on the Development of the Alphabet.
(I) Prof. J. A. Nixon: The Factor concerned in Diabetic Coma.
At 12.30.—(C) W. S. Bisat: The Major Subdivisions of the Carboniferous of Western Europe.
(K) Dr. E. H. Moss: The Parkland of Alberta.
At 2.—(H) E. E. Evans: An Industry of the Late Bronze Age in Western Europe.
(J) G. C. Grindley: Psychological Factors in Peripheral Vision.
At 2.15.—(K) Prof. R. R. Gates: Haploid Plants.
At 2.30.—(D) Major R. W. G. Hingston: An Expedition to British Guiana.
(E) Dr. C. E. P. Brooks: Climatic Changes in Historic Times.
(H) E. G. Bowen: The Racial Geography of Europe at the Dawn of the Age of Metal.
At 2.40.—(J) C. A. Mace: The Psycho-physics of Desire.
At 2.45.—(K) Dr. J. Walton: A Hollow Fossil Tree of Lower Carboniferous Age and its Contents.
At 3.—(H) W. A. Heurtley: A Neolithic and Early Bronze Age Site in Western Macedonia.
At 3.10.—(K) Prof. B. Sahni: (*a*) A Petrified Williamsonia from the Rajmahal Hills, India. (*b*) Petrified Plant Remains from certain Cherts of Upper Cretaceous Age in the Deccan.
At 3.20.—(J) J. M. Blackburn: Analytic Tests in Relation to Rifle Shooting Efficiency.
At 3.30.—(E) Prof. A. E. Douglass: Past Changes in Climate in Relation to Settlements in the New World.
(H) L. A. Cammiade: Pluvial Periods in Palæolithic India.
At 3.40.—(K) J. Stirling: Studies of the Morphology of Heterostyly.
At 4.—(H) S. J. Jones: The Domestication of the Horse.
At 5.—(K) Dr. Macgregor Skene: Dormancy and Germination (Semi-popular Lecture).
At 5.15.—(H) Miss G. Caton-Thompson: Excavations at Zimbabwe and other Ruins in Southern Rhodesia.

Tuesday, Sept. 9, at 10 A.M.—(A) Discussion on Flow in Gases.
(A) H. S. M. Coxeter: Regular Polytopes.
(B) Prof. M. W. Travers: New Experimental Methods for the Study of Gas Reactions.
(C, E, H) Discussion on The Relation between Past Pluvial and Glacial Periods.
(D) Dr. B. P. Uvarov: Cyclic Polymorphism in Locusts and the Periodicity of Locust Invasions.
(F) D. Caradog Jones and H. A. Mess: Social Surveys of Merseyside and Tyneside.
(G) The Economical Production of Power.
(I) Miss E. M. Killick: The Adaptation of Small Animals to Carbon Monoxide.
(J) Dr. W. J. Pinard: Perseveration and the Introvert.
(K) Prof. O. V. Darbishire: Observations on the Protothallus of the Lichen *Pertusaria communis* (L.) D.C.
(K) W. R. Day: The Relation of Frost Damage to Larch Canker.
(L) English and Foreign Ideas on Method of Education in Relation to Industry and Commerce.
(M) Discussion on Grass Land Improvement.
At 10.20 A.M.—(A) P. Du Val: Some Relations between the Theory of Polytopes and Algebraic Geometry.
At 10.25 A.M.—(K) Mrs. N. L. Alcock: A Phytophthora on Strawberries causing a Root-rot.
At 10.30 A.M.—(I) Prof. R. J. C. McDowall: The Function of Carbon Dioxide.
At 10.40 A.M.—(A) W. V. D. Hodge: Topological Methods in Algebraic Geometry.
(J) Dr. H. Banister: The Psychology of the Tuberculous Patient.
At 10.45 A.M.—(D) Dr. F. B. Turck: The Cell and its Fluid in the Process of Growth and Animal Metabolism.
At 10.55 A.M.—(K) Dr. W. R. I. Cook: *Cystochytrium radicale*, a new Species of Protista occurring in the Roots of *Veronica Beccabunga*.
At 11 A.M.—(A) L. C. Young: Continuous Groups and the Foundations of Geometry.
(B) Prof. N. Semenoff: The Initiation of Combustion.
(K) Dr. M. C. Rayner: Observations on the Behaviour of *Armillaria mellea* in Pure Culture with certain Conifers.
At 11.15 A.M.—(K) Dame Helen Gwynne-Vaughan and Mrs. H. S. Williamson: A Re-investigation of the Life-history of *Pyronema confluens*.
At 11.20 A.M.—(J) Dr. P. C. P. Cloake: Conditioned Reflexes: their Interest to the Psychologist.
At 11.30 A.M.—(A) Dr. W. S. Tucker: The Screening of Southend from Gun-Fire.
(D) Dr. Nellie B. Eales: The Mandible of Fœtal Elephants.
At 11.45 A.M.—(K) Dr. B. Barnes: On Variations in Fungi induced by heating the Spores.
At 11.50 A.M.—(A) Dr. H. W. Richmond: The Canonical Curve of Genus Five.
At 12 noon.—(A) Mr. Rothwell: Meteorological Acoustics.
(B) Dr. R. C. Menzies: The Organic Chemistry of Thallium.
(D) G. L. Purser: A Reconsideration of certain Embryonic Stages.
(F) Prof. F. W. Ogilvie: Margins.
(J) Dr. A. Wohlgemuth: Psychological Analogues of the Conditioned Reflex.
(K) K. St. G. Cartwright and W. P. K. Findlay: Diagnosis of Decay in Timber.
At 12.10.—(A) Prof. P. J. Daniell: The Mathematical Theory of Flame Motion.
At 12.15.—(K) Miss H. Heslop Harrison: The Cytology of the Genus *Euphorbia*.
At 12.30.—(B) Dr. F. G. Soper: The Effect of the Solvent on Reaction Velocity.
At 2 (in Victoria Rooms).—Conference of Delegates of Corresponding Societies.
Discussion on Co-operation between Scientific Societies.
At 2.15.—(D) Miss P. M. Jenkin and E. B. Worthington: A Symposium on The Ecology of African Lakes.
At 8 (in Victoria Rooms).—Dr. R. E. Slade: The Nitrogen Industry and our Food Supply (Evening Discourse).

Wednesday, Sept. 10, at 10 A.M.—(C) Dr. G. W. Tyrrell and Dr. K. S. Sandford: Tectonic Relations and Petrography of Spitsbergen Dolerites.
(E) Prof. Ll. Rodwell Jones: Physical Factors concerned in the Characteristic Functioning of the Port of London during the Period 1880 to the Present Day.
(F) W. H. Whyte: The Standard of Living and the Post-War Trade Depression.
(G) J. S. Wilson: Structional Steel Design and Regulations.
(G) J. S. Lewis: Standardisation of Design for Structural Steelwork.
(G) Prof. C. Batho: Experiment and Theory in Structural Design.
(H) L. S. B. Leakey: Human Types associated with various Stone-Age Cultures in Kenya.
(K) R. A. G. Knight: The Moisture Content of Wood in Relation to Hygrometric Conditions.
At 10.30 A.M.—(C) Dr. H. C. Versey: The Speeton (pre-Glacial) Shell Bed.
At 10.35 A.M.—(E) Dr. S. W. Wooldridge and D. J. Smetham: The Geographical Features of the Boulder Clay Margin in Essex and Hertfordshire.
At 10.45 A.M.—(C) Dr. A. Heard and J. F. Jones: *Eohepatica Dyfriensis*, a Liverwort-like Plant from the Lower Downtonian of the Llandovery District.
(H) Prof. E. Fischer: Inheritance of Variations in the Human Vertebral Column.
(K) S. H. Clarke: The Tertiary Wall of Wood Fibres.
At 11.15 A.M.—(E) H. J. Wood: Agricultural Distributions in Scotland.
(H) E. W. P. Chinnery: Natives and Government Mandated Territory in New Guinea.
At 11.30 A.M.—(K) J. Bryan: Antiseptic Treatment of some Home-grown Conifers.
At 11.45 A.M.—(C) Dr. A. Raistrick: The Moraines of Western Durham.
(E) Miss C. P. Snodgrass: Some Aspects of the Agricultural Geography of the Lothians and Berwickshire.
(H) Dr. M. Vassitz: Excavations on the Neolithic Site at Vinča.
At 12 noon.—(C) Miss E. M. Lind Hendriks: The Stratigraphy of South Cornwall.

SEPTEMBER 4 TO 7.

GERMAN PHARMACOLOGICAL SOCIETY (at Königsberg).—Discussion on Problems of the General Reaction of the Organism from the Pharmacological Standpoint, with papers on Problems of Inflammation, Problems of Febrile Diseases, Allergy, and Problems of Reticulo-endothelium and its Functions.

SEPTEMBER 4 TO 14.

INTERNATIONAL ZOOLOGICAL CONGRESS (at Padua).

SEPTEMBER 7 TO 13.

INTERNATIONAL CONGRESS OF AMERICANISTS (at Hamburg).—Papers on The Aboriginal Peoples of America and their Ethnic Relations, The Prehistory of America, Manners and Customs of the Various Groups of Indians and their Distribution in the Old and New World, The Aboriginal Languages, The Discovery and Colonisation of America, The Geography and Geology of America, with Special Reference to Human Activities, and a Discussion on The Civilisation of the Indians at the time of their first contact with Europeans and to-day.